2025 Spray Bulletin

for Commercial Tree Fruit Growers

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Virginia Cooperative Extension
Virginia Tech • Virginia State University

West Virginia University

University of Maryland Extension

Pesticide Incompatibilities

Mixing of the following products can cause incompatibility problems (physical/chemical) which can be UNSAFE TO HUMANS, DAMAGE CROPS OR REDUCE PESTICIDE EFFICACY

Product	Not compatible with	Not always compatible with
Afidopyropen (Versys)		Copper
Azadirachtin (Aza-Direct, Neemix)	Bordeaux mixture	Captan or Chlorothalonil (Bravo)
Bifenazate (Acramite, Banter)	Bordeaux mixture or copper	
BT	Bordeaux mixture	Chlorothalonil (Bravo)
Bordeaux Mixture	Azadirachtin (Aza-Direct, Neemix), bifenazate (Acramite, Banter), BT, captan, carbaryl (Sevin), or diazinon	Clofentezine, or hexythiazox (Apollo, Onager, Savey)
Buprofezin (Centaur)	Diazinon or dodine (Syllit)	
Captan	Bordeaux Mixture, fenbutatin (Vendex), ferbam, or lime,	Afidopyropen (Versys), Copper, or sulfur
Carbaryl (Sevin)	Bordeaux Mixture or diazinon	Ferbam
Chlorothalonil (Bravo)	Oil or sulfur	Azadirachtin (Aza-Direct, Neemix), BT, copper, or emamectin benzoate (Proclaim)
Clofentezine, hexythiazox (Apollo, Onager, Savey)		Bordeaux Mixture, copper, dichloran (Botran), dodine (Syllit), or ferbam
CM virus (Carpovirusine, Cyd-X, Madex)	Lime or oil	Dodine (Syllit)
Copper	Bifenazate (Acramite, Banter), or propargite (Omite)	Afidopyropen (Versys), captan, chlorothalonil (Bravo), clofentezine, hexythiazox (Apollo, Onager, Savey), ferbam, or iprodione (Rovral)
Cyantraniliprole (Exirel)	Lime	Diazinon, dodine (Syllit), iprodione (Rovral), oil, or spinosyn (Entrust, Delegate)
Cyclaniliprole (Verdepryn)		Fenbutatin (Vendex), ferbam, mancozeb, or Ziram
Cyflumetofen (Nealta)		Neonicotinoids (Actara, Admire Pro, Alias, Assail, Belay), or phosmet (Imidan)
Cyprodinil (Vanguard), pyrimethanil (Scala)		Lime
Diazinon	Bordeaux Mixture, buprofezin (Centaur), or carbaryl (Sevin)	Cyantraniliprole (Exirel), pyrethroids (see p. 49, group 3)

Product	Not compatible with	Not always compatible with
Dichloran (Botran)		Clofentezine or hexythiazox (Apollo, Onager, Savey)
Dinotefuran (Scorpion, Venom)	Pyriproxyfen (Esteem)	Lime, pyrethroids (see p. 49, group 3), or sulfur
Dodine (Syllit)	Buprofezin (Centaur)	Clofentezine, hexythiazox (Apollo, Onager, Savey), CM virus (Carpovirusine, Cyd-X, Madex), or cyantraniliprole (Exirel)
Emamectin benzoate (Proclaim)		Chlorothalonil (Bravo)
Etoxazole (Zeal)	Lime	Methomyl (Lannate), or propiconazole (Orbit, Tilt, PropiMax)
Fenazaquin (Magister)	Lime	Methomyl (Lannate) or oil
Fenbutatin (Vendex)	Captan	Cyclaniliprole (Verdepryn)
Fenpyroximate (Portal)		Lime
Ferbam	Captan	Carbaryl (Sevin), clofentezine, hexythiazox (Apollo, Onager, Savey), copper, cyclaniliprole (Verdepryn), or oxamyl (Vydate)
Flonicamid (Beleaf)		Lime, spinosyn (Entrust, Delegate), or sulfur
Fluazinam (Omega)		Methomyl (Lannate)
Imidacloprid + beta-cyfluthrin (Leverage)	Lime	Mancozeb, Ziram, neonicotinoids (Actara, Admire Pro, Alias, Assail, Belay), or sulfur
Iprodione (Rovral)		Copper or cyantraniliprole (Exirel)
kaolin (Surround)		Oxamyl (Vydate), or spinosyn (Entrust, Delegate)
Lambda-cyhalothrin (Warrior, Lambda-Cy, Silencer)	Oil	
Lime	Captan, CM virus (Carpovirusine, Cyd-X, Madex), cyantraniliprole (Exirel), etoxazole (Zeal), fenazaquin (Magister), or imidacloprid + beta-cyfluthrin (Leverage)	Cyprodinil (Vanguard), pyrimethanil (Scala), dinotefuran (Scorpion, Venom), fenpyroximate (Portal), or flonicamid (Beleaf)

Product	Not compatible with	Not always compatible with
Mancozeb, Ziram		Cyclaniliprole (Verdepryn), imidacloprid + beta-cyfluthrin (Leverage)
Methidathion (Supracide)		Phosmet (Imidan)
Methomyl (Lannate)		Etoxazole (Zeal), fenazaquin (Magister), fluazinam (Omega), oil, or sulfur
Neonicotinoids (Actara, Admire Pro, Alias, Assail, Belay)		cyflumetofen (Nealta), imidacloprid + beta-cyfluthrin (Leverage), or oil
Novaluron (Rimon)		Oil
Oil	Chlorothalonil (Bravo), CM virus (Carpovirusine, Cyd-X, Madex), lambda-cyhalothrin (Warrior, Lambda-Cy, Silencer), propargite (Omite), or sulfur	Cyantraniliprole (Exirel), fenazaquin (Magister), methomyl (Lannate), neonicotinoids (Actara, Admire Pro, Alias, Assail, Belay), novaluron (Rimon), or spinosyn (Entrust, Delegate)
Oxamyl (Vydate)		Ferbam or kaolin (Surround)
Phosmet (Imidan)		Cyflumetofen (Nealta), or methidathion (Supracide)
Propargite (Omite)	Copper or oil	
Propiconazole (Orbit, Tilt, PropiMax)		Etoxazole (Zeal)
Pyrethroids (see p. 49, group 3)		Diazinon, dinotefuran (Scorpion, Venom), or sulfur
Pyriproxyfen (Esteem)	Dinotefuran (Scorpion, Venom)	
Spinosyn (Entrust, Delegate)		Cyantraniliprole (Exirel), diazinon, flonicamid (Beleaf), kaolin (Surround), or oil
Spirotetramat (Movento)		Sulfur
Sulfur	Chlorothalonil (Bravo) or oil	Captan, Dinotefuran (Scorpion, Venom), flonicamid (Beleaf), Imidacloprid + beta-cyfluthrin (Leverage), Methomyl (Lannate), pyrethroids (see p. 49, group 3), or Spirotetramat (Movento)

Poison Control Centers and Emergency Facilities (Partial List)

Please take time now to fill in the blanks at the bottom of the page. This effort could save your life.

To contact your local Poison Control Center call 1-800-222-1222 (https://aapcc.org/centers).

The procedure to be followed **IN CASE OF SUSPECTED POISONING:**

(1) To avoid exposure to you and to emergency medical personnel, make sure the container is closed and preferably sealed in a plastic bag. Alert all those involved with the emergency that the patient has been exposed to pesticides and to protect themselves from exposure when handling the patient or container.

(2) Call a physician immediately. If the family physician is not available, the patient should be taken to the nearest physician or hospital emergency room together with the CONTAINER OF THE POISONING AGENT. If you are the patient, do not drive yourself unless there are extenuating circumstances.

(3) If necessary the PHYSICIAN will call the nearest poison control center for further information as to the toxicity of the suspected agent, treatment, and prognosis.

District of Columbia

National Capital Poison Center
3201 New Mexico Ave. N.W., Suite 310
Washington, D.C. 20016
1-800-222-1222
(202) 362-3867

Maryland

Maryland Poison Center
University of Maryland,
Baltimore Campus
School of Pharmacy
220 Arch Street,
Office Level 1
Baltimore, MD 21201
1-800-222-1222
(410) 706-7604

West Virginia

West Virginia Poison Center
Robert C. Byrd Health Sciences Center
Charleston Division
3110 MacCorkle Ave., SE
Charleston, WV 25304
1-800-222-1222
(304) 347-1212

Spills (Accidents and related emergencies)

CHEMTREC 1-800-424-9300
Chemical Transportation
Emergency Center
Industry assistance with clean up procedures, etc.

National Response Center 1-800-424-8802
Reporting spills to comply with EPA regulations
and the Clean Water Act.

In Virginia, you must report spills that threaten the environment or public health to:

Va. Dept. Agric. & Cons. Serv. Office of Pesticide Services 804-371-6560

Virginia

Blue Ridge Poison Center
UVA Health
1222 Jefferson Park Ave.
P. O. Box 800774
Charlottesville, VA 22903
1-800-222-1222
(434) 924-5185

Virginia Poison Center
VCU Health
830 E. Main St., Suite 300
Richmond, VA 23298-0522
1-800-222-1222
(804) 828-4780

North Carolina

Carolinas Poison Center
Atrium Health
4400 Golf Acres Dr., Suite B-2
P.O. Box 32861
Charlotte, NC 28208

For Assistance with Spills and Emergencies

Take time to jot down your local emergency numbers in the space provided.

Your State Police _____

Fire Department _____

Ambulance _____

Your Emergency Operations Center _____

Your Emergency Room Address _____

and Phone number _____

All poison Centers are AAPCC Certified (Certification by the American Association of Poison Control Centers requires that poison centers be staffed by registered nurses, be open 24 hours a day, and serve a large enough area of population).

Table 1. Pesticide Toxicity for Oral (Swallowed) and Dermal (Skin) Contact[1]

Common name	Trade name	Chemical Toxicity[1] Oral	Dermal
abamectin[2]	Abba, Agri-Mek, Temprano	M	S
abamectin[2] + thiamethoxam[2]	Agri-Flex	M	S
abamectin[2] + cyantraniliprole	Minecto Pro	M	S
acequinocyl	Kanemite	L	S
acetamiprid	Assail	S	S
afidopyropen	Versys	S	L
aluminum phosphide[2]	Phostoxin	H	H
aminovinylglycine (AVG)	Retain	L	L
ammonium soap	Hinder, Repel	L	L
azadirachtin	Aza-Direct	L	S
azoxystrobin	Abound	L	S
Bacillus thuringiensis	various	L	L
6-benzyladenine (6-BA)	Exilis Plus, MaxCel, RiteWay	S,L,L	S,L,L
6-benzyladenine (6-BA) + gibberellins (GA_4GA_7)	Perlan, Promolin	L,L	L,S
benzovindiflupyr	Aprovia	S	S
beta-cyfluthrin[2]	Baythroid XL	S	S
bifenazate	Acramite, Banter	L	L
bifenthrin[2]	Bifenture	M	S
buprofezin	Centaur	L	S
captan		L	L
carbaryl	Sevin	S	S
chlorantraniliprole	Altacor eVo	L	L
chlorophacinone[2]	Rozol, Parapel,	H	H
chlorothalonil	Bravo	L	L
clofentezine	Apollo	L	L
clothianidin	Belay	S	L
CM granulovirus	Cyd-X, Carpovirusine	L	L
copper sulfate (basic)	Cuprofix	S	S
cyantraniliprole	Exirel	L	L
cyclaniliprole	Verdepryn	L	L
cyclufenamid	Torino	S	S
cyflumetofen	Nealta	S	L
copper sulfate pentahydrate	Bordeaux	M	H
cyfluthrin[2]	Tombstone	S	S
cyprodinil	Vangard	L	S
diazinon		M	S
dichloran	Botran	L	L
difenoconazole[2] + cyprodinil	Inspire Super	L	L
diflubenzuron[2]	Dimilin	L	S
dinotefuran	Scorpion, Venom	L	L
diphacinone	Diphacin, Ramik	H	H
diuron	Karmex	S	S
dodine	Syllit	S	S
emamectin benzoate[2]	Proclaim	S	S
esfenvalerate[2]	Adjourn, Asana	M	M
ethephon	Ethephon 2, Ethephon 2SL, Ethrel	S,L,L	S,S,S
etoxazole	Zeal	S	L
fenarimol	Rubigan	S	S
fenazaquin	Magister	M	L
fenbuconazole	Indar	S	S
fenbutatin oxide[2]	Vendex	S	S
fenhexamide	Elevate	S	S
fenpropathrin[2]	Danitol	M	S
fenpyroximate	Portal	S	S
flonicamid	Beleaf	S	S
fluazifop-P	Fusilade DX	S	S
fluazinam	Omega	L	S
fludioxonil	Scholar	L	S
fluopyram + pyrimethanil	Luna Tranquility	S	S
fluopyram + trifloxystrobin	Luna Sensation	S	S
flupyradifurone	Sivanto	S	S
flutriafol	Topguard, Rhyme	S	L
fluxapyroxad	Sercadis	S	L
fluxapyroxad + pyraclostrobin	Merivon	M	L
fosetyl-al	Aliette	S	S
gamma-cyhalothrin[2]	Declare, Proaxis	S	L
gibberellins (GA_4GA_7)	ProVide 10SG	S	S
glufosinate	Rely	S	S
glyphosate	Roundup, various	L	L
hexythiazox	Onager, Savey	L	L
imidacloprid	Admire Pro, Alias	S	S
imidacloprid + beta-cyfluthrin[2]	Leverage 360	S	S
indoxacarb	Avaunt eVo	S	L
inpyrfluxam	Excalia	S	L
iprodione	Rovral	S	S
kaolin	Surround	L	L
kasugamycin	Kasumin	L	L
kresoxim-methyl	Sovran	L	S
lambda-cyhalothrin[2]	Lambda-Cy, Warrior, Silencer	M	S
lambda-cyhalothrin[2] + chlorantraniliprole	Besiege	M	S
lambda-cyhalothrin[2] + thiamethoxam	Endigo	M	S
lime sulfur	various	S	S
mancozeb	various	L	L
mefenoxam	Ridomil Gold	S	S
metalaxyl	Ridomil	S	S
mefentrifluconazole	Ceyva	S	L
methomyl[2]	Lannate	H	M
methoxyfenozide	Intrepid	L	L
metiram	Polyram	L	L
metrafenone	Vivando	L	L
myclobutanil	Rally	M	L
1-naphthalene acetic acid (NAA)	Fruitone-L, Fruitone-N, PoMaxa	L,L,L	S,S,L
1-naphthlacetamide (NAD,NAAm)	Amid-Thin W	L	L
napropamide	Devrinol	S	S
norflurazon	Solicam	L	L
novaluron	Rimon	L	L
oryzalin	Surflan	L	S
oxamyl[2]	Vydate	H	S
oxyfluorfen	Goal	L	L
oxytetracycline	Mycoshield, FireLine	L	S
paraquat[2]	Gramoxone Extra	M	M
penthiopyrad	Fontelis	L	L
permethrin[2]	Ambush, Perm-UP, Pounce	S	S
phosmet	Imidan	M	L
potassium phosphite	ProPhyt	L	S
prohexadione-Ca	Apogee	L	S
pronamide[2]	Kerb	L	S
propiconazole	Orbit, PropiMax, Tilt	S	S
pyraclostrobin	Cabrio, Pristine	S	S
pyridaben	Nexter	S	S
pyrimethanil	Scala	L	L
pyriproxyfen	Esteem	S	S
sethoxydim	Poast	S	L
simazine	Princep	L	L
spinetoram	Delegate	L	L
spinosad	Entrust	L	L
spirodiclofen	Envidor	S	S
spirotetramat	Movento	S	S
streptomycin	Agristrep, Firewall	L	L
stylet oil	JMS Stylet-Oil	L	L
sulfosate	Touchdown	S	S

Footnotes at end of table, p. III.

Common name	Trade name	Chemical Toxicity[1] Oral	Dermal
sulfoxaflor	Closer	L	L
sulfur	various	S	S
tebuconazole	Elite	S	S
terbacil	Sinbar	L	L
thiabendazole	Mertect	S	L
thiamethoxam	Actara	L	S
thiamethoxam + chlorantraniliprole	Voliam Flexi	L	S
trifloxystrobin	Flint, Gem	L	S
triflumizole	Procure	S	S
thiophanate-methyl	Topsin, Topsin-M	L	L
thiram		M	M
tolfenpyrad	Apta	S	L
2,4-D	-	S	S
zeta-cypermethrin[2]	Mustang Maxx	S	L
zeta-cypermethrin[2] + avermectrin	Gladiator	S	L
zinc phosphide[2]	ZP Bait, Phosvin	H	H
ziram		S	S

[1] L = Low; S = Slight; M = Moderate; H = High; - = information lacking. Lethal Dose (LD50) Scale for Toxicity: High = 1-50 mg/kg (Danger); Moderate = 51-500 (Warning); Slight = 501-5000 (Caution); Low = More than 5000 (Caution).

[2] Restricted use insecticide - Pesticides restricted for use by certified applicators or those working under their direct supervision.

Table of Contents

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Virginia - West Virginia - Maryland Commercial Tree Fruit Spray Bulletin

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INTEGRATED PEST MANAGEMENT

Integrated pest management (IPM) is the approach emphasized in this guide; some aspects of IPM are incorporated throughout, although this guide mainly deals with the chemical component of IPM. IPM combines biological control from predators with selective chemical application for maintaining pest populations below economic threshold levels. This approach requires that growers give careful consideration to the selection, application rate and timing of chemical sprays. The degree of integration achieved will vary according to the management ability, training and objectives of the orchardist. Inadequate monitoring or implementation of IPM practices will lead to unsatisfactory results. In order to encourage the biological control components of the program, growers must consider the **toxicity of chemicals to predators** (Table 9, page 59) in addition to their **efficacy against fruit pests** (Tables 7 and 8, pages 56-58).

To be successful, IPM requires *careful management, systematic orchard scouting and well-calibrated spray equipment.* Some growers have been following the IPM approach, and have experienced benefits through reduced pesticide application, improved fruit quality and an increased awareness of the orchard situation. Insecticide application has been reduced as a result of the elimination of some cover sprays for codling moth control because of low population levels. Biological control of mites has also resulted in fewer miticide applications. Improved fruit quality has occurred as a result of better timing of insecticide applications for the control of fruit feeding insects.

Spray timing can be improved for codling moth, tufted apple bud moth and oriental fruit moth through the use of **degree-days**. Degree-days (DD) are approximated by the mean temperature of a given day, minus the developmental threshold (the minimum temperature at which a species can develop). Tables 29 and 30 on pages 175-176 facilitate accumulation of DD for these pests. Knowing the maximum and minimum temperatures, growers can use these tables to accumulate the DD starting at the onset of flight of each moth species in the spring, called the **Biofix**. Determining when biofix occurs each year requires deploying at least three, spatially separated pheromone traps for the target species in an orchard block before flight of that species begins. The onset of flight for each species varies to some extent among years, based on annual variations in spring temperatures. Based on data from Winchester, Va, traps for setting biofix for oriental fruit moth, codling moth, and tufted apple budmoth should be deployed during the first week of April, the last week of April, and the first week of May, respectively. In more southern regions of Virginia, traps should be deployed at least one week earlier. Biofix dates for these three species recorded at Winchester since 2000 are posted at http://blogs.ext.vt.edu/tree-fruit-pest/category/historical-biofix-dates-winchester/. As well, annual biofix dates and DD accumulations from biofix for these species are posted at http://blogs.ext.vt.edu/tree-fruit-pest/category/degree-day-updates/. Once traps have been deployed, moth captures should be recorded daily. Captures of new moths in at least two traps on at least 2-3 consecutive days indicates that sustained flight has begun. The first day on which sustained captures were recorded is considered the biofix date. It is, however, common for the flight of some species (particularly oriental fruit moth) to stop and start during the early portion of their emergence period, due to fluctuating spring weather. Initial periods of flight that are separated by several days of no captures should be disregarded, and the biofix date should be based on when truly sustained flight has occurred.

Codling moth. Control is necessary in orchards if captures in pheromone traps exceed the threshold of 5 moths/trap/week. Protracted first generation flight in recent years may require management through third cover (about mid-June), depending on captures. Recent information from North Carolina State University indicates that the Michigan State codling moth DD model continues to perform well for timing sprays against first generation larvae, but that DD recommendations for sprays against second and third generations were earlier than indicated by the flights of these later generations in our region. Consequently, revised DD timings for timing sprays against the second and third codling moth generations have been incorporated here. Spray timing for optimal codling moth control, based on DD accumulations from biofix (base 50oF, Table 29), differ according to the different modes of action of the different products available. ***First brood:*** Rimon at 50-150 DD, then after about 2 weeks, at 400 DD. Assail, Belay, Esteem, or Intrepid at 150 DD, then after about 2 weeks if needed, at 450 DD. Organophosphates, carbamates, Altacor eVo, Avaunt eVo, CM virus, Delegate, Exirel, Minecto Pro, Verdepryn, or Voliam Flexi at 250 DD, then at 550 DD if needed (with the exception of Minecto Pro). ***Second brood:*** Rimon at 1250-1320, then after about 2 weeks if needed, at 1650 DD. Assail, Belay, CM virus, Esteem, or Intrepid 1350 DD, then at 1650-1700 DD, if needed. Organophosphates, carbamates, Altacor eVo, Avaunt eVo, CM virus, Delegate, Exirel, Verdepryn, or Voliam Flexi at 1450 DD, then at 1750-1800 DD, if needed. ***Third brood:*** Control should be initiated if captures in pheromone traps exceed threshold (see above).

Tufted apple budmoth. Intrepid, Proclaim, Altacor eVo, Delegate, Exirel, Verdepryn, Voliam Flexi, or Besiege will provide the best control in most situations. For first brood control, these products should be applied as a complete spray at 585-640 DD from biofix (base 45ºF, Table 28), or as two alternate-row-middle applications 7 days apart beginning at 530 DD. An additional application may be needed (in 14 days for complete, in 7 and 14 days for alternate-row-middle) in high pressure situations. For all other materials, control first brood with two complete applications at 530-585 DD and 805-855 DD. Alternate-row-middle applications should commence 50-75 DD earlier and be repeated every 7 days for a total of up to four applications, depending upon insect pressure. For second brood control, apply Intrepid, Proclaim, Altacor eVo, Delegate, Exirel, Verdepryn, Voliam Flexi, or Besiege as two complete sprays at 2355-2435 DD and 2665-2740 DD, or as four alternate-

row-middle applications, 7 days apart, beginning at 2280 DD after spring brood biofix. For all other materials, control second brood with two complete applications at 2280-2355 DD and 2665-2740 DD, or four alternate-row-middle applications at 7-day intervals, beginning 50-75 DD earlier.

Oriental fruit moth. Recommended trap thresholds for the **first flight** of oriental fruit moth differ for apple and peach. In peach, control of first brood is recommended if more than 15 moths/trap/week are captured. In apple, control is warranted if trap capture exceeds 30 moths/trap/week. **After the first flight**, thresholds for apple and peach are the same, at greater than 10 moths/trap/week. Optimal spray timings for oriental fruit moth control in apple and peach differ through the season and are based on accumulated DD from separate biofix dates established for each crop at the beginning of each season (See Table 30). Timings are as follows, and are based on recommendations from The Penn State University, Fruit Research and Extension Center, Biglerville, PA.

Peach – First brood: Intrepid or Assail at 70-100 DD, then at 250-275 DD, if needed. Organophosphates, carbamates, pyrethroids, Altacor eVo, Besiege, Delegate, Exirel, Madex HP, Verdepryn, Virusoft, Voliam Flexi at 170-195 DD, then at 350-375 DD, if needed.

Peach – Second brood: Intrepid or Assail at 1050-1100 DD, then at 1350-1400 DD, if needed. Organophosphates, carbamates, pyrethroids, Altacor eVo, Besiege, Delegate, Exirel, Madex HP, Virusoft, Voliam Flexi at 1150-1200 DD, then at 1450-1500, if needed.

Peach – Third brood: Intrepid or Assail at 2000-2100 DD, then at 2350-2400 DD, if needed. Organophosphates, carbamates, pyrethroids, Altacor eVo, Besiege, Delegate, Exirel, Madex HP, Virusoft, Voliam Flexi at 2100-2200 DD, then at 2450-2500 DD, if needed.

Apple – First brood: Rimon at 200-250 DD. Assail, Belay, or Intrepid at 250-275 DD. Organophosphates, carbamates, pyrethroids, Altacor eVo, Avaunt eVo, Delegate, Exirel, Madex HP, Verdepryn, Virusoft, or Voliam Flexi at 350-375 DD.

Apple – Second brood: Rimon at 1300-1350 DD. Assail, Belay, or Intrepid at 1350-1400 DD. Organophosphates, carbamates, pyrethroids, Altacor eVo, Avaunt eVo, Delegate, Exirel, Madex HP, Verdepryn, Virusoft, or Voliam Flexi at 1450-1500 DD. These timings target the middle of egg hatch of second brood.

Apple – Third brood: Rimon at 2300-2350 DD. Assail, Belay, or Intrepid at 2350-2400 DD, then at 2800-2900 DD, if needed. Organophosphates, carbamates, Altacor eVo, Avaunt eVo, Delegate, Exirel, Madex HP, Verdepryn, Virusoft, or Voliam Flexi at 2450-2500 DD, then at 2900-3000 DD, if needed. Control of the fourth and fifth broods should be maintained in orchards where the pheromone trap-capture threshold is exceeded.

San Jose Scale. If scale control is needed, target crawler sprays against first-appearing crawlers, at 350 DD after first male catch in pheromone traps.

Integrated disease management practices include timing of applications of management products based pathogen development and activity, as well as fungicide resistance management practices. Apple scab fungicides with after-infection control can be applied based on Mills Table (see Table 11, p. 96), Fire blight management can be based on protection ahead of infection, using a predictive program such as MARYBLYT : http://grapepathology.org/maryblyt Predictive programs for apple scab, fire blight, sooty blotch / flyspeck are available on the NEWA web site: http://newa.cornell.edu/.

PESTICIDE SAFETY AND APPLICATION

INTRODUCTION

The orchard owner or manager is directly and legally responsible for the effective and safe use of pesticides. Pesticides, as a whole, are relatively safe when used as directed by the label, but they can become a potential liability in the hands of a careless operator or an inexperienced person. Pesticides vary in their toxicity to humans and other animals, and all should be used with care. Ask your Extension agent to help you become a certified applicator. PROCEED CAUTIOUSLY AND LIMIT THE ACREAGE TREATED UNTIL YOU HAVE GAINED FIRST-HAND EXPERIENCE IN THE USE OF PESTICIDES.

PESTICIDE APPLICATOR CERTIFICATION AND TRAINING

Applicators of restricted use pesticides must be trained and certified in their state of residency to purchase or use these chemicals. Fruit growers using restricted use pesticides are required to be certified private pesticide applicators. Certified applicators in Virginia are required to be recertified every two years. In West Virginia and Maryland, recertification is required every three years. If you have any questions about certification or training, please contact your Extension agent or State Department of Agriculture.

CHANGES IN FEDERAL REGULATIONS

Ongoing changes in federal pesticide laws will continue to affect the ways in which you apply, store, and dispose of pesticides. These include the Food Quality Protection Act (FQPA), the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), the Worker Protection Standard (WPS), record-keeping rules, and laws affecting storage, disposal, non-target species, and water quality.

Handling and Storage of Pesticides

READ THE LABEL

Before using pesticides, always read all directions and follow them exactly. Pesticide labels may change during the growing season; thus, read the label on each new container purchased and before each use. Note warnings and precautions before opening the container. Repeat the process every time, no matter how often you use a pesticide. Apply pesticides only on crops specified, in amounts required, and at times indicated on the latest manufacturer's label.

STORE PESTICIDES WISELY

Keep pesticides out of the reach of children, pets, irresponsible persons, and livestock. All pesticides should be stored in a specifically designated area that can be securely locked. The designated building or area should be clearly marked on the outside to indicate that dangerous chemicals are stored within. The local fire department and your local emergency response council (see section on "Community Right to Know") should be notified of the location of the storage area and the nature of the stored materials. Proper records should be maintained at all times to aid in identification in emergencies as well as on a routine basis. Good ventilation, lighting, and neatness are most helpful in preventing accidents. Liquids must not freeze if stored over winter. All pesticides should be protected from extreme temperatures to maintain their shelf life. Always store pesticides in their original containers and keep them tightly closed. Never store pesticides in unmarked containers or in containers previously used to store food or drink.

AVOID PHYSICAL CONTACT WITH PESTICIDES

Never smoke, eat, chew tobacco, or use snuff while handling or applying pesticides. Protect your eyes from pesticides at all times. Avoid inhaling sprays or dusts. When directed on the label, wear protective clothing and a proper respirator. If you spill pesticides on your skin or clothing, remove contaminated clothing immediately and wash thoroughly with soap and water. If clothing becomes wet during spraying operations, take a shower immediately, using soap, and put on clean clothes. Wash hands and face and change to clean clothing after applying pesticides. Also wash clothing each day before re-use and separately from the family laundry. Do not spray with leaking hoses or connections. Do not use the mouth to siphon liquids from containers or blow out clogged lines, nozzles, etc. Do not breathe pesticide dusts, powders, or spray mists; they are extremely hazardous and are apt to damage mucous membranes.

Always wear clean unlined waterproof gloves which cover the hands, wrists and forearms when handling pesticides. Choose gloves made of chemical-resistant barrier laminate, butyl, viton, neoprene, nitrile, or PVC as listed on the pesticide label. Avoid gloves made of latex or natural rubber. Avoid gloves with seams. If you have no choice, make sure they are well sealed by their coating. Gloves are easily contaminated on the inside. Those which become contaminated are dangerous and should be discarded so they can't be reused.

PESTICIDE POISONING

There are two types of pesticide poisoning. Acute poisoning is the most easily recognized since symptoms are produced as the result of a single exposure to a pesticide.

Chronic poisoning is caused by repeated exposures to certain pesticides which may not cause symptoms after an initial exposure, but after repeated exposures of even small amounts of these chemicals, symptoms will occur. You can safeguard yourself against chronic poisoning by using protective clothing and equipment, and by knowing which pesticides can cause this problem and how to monitor it. The organophosphate and carbamate insecticides inhibit an enzyme called cholinesterase. By having your blood cholinesterase levels monitored year round, one can somewhat safeguard themselves against chronic poisoning by these pesticides. Consult a physician for information on having blood cholinesterase levels monitored if you or your employees use any of the commonly used insecticides listed in this guide. Consult the label statement: "Notes to Physician" for the words "cholinesterase inhibitor" or similar warnings to determine if a particular chemical you are using can cause chronic poisoning. Avoiding exposure through proper handling and use of protective clothing is even more important when tling such pesticides.

Symptoms of pesticide poisoning include headache, blurred vision, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Do not take chances. SEE YOUR DOCTOR IMMEDIATELY IF SYMPTOMS OF ILLNESS OCCUR DURING OR AFTER THE USE OF PESTICIDES. A list of Poison Control Centers located in our region is included at the front of this guide.

Protective Clothing and Equipment

Dermal exposure accounts for 97 percent of the pesticide the body is exposed to during the application of liquid spray. Thus, the primary purpose of wearing protective clothing is to prevent pesticides from coming into contact with the skin. Any body covering will provide some protection because dermal absorption is reduced to some degree by a fabric barrier. Protective clothing may be classified according to the part of the body it protects; i.e., feet (boots and shoes), hands (gloves), eyes (goggles and face shields), head (hats and hoods), and trunk (jackets, shirts, pants, coveralls, overalls, and raincoats).

Because of its comfort, conventional work clothing is worn most often, although it provides minimal protection during the application of liquid spray. Shirts, pants, and jackets of cotton or denim are not recommended by the National Safety Council or EPA researchers because they provide little protection from the accidental spilling of concentrated pesticides.

Plastic or rubber protective garments are recommended for use when handling pesticide concentrates and for working in liquid spray operations, particularly when the spray is heavy. However, wearing rubber garments that encase a large part of the body at temperatures above 80 degrees fahrenheit may result in heat exhaustion or heatstroke.

Lightweight synthetic garments may provide adequate protection from dry pesticides and may be used for spray application when laminated with a plastic coating.

The minimum protective clothing and equipment recommended for use by growers using any pesticide includes: long-sleeved shirt, long pants, socks and shoes. Growers should also consider wearing a hooded chemical resistant coverall, chemical splash-proof goggles, a properly fitted respirator, and chemical-resistant unlined gloves and boots. These should be based on proper label directions for PPE (personal protective equipment.)

If at all possible, never apply chemicals against the wind; the spray may be blown onto the sprayer operator. Maintain a buffer of vegetation between your orchard and adjoining property to prevent drift from reaching neighboring homes, gardens, crops, animals, and people. Many pesticides discharge some fumes at room temperature. Lengthy or repeated exposure to even minute quantities of these fumes is harmful to animals and people. Do not spray or store any pesticides inside buildings inhabited by domesticated animals, or humans, except where labeled.

Protective Clothing and Equipment Guide

Use this table as a guide to the selection of protective clothing and equipment. Cross-reference the signal word from the product label and the type of formulation to determine the minimum protection you should wear. This guide is not to be used in place of label statements; refer to the label for specific information.

Label Signal Word			
Formulation	**Caution**	**Warning**	**Danger**
Dry	Long-legged trousers and long-sleeved shirt; shoes and socks; chemical-resistant gloves.	Long-legged trousers and long-sleeved shirt; shoes and socks; wide-brimmed hat; chemical-resistant gloves.	Long-legged trousers and long-sleeved shirt; shoes and socks; chemical-resistant gloves. Cartridge or canister respirator if dusts in air or if label precautionary statement says: “Poisonous or fatal if inhaled.”
Liquid	Long-legged trousers and long-sleeved shirt; shoes and socks; wide-brimmed hat; chemical-resistant gloves.	Long-legged trousers and long-sleeved shirt; shoes and socks; wide-brimmed hat; chemical- resistant gloves; goggles if required by label. Cartridge or canister respirator if label says: “Do not breathe vapors or spray mists,” or “Poisonous or fatal if inhaled."	Long-legged trousers and long-sleeved shirt; chemical-resistant rubber boots; wide-brimmed hat; chemical- resistant gloves; goggles or face shield. Canister or cartridge respirator if label precautionary statement says: “Do not breathe vapors or spray mists,” or “Poisonous or fatal if inhaled.”
Liquid (when mixing)	Long-legged trousers and long-sleeved shirt; shoes and socks; wide-brimmed hat; goggles or face shield; chemical-resistant gloves.	Long-legged trousers and long-sleeved shirt; shoes and socks; wide-brimmed hat; goggles or face shield; chemical-resistant gloves; chemical-resistant rubber apron. Cartridge or canister respirator if label says: “Do not breathe vapors or spray mists,” or “Poisonous (or fatal or harmful) if inhaled.”	Long-legged trousers and long-sleeved shirt; chemical-resistant rubber boots; wide-brimmed hat; chemical-resistant gloves; goggles or face shield; chemical-resistant rubber apron; and cartridge or canister respirator.

Label Signal Word			
Formulation	**Caution**	**Warning**	**Danger**
Liquid (prolonged exposure to spray, or application in enclosed area)	Long-legged trousers and long-sleeved shirt; chemical-resistant rubber boots; chemical-resistant gloves; waterproof hood or wide-brimmed hat; goggles; cartridge or canister respirator if required by label.	Long-legged trousers and long-sleeved shirt; chemical-resistant rubber boots; chemical-resistant gloves; waterproof hood or wide-brimmed hat; face shield or goggles; and canister respirator.	Long-legged trousers and long-sleeved shirt; chemical-resistant suit; chemical-resistant gloves; waterproof hood or wide-brimmed hat; goggles or face shield; and canister respirator.

Chemical Resistance of PPE Materials

Many pesticide labels instruct the user to wear personal protective equipment (PPE) — clothing and devices that protect the body from contact with pesticides or pesticide residues. Some labels require the use of **chemical-resistant** PPE — items that the pesticide cannot pass through during the time it takes to complete the task. The labels of a few pesticides, such as some fumigants prohibit the use of chemical-resistant PPE.

Most chemical-resistant PPE items are plastic or rubber. But not all these materials are equally resistant to all pesticides and under all conditions.

Three factors affect a material's chemical resistance: the exposure time, the exposure situation, and the chemical properties of the pesticide product to which the material is exposed.

Choosing Chemical-Resistant PPE

Unless the pesticide label directs otherwise, do not use items that are made of — or lined with — absorbent materials such as cotton, leather, and canvas. These materials are not chemical resistant, and they are difficult or impossible to clean after a pesticide gets on them. Even dry formulations can move quickly through woven materials and may remain in the fibers after several launderings.

Look for PPE items whose labels state that the materials have been tested using ASTM (American Society for Testing and Materials) test methods for chemical resistance, such as test method F739. Gloves and footwear made of polyvinyl chloride (PVC) or rubber (butyl, nitrile, neoprene, or natural rubber) must be at least 14 mils thick.

Pesticides can leak through stitching holes and gaps in seams. For chemical resistance, PPE should have sealed seams or no seams at all.

Barrier-Laminate materials are resistant to most pesticides and are a good choice for many situations.

Barrier-laminate gloves may be uncomfortable and clumsy to wear for some kinds of tasks. Try wearing fitted rubber gloves over barrier-laminate gloves for comfort, protection, and dexterity.

Any plastic or rubber material is resistant to dry pesticides and to water-based pesticides (those that use water as the only diluent or solvent).

Dry pesticides include dusts, granules, pellets, and some baits. Water-based pesticides include wettable powders, soluble powders, some solutions, dry flowables (water-dispersible granules), and microencapsulated pesticides.

The type of material that is resistant to non-water-based liquid pesticides depends on the contents of the formulation.

Liquid pesticides that are not water-based may be emulsifiable concentrates, ultra-low-volume and low-volume concentrates, low-concentrate solutions, flowables, aerosols, dormant oils, and invert emulsions. Common solvents are xylene, fuel oil, petroleum distillates, and alcohol.

Materials not listed on label

If the pesticide label requires the use of chemical-resistant PPE but does not indicate the types of materials that are resistant to the product, select sturdy barrier-laminate, butyl, or nitrile materials. Then watch for signs that the material is not chemical-resistant. For example, the material may:

- change color,
- become soft or spongy,
- swell or bubble,
- crack or get holes,
- dissolve or become jelly-like,
- become stiff or brittle.

If any of these changes occur, discard the item and choose another type of material.

USING THE CHEMICAL-RESISTANCE CATEGORY SELECTION CHART

When pesticide labels list a chemical-resistance category, you can find that category on an EPA chemical-resistance category selection chart. Such a chart will allow you to determine the entire range of PPE materials from which you can choose. The chart indicates how long you can expect the various types of PPE materials to be resistant to the type of pesticide you are using.

Failure to replace or clean the PPE items within the time intervals specified on the chart would be considered a misuse of the pesticide, because the items would no longer meet the label's requirements for "chemical- resistant" PPE.

When choosing an appropriate material, also consider the dexterity needed for the task and whether the material will withstand the physical demands of the task. The PPE will protect you for the approximate time listed on the chart, if:

- no punctures, tears, or abrasions allow pesticide to penetrate the material, and
- pesticide does not get inside the PPE through careless practices, such as allowing pesticide to run into gloves or footwear or putting the PPE on over already contaminated hands or feet.

EPA Chemical Resistance Category Selection Chart

For use when PPE section on pesticide label lists chemical resistance category

Selection Category Listed on Pesticide Label	TYPE OF PERSONAL PROTECTIVE MATERIAL							
	Barrier Laminate	Butyl Rubber ≥ 14 mils	Nitrile Rubber ≥ 14 mils	Neoprene Rubber ≥ 14 mils	Natural Rubber*	Polyethylene	Polyvinyl Chloride (PVC) ≥ 14 mils	Viton ≥ 14 mils
A *(dry and water based formulations)*	high	high	high	high	high	high	high	high
B	high	high	slight	slight	none	slight	slight	slight
C	high	high	high	high	moderate	moderate	high	high
D	high	high	moderate	moderate	none	none	none	slight
E	high	slight	high	high	slight	none	moderate	high
F	high	high	high	moderate	slight	none	slight	high
G	high	slight	slight	slight	none	none	none	high
H	high	slight	slight	slight	none	none	none	high

* Includes natural rubber blends and laminates

HIGH: Highly chemical-resistant. Clean or replace PPE at end of each day's work period. Rinse off pesticides at rest breaks.
MODERATE: Moderately chemical-resistant. Clean or replace PPE within an hour or two of contact.
SLIGHT: Slightly chemical-resistant. Clean or replace PPE within ten minutes of contact.
NONE: No chemical-resistance. Do not wear this type of material as PPE when contact is possible.

HIGHLY RESISTANT PPE

A rating of **high** means that the material is highly resistant to pesticides in that category. PPE made of this type of material can be expected to protect you for an 8-hour work period. The outside of the PPE, especially gloves, should be washed at rest breaks — about once every 4 hours. Highly resistant PPE is a good choice when handling pesticides, especially concentrates, for long periods of time.

MODERATELY RESISTANT PPE

A rating of **moderate** means that the material is moderately resistant to pesticides in that category. PPE made of this type of material can be expected to protect you for 1 or 2 hours. After that, replace the PPE with clean chemical-resistant PPE or thoroughly wash the outside of the PPE with soap and water. Moderately resistant PPE may be a good choice for pesticide handing tasks that last only a couple of hours.

SLIGHTLY RESISTANT PPE

A rating of **slight** means that the material is only slightly resistant to pesticides in that category. PPE made of this type of material can be expected to protect you for only a few minutes after exposure to the pesticide product. After that, replace

the PPE or thoroughly wash the outside of the PPE with soap and water. Slightly resistant PPE may be a good choice for pesticide handling tasks that last only a few minutes.

Inexpensive disposable gloves or shoe covers, such as those made from polyethylene, may be useful for such brief tasks as:

- adjusting contaminated parts of equipment,
- unclogging or adjusting nozzles,
- opening pesticide containers,
- moving open pesticide containers or containers with pesticides on the outside,
- handling heavily contaminated PPE,
- climbing in and out of cabs or cockpits where the outside of the equipment is contaminated, and
- operating closed systems.

These disposable PPE items should be used only once, for a very short-term task, and then discarded. At the end of the task, it is a good idea to first wash the outside of the gloves or shoe covers, and then remove them by turning them inside out. Discard them so they cannot be reused.

SPECIFIC PPE MATERIALS LISTED DIRECTLY ON LABEL

If the pesticide label specifies the PPE materials that **must** be worn when using the product, follow those instructions.

Some labels may list **examples** of PPE materials that are highly resistant to the product. The label may say, for example: "Wear chemical-resistant gloves, such as barrier laminate, butyl, nitrile, or viton." You may choose PPE items made from any of the listed materials.

Interpreting PPE Statements on Pesticide Labels

Label Statement	Acceptable PPE
Long-sleeved shirt and long pants	Long-sleeved shirt and long pants, or Plastic-or other barrier-coated coverall, or chemical-resistant suit
Coverall worn over long-sleeved shirt and long pants	Coverall worn over long-sleeved shirt and long pants, or Coverall worn over another coverall, or Plastic- or other barrier-coated coverall, or chemical-resistant suit
Chemical-resistant apron worn over coverall or over long-sleeved shirt and long pants	No substitute
Chemical-resistant suit	No substitute
Chemical-resistant gloves	Barrier-laminate gloves, or Other gloves that glove selection charts or guidance indicate are chemical-resistant to the pesticide for the period of time required to perform the task
Chemical-resistance gloves such as butyl or nitrile	Butyl gloves, or Nitrile gloves, or Other gloves that glove selection charts or guidance indicate are chemical-resistant to the pesticide for the period of time required to perform the task
Shoes	Leather, canvas, or fabric shoes or chemical-resistant shoes, or chemical-resistant boots, or chemical-resistant shoe coverings (booties)
Chemical-resistant footwear	Chemical-resistant shoes, or Chemical-resistant boots, or Chemical-resistant shoe coverings (booties)
Chemical resistant boots	No substitute

Label Statement	Acceptable PPE
Chemical-resistant hood or wide-brimmed hat	Chemical-resistant safari-style hat or fire-fighter hat, or chemical-resistant hood, or Full hood or helmet that is part of some respirators

CHEMICAL-RESISTANCE CATEGORY LISTED ON LABEL

Pesticide labels that list examples of PPE materials will often also specify a chemical-resistance category (A through H) for the product. This allows you to consult an EPA chemical-resistance chart (such as the one in this publication) to learn whether you have PPE material options other than those listed in the examples on the label.

(The information about chemical-resistant PPE and the EPA Chemical-Resistant Category Chart was obtained from the EPA/USDA brochure "Choosing Chemical-Resistant PPE", 2012.)

LAUNDERING INFORMATION FOR PESTICIDE-CONTAMINATED CLOTHING - Before laundering, read the pesticide label to determine which chemicals are more toxic. Key words on all pesticide labels identify the toxicity of the product: **DANGER POISON** (highly toxic), **WARNING** (moderately toxic), and **CAUTION** (slightly toxic).

Clothing contaminated with highly toxic and concentrated pesticides must be handled very carefully because pesticides are easily absorbed through skin. **IF THE CLOTHES HAVE BEEN COMPLETELY SATURATED WITH ANY CONCENTRATED PESTICIDE, DISCARD THEM.**

CLEANING/LAUNDERING RECOMMENDATIONS

1. **COTTON OR DENIM FABRIC** - Wash contaminated clothing separately from the family wash. Pesticide residues are transferred from contaminated clothing to other clothing when they are laundered together.

   Pre-rinsing contaminated clothing before washing will help remove pesticide particles from the fabric. Pre-rinsing can be done by:

   1) Pre-soaking in a suitable container prior to washing to dislodge the particles;
   2) Pre-rinsing with agitation in an automatic washing machine; and
   3) Spraying/hosing garments outdoors.

   Clothing worn while using slightly toxic pesticides may be effectively laundered in one machine washing. It is strongly recommended that multiple washings be used on clothing contaminated with pesticides to draw out excess residues. Always wear chemical-resistant rubber gloves when handling contaminated clothing to prevent pesticide absorption into the body.

   Washing in hot water removes more pesticide from the clothing than in other water temperatures. Avoid cold water washing. Although cold water washing might save energy, cold water temperatures are relatively ineffective in removing pesticides from clothing.

   Laundry additives, such as bleach or ammonia, do not contribute to the removal of pesticide residues. Either of these additives may be used, if desired, but caution must be used. Bleach should never be added to or mixed with ammonia, because they react together to form a very toxic chlorine gas. **Be careful! Do not mix ammonia and bleach.**

   Choose heavy-duty liquid detergent. Heavy-duty detergents are particularly effective in removing oily residues (like those from liquid concentrate formulations). In addition, their performance is not affected by water hardness. Increasing the amount of detergent used is recommended. For unfinished fabrics, 1.25 times the amount recommended on the package should be used. If the fabric has been treated with a stain/water repellent finish (like Scotchgard or Zepel), use 1.5 times the amount the package directs.

RESPIRATORY PROTECTION

Respirators

A respirator is a safety device that covers at least the mouth and nose. Respirators protect you from breathing pesticide-contaminated air. Various pesticide formulations require different types of respirators. The product label states whether you must use a respirator and, if so, which type.

There are two main types of respirators:

1. Atmosphere-supplying respirators, which provide clean, uncontaminated air from an air tank or an offsite location.
2. **Air-purifying respirators**, which remove contaminants from the surrounding air using a cartridge, canister, or particulate filter.

Atmosphere-Supplying Respirators

Use atmosphere-supplying (also called air-supplying) respirators when required to do so by the product label. Use these devices:

- when the oxygen supply is low or
- when fumigating in enclosed areas.

Such areas might include greenhouses or other buildings, railcars, ship holds, and grain bins.

When the oxygen supply is low, you must use a self-contained breathing apparatus (SCBA) or an airline respirator with an escape cylinder.

Fumigant gases are extremely toxic to people, and PPE requirements are more stringent than for other types of pesticides. Use great caution and wear appropriate personal protective equipment whenever you handle fumigants. Wear the respirator listed on the fumigant labeling during any handling activity. This includes removing tarps or other coverings, and when exposure to the gas is likely.

There are two types of atmosphere-supplying equipment: SCBA and airline (also called supplied-air) respirators.

Air-Purifying Respirators

Air-purifying respirators remove particles as well as toxic gases and vapors. They use filters, sorbents, and catalysts to trap and remove contaminants from the air. When you breathe in, you draw air from outside the respirator, through air-purifying filters, and into the mask. The filtering material absorbs impurities as the air passes through.

Air-purifying respirators will not protect you from fumigants, from extremely high concentrations of gases or vapors, or when the oxygen supply is less than 19.5% by volume. However, in most situations requiring the use of respiratory protective equipment, an air-purifying respirator is sufficient.

Air-purifying respirators may be either powered or nonpowered.

Powered, Air-Purifying Respirators

Powered, air-purifying respirators (PAPRs) use a blower to move the contaminated air through one or more purifying filters. Do not confuse PAPRs with atmosphere-supplying respirators – PAPRs do not supply breathable air from an outside source. These respirators are available as lightweight backpacks. They may also be mounted on or in application equipment powered by the vehicle's electrical systems.

Some PAPRs have tight-fitting facepieces; others have loose-fitting hoods or helmets. PAPRs may also have another type of hood called a loose-fitting facepiece. Loose-fitting respirators constantly pump air through one or more cartridges or canisters into a head covering that resembles a helmet or hood. The positive outward pressure caused by the steady outflow of air keeps contaminants out of the headpiece. The purified air circulates over the user's head, face, and neck and provides some cooling.

Not all PAPRs move air at the same rate. **The National Institute for Occupational Safety and Health (NIOSH)** requires tight-fitting PAPRs to have a minimum airflow rate of 4 cubic feet per minute (cfm). Loose-fitting PAPRs must have an airflow rate of at least 6 cfm.

Because loose-fitting respirators do not have to form a seal, people with facial hair can use them safely. They do not require extra lungpower and are not nearly as tiring or as hot as face-sealing respirators.

Loose-fitting respirators are a good choice:

- To avoid the need for **fit tests** and **fit checks**.
- For pesticide exposure lasting several hours.
- If heat stress is a concern.

See "Fit Testing Respirators" below for more information about fit tests and fit checks.

Nonpowered, Air-Purifying Respirators

Nonpowered respirators can be either half-face or full-face devices. They place a filtration unit between your nose and mouth and the contaminated air source. Filtering facepiece respirators and most cartridge and canister respirators are examples of nonpowered, air-purifying respirators.

Cartridges for gases and vapors are approved for specific contaminants. Particulate-removing filters will work, regardless of the exact composition of the aerosol. Combination chemical- and particulate-removing cartridges are also available. When handling some pesticides, an organic vapor (OV) cartridge is required. Many pesticide labels require using respirators with OV cartridges without specifying any other type of cartridge. Therefore, all cartridge respirators used for protection against pesticides must be fitted with cartridges that are approved for organic vapors. (Filters are also usually required.) The parts of a typical nonpowered, air-purifying cartridge respirator are:

- One or more air-purifying cartridges.
- A facepiece with exhalation and inhalation valves.
- Adapters to mount the cartridges or filters.
- A head harness.

A prefilter – together with a NIOSH-approved filter – may also be included as an accessory item.

A licensed healthcare professional must clear you before you wear ANY respirator.

Styles of Air-Purifying Respirators

There are three basic styles of air-purifying respirators: particulate filtering, cartridge, and canister.

Particulate-Filtering Respirator

Particulate-filtering respirators offer protection from small, airborne particles. Disposable filtering facepiece respirators are one type. Particulate-filtering respirators cover the nose and mouth to filter out dusts, mists, powders, and particles.

Look for models held in place by two straps. One-strap styles do not keep the respirator adequately sealed against the face.

When you wear a respirator with a particulate-removing filter, you will have trouble breathing as more dusts, mists, and other particles become trapped in the filter material. When breathing becomes too difficult, replace the filter. Always check the user's instructions for specific requirements. Eight hours of use is usually the limit. During continual use, you may need to change filters twice a day – more often in dusty or dirty conditions. Do not use a filtering facepiece respirator if the pesticide will completely soak the mask. Replace the mask if it gets soaked or loses its shape. Dispose of according to the manufacturer's instructions.

Cartridge Respirator

Cartridges contain gas- and vapor-removing material. Many pesticide labels specify a NIOSH-approved, combination OV/particulate-filtering respirator with any R or P filter that has these approval number prefixes: TC-84A and TC-14G for nonpowered, air-purifying respirators, or TC-23C and TC-14G for PAPRs.

Some cartridge-type respirators are one-piece units with cartridges permanently attached to the facepiece. After use, the entire unit is discarded. Other cartridge respirators are two-piece units with removable cartridges and a body that may be cleaned and reused.

Canister Respirator

A canister contains both gas- and vapor-removing material. Canisters contain more air-purifying material than cartridges. They last longer and may give better protection when the concentration of gas or vapor in the air is high. They are also heavier and more uncomfortable to wear than cartridge respirators.

Canister-type respirators are often called gas masks. The canister is usually connected directly to the facepiece or worn on a harness and connected to the facepiece by a flexible hose. The facepiece and other parts are designed to be cleaned and reused. You can replace the canisters when necessary.

Gas- and Vapor-Removing Devices

Gas- and vapor-removing devices (cartridge and canister respirators) are rated by NIOSH for the types of gases and vapors they will remove. Pesticide handlers must use one of the following:

- A cartridge approved for organic vapors plus a filter.
- A canister approved for organic vapors (NIOSH code TC-14G) plus a filter.

In both cases, the pesticide label will designate the filter's level of protection.

Gas- and vapor-removing materials gradually lose their ability to hold more gases and vapors. The useful life of respirators can vary greatly depending on:

- Concentration of gas or vapor in the air.
- Amount of absorbent material they contain.
- Breathing rate of the wearer.
- Temperature and humidity.

- Length of storage time before use and between uses.

A noticeable odor, taste, irritation, or dizziness means you are no longer being protected. Refer to the end-of-service-life indicator or other instructions (ex. cartridge service-life prediction software) to tell you when to replace the cartridge or canister.

Selecting and Using Respirators

Label examples based on EPA respiratory-protection criteria

Solid pesticides with Toxicity Class II, III, or IV	Use a NIOSH-approved respirator with any N, R, P, or HE filter with approval code TC-84A or TC-21C.
Liquid pesticides, Toxicity Class I	Use a NIOSH-approved respirator with a combination OV/particulate-filtering cartridge or canister with any R, P, or HE filter with approval code TC-84A, TC-14G, or TC-23C.
Gas applied in enclosed area	Use an air-supplying respirator with NIOSH TC-19C, or use a self-contained breathing apparatus with NIOSH TC-13F.

Source: National Pesticide Applicator Certification Core Manual, p. 96.

The National Institute for Occupational Safety and Health is the federal agency responsible for testing and certifying respirators used by pesticide handlers. Approval numbers beginning with the letters "TC" (testing and certification) are assigned to all respirators reviewed by the agency. Pesticide product labels often specify the type of respirator required by listing its TC schedule number (see below). In addition, filters are classified based on oil degradation resistance and filter efficiency. The classification levels for oil degradation resistance are N (not oil resistant), R (limited oil resistance), and P (oil proof).
N, R, and P Series – Filters classified by NIOSH based on oil degradation resistance. N-series filters are not oil resistant, R-series filters have limited oil resistance (typically eight hours of use), and P-series filters have indefinite oil resistance (oil proof). The filter efficiency level for each classification may be 95%, 99%, or 99.97%.

Another designation, HE (high efficiency), is used for PAPRs. HE filter efficiency is equal to or greater than 99.97%. Numerical codes are not used with HE filters.

Below is a list of several types of respirators and their TC schedule number designations:

- TC-84A – nonpowered, particulate-filtering respirators (N, R, P, or HE filters). Also includes combination cartridges for gas/vapor and particulates.
- TC-21C – powered, air-purifying, particulate-filtering respirators only (100 series filters).
- TC-23C – powered, air-purifying, chemical cartridge respirators with or without particulate filters.
- TC-14G – gas masks with canisters.
- TC-19C – supplied-air respirators.
- TC-13F – self-contained breathing apparatus.

The complete NIOSH approval number has this format: TC + schedule number (ex. 84A) + serial number for each make and model.

The product formulation, toxicity, and type of application influence the type of respirator you need. Manufacturers use criteria approved by the Environmental Protection Agency (EPA) to assign PPE respirator requirements on labels (see above table). When a pesticide label requires a respirator, wear a NIOSH-approved one that matches the specifications given on the product label. Remember, no one respirator will protect you from every pesticide or formulation that you may use.

NIOSH no longer uses the term "dust/mist respirators," and the term "prefilter" is no longer used for NIOSH-approved products. NIOSH has replaced the dust/mist classification with N, P, R, or HE types of particulate-removing respirator (minimum efficiencies of 95%, 99%, or 99.97%). Some pesticide labels call out a NIOSH-approved N95 respirator, for example. This refers to a respirator with an N95 filter. Some call out N95, R95, or P95.

Fit Testing Respirators

Respirators fit wearers in one of two ways: most seal tightly to the face; others are loose-fitting. See "Air-Delivery Systems" above for more information on loose-fitting respirators.

Respirators that seal must fit your face tightly. They must be fit tested to their users. For a firm and comfortable fit of your face mask, adjust the headbands in this order:

1. Make sure the straps lie flat against your head.
2. Tighten the lower or neck straps.
3. Tighten the head cradle straps.
4. Place both hands on the headband or head cradle and position it on the crown of the head.
5. Repeat steps 1 and 2.
6. Tighten the forehead or front strap a few notches.

The mask should feel comfortable, while forming a tight seal against your face. OSHA requires that respirators fit properly and that you test their facepiece-to-face seal.

Fit Tests

The fit test is a method used to select the right size respirator for each user. OSHA's respiratory-protection standard requires a fit test before using a respirator for the first time, when using a different respirator facepiece, and at least once a year thereafter. A fit test is also required for anyone whose physical condition has changed in a way that could affect the fit of a respirator (ex. facial scarring or cosmetic surgery). All employees using either a negative- or positive-pressure, tight-fitting, facepiece respirator must pass an appropriate fit test.

There are two types of fit tests: qualitative and quantitative. The qualitative fit test uses irritant smoke released in the air to detect leakage into the respirator. The test operator directs a stream of smoke from the smoke tube toward the face seal area, using a low-flow pump or a squeeze bulb. When cued, the wearer makes certain movements (breathe normally, breathe deeply, move the head, grimace, bend at the waist, and talk). He or she then reports any noticeable odor or taste agent that leaks into the mask. Qualitative fit testing is used for half-face respirators only.

The quantitative fit test uses a particle-counting instrument. This device measures respirator fit by comparing the dust concentration in the surrounding air with that inside the respirator. The ratio of these concentrations is called the fit factor. A modified filter cartridge (or a modified respirator facepiece) equipped with a sample port collects air from inside the respirator. With the sampler attached, the wearer makes the same movements as described for the qualitative fit test. During these movements, the particle-counting device measures any leakages. Quantitative fit testing is required for all full-face respirators.

Fit Checks

The purpose of a fit check (also called a user seal check) is to make sure your respirator is positioned properly and forms a complete seal around your face. Do a fit check each time you put on your respirator *before* you enter the target area. Follow up from time to time while in the field.

The seal-checking process has two parts: a positive-pressure check (breathing out) and a negative-pressure check (breathing in). You must complete both parts each time. If you cannot pass both parts, your respirator is not working properly. Adjust it and try again.

Positive-Pressure Check

Cover the exhalation valve with your hand and exhale gently into the facepiece. If the facepiece remains inflated with no sign of leakage, the fit is good. If there is leakage, inspect the respirator. Reposition it, and try the test again. This method is the most widely used to check proper fit in the field.

Negative-Pressure Check

Close off the air inlet valves by covering the cartridges with your hands. (It may be difficult to get a good seal when trying to cover the inlet valves.) Inhale gently to collapse the facepiece slightly and hold your breath for 10 seconds. If the facepiece remains slightly collapsed with no sign of leakage, the respirator fits properly. If there is leakage, inspect the respirator. Reposition it and try the test again.

Guidelines for Disposal of Pesticides and Empty Containers

Always dispose of pesticides and empty containers so they pose no hazard to humans or the environment. Follow label directions, and consult your local Extension agent if you have questions. The best solution to the problem of what to do

with excess pesticide is to avoid having any. Waste minimization strategies include:

- buy only the amount needed for a year or a growing season,
- minimize the amount of product kept in storage, and store all existing stocks properly,
- calculate how much diluted pesticide you will need for a job, and mix only that amount,
- apply pesticide with properly-calibrated equipment,
- use all pesticides in accordance with label instructions,
- purchase pesticide products packaged in such a way as to minimize disposal problems, or packaged in containers that have legal disposal options available in your area.

The best disposal option for excess usable pesticide is to find a way to use the material as directed by the label. Please note that the total amount of active ingredient applied to a site, including all previous applications, must not exceed the rate and frequency allowed by the labeling. If you have usable pesticide product in its original container that you cannot use, you may be able to find another pesticide handler who can.

Other pesticide waste disposal options include:

- following valid label disposal directions,
- returning product to the dealer, formulator or manufacturer,
- participating in a federal indemnification program for canceled / suspended products,
- employing a professional waste disposal firm,
- participating in a state or local "clean day", like the Virginia Department of Agriculture and Consumer Services – Office of Pesticide Services-sponsored Pesticide Disposal Program.

Pesticide wastes that cannot be disposed of right away should be marked to indicate the contents and then stored safely and correctly until legal disposal is possible.

Federal law (FIFRA) requires pesticide applicators to rinse "empty" pesticide containers before disposing of them. Pesticide containers that have been properly rinsed can be handled and disposed of as non-hazardous solid waste. The containers of some commonly-used pesticides are classified as hazardous waste if not properly rinsed. Proper disposal of hazardous waste is highly regulated. Improper disposal of a hazardous waste can result in large fines and/or criminal penalties.

A "drip-drained" pesticide container contains product. Immediate and proper rinsing generally removes more than 99% of container residues. Properly rinsed pesticide containers pose minimal risk to people and their environment.

The time to rinse is during mixing/loading. If containers are rinsed as soon as they are emptied, the rinsate can be added to the spray tank, avoiding the problem of rinsate disposal. Properly rinsing the container and using the rinse water (rinsate) to make the spray mix makes sure that nothing is wasted, and ensures that pesticide residues do not have time to dry in the container. Dried residues are difficult (or impossible!) to remove. Never postpone container rinsing!

There are two methods for proper rinsing:

- Triple Rinsing
- Pressure Rinsing

Be sure to wear protective clothing when rinsing pesticide containers. See the product label for information on what to wear.

Container Disposal Options after Triple Rinsing (or Equivalent)

	On-Site Disposal			
Container Type	**Burn**	**Bury**	**Landfill**	**Recycle**
Plastic Jug or Pail	no[1,2]	no[1]	yes	yes[3]
Plastic Bag	no[1,2]	no[1]	yes	yes[3]
Plastic Drum	no[1,2]	no[1]	yes	yes[3]
Metal Pail	no	no[1]	yes	yes[3]
Metal Drum	no	no[1]	yes	yes[3]
Paper Bag	no[1,2]	no[1]	yes	no

Container Disposal Options after Triple Rinsing (or Equivalent)

Container Type	On-Site Disposal		Landfill	Recycle
	Burn	Bury		

Legend: yes = recommended
no = not recommended
1 = Residues make this an unsafe practice.
2 = Not allowed in Virginia
3 = Prefered disposal method

This chart was adapted from the National Agricultural Chemicals Association booklet: *Empty Container Disposal*, #68001. It was updated in 2003 with input from VDACS/OPS and VDEQ. If you have questions about container disposal, contact your state or regional environmental agency.

Drift Control and Volatility of Pesticides

Drift can be a problem with any pesticide because visible spray can drift more than 100 yards and invisible vapor may drift one mile or more. Drift of herbicides is the most commonly encountered cause of pesticide damage to adjacent susceptible crops. No pesticide can be applied by either aerial or ground equipment without some drift. Spray drift is influenced by air movement, droplet size, and distance traveled by the spray before reaching the target area. For minimum drift, application should be made as close to the target as possible, when air movement is moving away from sensitive areas and at a minimum wind (3-9 mph) speed but not dead calm, and using spray nozzles that eliminate fine droplets. In some instances, spray additives or thickeners may be used to improve application to the target area and to reduce drift. When in the vicinity of heavily populated areas, buffer zones should be established around orchards to reduce any potential drift (fence rows with trees or other vegetation intercept any drift at the edge of the field).

To avoid the possibility of vapor drift, do not use ester formulations of 2,4-D in the orchard for any reason. Amine formulations of 2,4-D are the only formulations registered for use in orchards.

Protect Sensitive Areas from Pesticide Drift!

OUR CHANGING ENVIRONMENT

With the urbanization of many agricultural areas, growers increasingly find themselves in situations where the offsite movement of pesticides presents a liability for the grower and a fear of exposure by nearby residents. Any amount of pesticide drift is NOT acceptable and any violation of the pesticide label can bring state and federal legal response. You can control pesticide drift with knowledge and responsible application practices.

WHAT IS DRIFT?

Pesticides sprayed on crops and other sites can drift. **Drift** is the uncontrolled movement of pesticides through the air away from a target site. Drift is largely a problem with liquid pesticides but can also occur with dry formulations. With liquid formulations, it is all about the "drops." **Drops** (**droplets**) are small particles of liquid spray containing pesticide active ingredients that come out of a sprayer nozzle. **Control your droplet size, and you can control where your drops will land**. Large drops are more likely to settle on the target area. Smaller drops are more likely to move off-target. A small droplet is less than 150 microns in size (very close to the diameter of a human hair).

Types of Drift:

- **Particle Drift** – movement of fine particles through the air away from the target site of application. This type of drift only occurs while the pesticide is being applied.
- **Vapor Drift** – movement of pesticide as a gas or vapor during or after application. Some formulations and active ingredients are more prone to vapor drift than others.

WHAT IS A SENSITIVE AREA?

Drift can occur anywhere. When it becomes a problem, drift is usually associated with areas where there are people, other nontarget animals, or valuable plants. Drift can also be a problem when it comes into contact with sensitive surfaces or sites. Sensitive sites include:

- Schools and Daycare Facilities
- Hospitals and Healthcare Facilities
- Homes and Office Buildings

- Recreation Areas and Playgrounds
- Nontarget Plants and Animals
- Wildlife Refuges and Protected Areas
- Beehives and Areas with Pollinators

HOW DO YOU PROTECT SENSITIVE AREAS?

Below are some **best management practices (BMPs)** that pesticide applicators, landowners, and managers can use to prevent pesticide drift from impacting sensitive areas.

Keep Pesticides Away from Sensitive Areas: Never apply pesticides when the wind is blowing toward sensitive areas. Locate crops at a distance where drift can be intercepted by a barrier or can settle harmlessly on your property. Assess the area well beyond your property lines for possible sensitive areas.

Locate Sensitive Areas Away from Pesticide Use: Sensitive areas should NOT be located near sites where pesticides are applied routinely. Removing natural barriers between agricultural and sensitive sites can allow pesticides to drift onto your property. Locate sensitive areas away from property lines and maintain fencerows. Make sure you are aware of all land use around a property before you buy it or locate a sensitive area on this land.

Use Windbreaks, Buffers, or Buffer Zones: It is possible to reduce spray particles from drifting offsite by using various types of barriers. Barriers are NOT foolproof solutions, nor can they substitute for proper location and application.

Windbreaks are barriers, such as a line of trees, designed to reduce wind movement. Dependent on wind direction and placement, they are capable of intercepting spray drift. Windbreaks can be single rows or multiple rows of established trees. To be effective, windbreaks may need to be several times higher than the highest release point of the spray material. When located farther away they can lose their effect.

Spray buffers are not the same as windbreaks. They can be man-made or natural. They are located directly downwind (from the prevailing wind direction) from a spray release area and are designed to catch spray drift. Buffers should be several times higher than the spray release height. They should be placed as close to the spray release site as possible. If located farther away they will lose their effect. Buffers are more effective if they are a mixture of vegetation and open areas to break up wind patterns. Their effectiveness will vary depending upon the lay of the land and the weather conditions.

Buffer zones are areas where no pesticide application should occur and are designed to catch off-target spray on their surfaces. If buffers are open areas, they will depend on distance to allow spray materials to settle. This means they need to be relatively wide areas (over several hundred feet) and will be more effective if vegetation or other surfaces are present. Most sprayers (ground and aerial) have defined distances that spray can travel after release. These data are specific to crop and sprayer type, and knowing them can help you determine the size of a buffer zone. Consult your equipment manual for further information.

Select The Proper Chemicals: Choose pesticides with **minimal toxicity** to nontarget species. Avoid volatile pesticides because they can move off site in the form of vapor drift hours after application. This is especially important if there are sensitive plants like grapes, tomatoes, tobacco, soybeans, cotton, or other fruit and vegetable crops planted nearby.

Choose chemicals that can be applied in large drops, or substitute formulations that are less likely to drift. Avoid ultra low volume (ULV) formulations if you seek to keep droplets large enough to avoid drift. Drops should be large enough to avoid drift, yet small enough to allow adequate penetration of foliage for effective pest control. You may have to increase spray volume with less concentrated products.

Consider IPM or Non-chemical Alternatives: All applicators should practice integrated pest management (IPM). Integration of alternative control measures saves money and reduces the number of pesticide applications. Contact your Extension agent for more information on IPM and sustainable agricultural practices.

Choose Application Equipment with Drift Guards or Deflectors: Drift reduction devices include air assist and boom skirts. Shields, skirts, deflectors, and other devices can be retrofitted on older sprayers to reduce drift.

Choose Low-Drift Nozzles and Maintain Your Sprayer: A major contributor to drift from liquid pesticides is small droplet size. Sometimes worn spray nozzles can cause droplets to fragment. Drift-reduction nozzles (tips) are designed to keep droplets intact and reduce drift. Nozzles should be replaced when they show signs of wear. Calibration, flow meters, and observation of spray patterns can indicate worn or clogged nozzles.

Choose Favorable Weather Conditions: Wind, low humidity, and high temperatures all contribute to pesticide drift. Do not spray when atmospheric conditions are highly unstable (thermals) or highly stable (inversions). Avoid application during a dead calm or in light winds (<2 mph) because fine particles can move unpredictably. A steady crosswind blowing at 3-9 mph is ideal. Do not spray if the wind is blowing above 10 mph, or at any speed, if the wind is blowing toward a sensitive area. High temperature (>82˚F) and low humidity (<50%) encourage droplets to evaporate, become smaller, and drift. Continually monitor weather conditions at the site.

Keep Accurate and Thorough Records: Good recordkeeping is key to protecting yourself from false accusations, unnecessary enforcement actions, and potential liability. There have been cases where growers who kept accurate records prevented themselves from being sued or fined because their records proved when and what they applied on their property. Contact your Extension Agent for help with pesticide recordkeeping.

Keep the Application On Target: Proper equipment operation, maintenance, and proper and careful pesticide application under favorable weather conditions help achieve effective and efficient pest management. Minimize ground rig boom (release) height by converting to 110˚ nozzles or angling nozzle bodies. Use nozzles that produce coarser droplets when possible. Keep travel and/or fan speeds to the minimum necessary.

Communicate: Communicate with your neighbors and maintain a good relationship to prevent disagreements and misunderstandings. Communicate with your local Extension agent. Cooperative Extension teaches drift minimization as part of its pesticide safety education programs. These programs are available to you in your community.

For More Information, Contact:

Virginia Department of Agriculture and Consumer Services, Office of Pesticide Services – 102 Governor Street, Lower Level, Richmond, VA 23219; 804-786-3798 or *http://www.vdacs.virginia.gov/pesticides.shtml*.

Virginia Tech Pesticide Programs – Department of Entomology, 302 Agnew Hall – 0409, Blacksburg, VA 24061 – 540-231-6543 or *http://www.vtpp.org*.

Virginia Cooperative Extension – Your local Extension agent is listed under the Blue Pages of your telephone book or *http://www.ext.vt.edu/offices.*

National Pesticide Information Center (NPIC) – 800-858-7378 or *http://npic.orst.edu*.

USEPA – Office of Pesticide Programs at: *http://www.epa.gov/pesticides*.

Some Important Points About Drift and Orchard Airblast Sprayers

This information cites the publication – "A Summary of Airblast Application Studies." Published by the Spray Drift Task Force (SDTF) and Stewart Agricultural Research Services, Inc., (P.O. Box 509, Macon, Missouri 63552. 12pp.) in 1997.

The goal of orchard applicators is to protect their fruit crops from diseases, insects, and other pests. At the same time, applicators must keep drift as close to zero as possible. The pesticide label has no tolerance for drift. If you drift, you violate the label and thus break the law.

The SDTF study shows that drift can be kept very low by using good application procedures. Based on data generated by the SDTF, *"in a typical orchard airblast application to a 1200 feet wide grove of oranges, over 99% of the applied active ingredient stays on the crop and less than 0.5% drifts. The amount of material deposited on the ground decreased rapidly with distance and approached zero at 100 feet downwind."*

Among other information the study reported information with ground deposition of residues in apple orchards. The report indicated that *"the highest levels of ground deposition occurred from dormant apples where there was no foliage to intercept the spray droplets."* Another situation where ground deposition was high was where there were large gaps between trees. *"Ground deposition was approximately 22 times greater at 25 feet from dormant compared to foliated apples."* In comparison to other crops in the study, *"the lowest drift came from apples and grapes, the shortest crops evaluated. The ground deposition from apples was approximately five times less than from the California oranges at 25 feet downwind."*

"A special series of applications was used to better understand how canopy characteristics influence the movement of spray droplets within, and subsequently outside, different orchard types. The interaction of many canopy-related factors affect the amount of drift from orchards, results from the SDTF attempted to separate effects due to 1) height and shape, 2) foliage density, and 3) space between trees."

In terms of canopy height, the apple trees used in the SDTF study *"were approximately 14 feet tall with open areas at the bottom, no distinct gaps between trees, and a moderately dense canopy." "Most of the spray passing the first row moved through the open space under the trees. The highest amount measured was less than 2.5%, compared to 0.75% in grapes. However, because these higher levels were measured relatively close to the ground, the majority of the droplets deposited before passing the second row. Therefore, the vertical profile beyond the second row was very similar to that from grapes. This explains why the downwind ground deposition was very low for both apples and grapes."*

"The same apple orchard that was tested with full foliage was also tested when dormant (no foliage). Because of the lack of foliage, dormant apples were the only crop tested in which wind speed had a substantial effect on the vertical and ground deposition profiles. This was because it was also the only situation where a change in the wind speed outside the orchard was reflected by a change in wind speed inside the orchard. In a 4.4 mph wind, approximately five times more spray passed the first row in dormant compared to foliated apples. However, because most of the spray was moving close to the ground, it deposited rapidly before moving very far downwind. At five rows downwind, the amount of spray measured from

both dormant and foliated apples was very low. In a 12 mph wind, more of the spray moved above the dormant trees and approximately ten times more spray was measured after the fifth row than in a 4.4 mph wind."

"Although the amount of drift from orchards results from the interaction of many canopy-related factors, the differences in ground deposition were due primarily to differences in foliage density. The greatest amount of downwind ground deposition was from dormant apples, where only trunks and branches intercepted droplets and modified the effects of the wind. Wind speed in the dormant apple ground deposition studies was intermediate between the 4.4 mph and 12 mph wind speeds measured in the vertical deposition studies. In comparison, ground deposition from the same apple orchard with full foliage was close to the lowest level measured in the study."

"At the time of the SDTF studies, most orchard and vineyard sprays in the U.S. were applied with radial type airblast sprayers. However, the SDTF also included of two other sprayer types, a 'wrap-around' hydraulic sprayer used in vineyards, and a low volume 'mist blower' used in orchards."

"The wrap-around sprayer has booms positioned horizontally over the tops of the rows and vertically along the sides. It uses hydraulic nozzles, sometimes at very high spray pressures. Unlike the airblast sprayer, there is no fan to increase airflow. Although the drift is very low for both sprayers, much less spray was collected from the wrap - around sprayer, particularly above the vines."

"Ground deposition from the wrap-around sprayer was four times less than from the airblast sprayer at 25 feet downwind." In terms of drift minimization, the wrap-around sprayer would be a better choice than a conventional airblast sprayer or mist blower.

"The amount of drift from orchard airblast applications was found to be much lower than is often perceived. There are several reasons for this apparent discrepancy.

a. The relatively high application volumes result in very visible spray plumes, which are comprised primarily of larger droplets that settle out before drifting from the site.

b The high spray volumes also result in relatively low concentrations, so that drifting droplets do not contain much active ingredient.

c. Most of the very small droplets that are capable of drifting long distances are either intercepted by the canopy, or do not have enough momentum to leave the site.

d. Most of the spray volume leaving a site is comprised of relatively large droplets that do not drift long distances.

e. The orchard canopies tend to reduce the effects of wind."

"Even though active ingredients do not differ in drift potential, they can differ in their potential to cause adverse environmental effects." Even with current technology, drift cannot be completely eliminated. Therefore, *"when drift cannot be reduced to low enough levels by altering spray equipment set-up and application techniques, buffer zones should be imposed to protect sensitive areas downwind of applications."*

Pesticide Laws, Regulations, and Restrictions

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) has been amended several times since its inception in 1947. The more recent amendments to this act in 1972 and again in 1978 are perhaps some of the most significant laws impacting American agriculture.

The 1972 amendment is known as the Federal Environmental Pesticide Control Act (FEPCA). FEPCA stipulates that the use of any pesticide inconsistent with its labeling is prohibited; that violations of FEPCA by growers, applicators, and dealers can result in heavy fines and imprisonment; that pesticides must be classified for either general use or for restricted use; that anyone using or purchasing restricted-use pesticides must be certified by their state of residency; that pesticide manufacturing plants must be inspected by the EPA; that states may register pesticides on a limited basis for special local needs; that all pesticides must be registered by the EPA; and that all product registrations must be backed by scientific evidence to control the pests on the label, not injure people, crops, animals, or the environment, and not result in illegal residues in food and feed when used according to label directions.

The 1978 amendment was designed to improve the registration processes. It stipulates that efficacy data can be waived and that generic standards can be set for active ingredients rather than for each product. Re-registration of older products is required to make certain that scientific data exists to back them. Pesticides can be given a conditional registration prior to full registration. Registrants can use supporting data supplied from other companies if paid for. Trade secrets are to be protected. States have primary enforcement responsibility for both federal and their own state pesticide laws and regulations. States can register pesticides under a Special Local Needs (SLN or 24C) label. Finally, the phrase "to use any registered pesticide in a manner inconsistent with its labeling" was defined in detail.

It is illegal to use a pesticide in any way not permitted by the labeling. A pesticide may be used only on the plants, animals, or sites named in the directions for use. You may not use higher rates or more frequent applications. You must follow all directions for use, including directions concerning safety, mixing and loading, application, storage, and disposal. You must wear the specified personal protective equipment. Pesticide use directions and label instructions are not advice, they are legal requirements. Persons who derive income from the application, recommendation, sale, or distribution of pesticides CANNOT make recommendations which call for uses inconsistent with labeling.

The Food Quality Protection Act (FQPA) of 1996 amends both the Federal Food, Drug, and Cosmetic Act (FFDCA) and FIFRA. FQPA provides a unified, comprehensive regulatory plan for pesticides. Because it requires the EPA to consider pesticide use and safety data in new ways, it may result in significant changes in U.S. pesticide use patterns.

STATE PESTICIDE CONTROL LAWS AND REGULATIONS

The pesticide control laws and regulations in your state are enforced by your state's Department of Agriculture. Information concerning regulatory changes impacting pesticide users is available from your state Land Grant University, Department of Agriculture, and your local Extension office.

Community Right To Know (SARA Title III)

The public outcry following the 1984 chemical disaster in Bhopal, India, resulted in a public right-to-know law being implemented in the US in 1986. The Emergency Planning and Community Right-to-Know Act (SARA Title III) was drafted to require those producing or storing hazardous chemicals to provide communities with the identity and amounts of chemicals located in their vicinity. The law also addresses the need for communities to establish emergency response plans to follow in the event of an emergency.

Each local government in your state has established an Emergency Response Council to deal with reporting and notification under SARA Title III. These councils are made up of local government officials who should be able to advise you on how to deal with compliance associated with local requirements under the statute.

For the farmer, this law requires you to notify local authorities if you store any chemical listed under Section 302 of the Act. This list is extensive and the amount stored before notification is according to a Threshold Planning Quantity (TPQ) specific to each chemical active ingredient. This list applies if you store 10 or more pounds of paraquat (Gramoxone Extra), 100 or more pounds of oxamyl (Vydate), or 500 or more pounds of methomyl (Lannate, Nudrin). For a full list of chemicals under Section 302, see Title 40 CFR Part 355 (https://www.ecfr.gov/current/title-40/chapter-I/subchapter-J/part-355#p-355.10(b)).

The amount of formulated product that may be stored but not reported depends on the active ingredient itself and percent active ingredient in the product. If a product was 10% active ingredient and the TPQ was 10 pounds, then you could store up to 100 pounds of the formulated product before you would be required to report to local authorities.

In the event of any spill, you are advised to contact local authorities immediately. In addition, spills in Virginia must be reported to VDACS Office of Pesticide Services at 804-371-6560. If the spill is of a reportable quantity (information available from your State Department of Agriculture or State Department of Environmental Quality) then contact the National Response Center at 800-424-8802.

The law also requires notification in the event of an emergency release which would impact others or other property (spill, drift, etc.) to your state Emergency Response Center [In Virginia – Virginia Department of Emergency Management (DEM) at 800-468-8892.]

For additional information about SARA Title III, contact your State Department of Environmental Quality. [In Virginia – Virginia Department of Environmental Quality at 800-592-5482 (in-state calls only) or 804-698-4000 (out-of-state calls) (*http://www.deq.virginia.gov*)]

PLEASE NOTE: The Virginia Department of Agriculture and Consumer Services has offered a pesticide waste disposal program for farmers since 1990. If you find yourself accumulating old pesticides, please remember to not proclaim these products as waste until you are ready to dispose of them. As such you are still required to comply with storage regulations and keep these materials in proper order and condition. To participate in a pesticide waste disposal program for your locality, please contact your local Extension agent. For other states this procedure may vary. This might include contacting other local or state authorities or hiring a professional waste disposal contractor.

Groundwater Restrictions

The EPA and Congress have placed special emphasis on protection of water resources. Water quality programs are being implemented in education and research programs throughout the country. Federal and state efforts to protect groundwater are resulting in new pesticide product label instructions and use restrictions.

As an applicator and landowner, you must adhere to label restrictions, and should follow best management practices in handling pesticides. Particular attention should be given to prevention of spills, backsiphoning, and disposal of pesticides. Applicators can do much to prevent contamination by following label rates, and maintaining and calibrating application equipment. In Virginia, it is against the law to use equipment in poor repair or to fill tanks directly from a water source without an anti-siphon device in use on the spray equipment. Applicators should expect a continued emphasis on protection of water supplies.

For more information on anti-siphon devices, sometimes referred to as back-flow preventers, contact your local water authority. For large operations these devices are precision equipment and can cost thousands of dollars. Before you decide to plumb a spray system directly to a water supply you should investigate the costs of such devices and determined what local and state regulations apply. Contact your local water authority for help. For the smaller operator, devices are available at local hardware stores and plumbing suppliers. Their cost is usually under $15 for bib-cock devices and higher for in-line anti-siphon devices and check valves. Remember, that most check valves do not qualify as "anti-siphon" devices because they do not break the siphon. You should use these in conjunction with an anti-siphon device. For most situations, applicators only need to maintain an air gap between the end of the fill hose and the spray tank to avoid water contamination.

Endangered Species Pesticide Use Restrictions

Under authority of the Endangered Species Act and FIFRA, the US Fish and Wildlife Service and the EPA may restrict pesticide use in counties where such use jeopardizes a federally listed Threatened or Endangered species. EPA's Endangered Species Protection Program is designed to protect federally-listed endangered and threatened species from exposure to pesticides. The program is intended to provide information and regulation concerning pesticides that may adversely affect the survival, reproduction and/or food supply of listed species.

Please observe pesticide labeling for changes and keep up to date on this topic. Information is available through your local Extension office, from your State Department of Agriculture, and from your state Department of Wildlife Resources. For more information see EPA's website (*http://www.epa.gov/espp/*) or call (800) 447-3813.

Worker Protection Standard for Agricultural Pesticides

EPA's Worker Protection Standard for Agricultural Pesticides (WPS) was developed to protect workers and pesticide handlers from exposures to agricultural pesticides, thus reducing the risks of pesticide poisonings and injuries. The WPS targets workers who perform hand labor operations in agricultural fields, nurseries, greenhouses and forests treated with pesticides. It also impacts employees who handle pesticides (mix, load, apply, etc.) for use in those locations.

Labels of pesticides used in agricultural plant production, nursery / greenhouse operations and forestry now reflect the WPS requirements. Growers must comply with WPS requirements listed in the Agricultural Use Requirements box on the label.

These include:

- use of personal protective equipment (PPE);
- restricted-entry intervals (REI);
- double notification (if applicable);
- display of information at a central location (WPS safety poster, information about location of medical facilities, and a list of recent pesticide applications);
- pesticide safety training for workers and non-certified pesticide handlers;
- employer information exchange between the employers of agricultural workers (growers) and employers of commercial (for-hire) pesticide handlers;
- decontamination sites;
- emergency assistance, including transportation to medical care and providing information to medical personnel or employees;
- notice of applications for products that allow a choice of warning workers orally or by posting treated areas;
- specific instruction to handlers, including label information and safe operation of application equipment;
- equipment safety, including inspection and maintenance;
- providing PPE (clean and maintained in good condition), and preventing heat stress or illness;
- providing protection for early entry workers;
- specific application restrictions in nurseries and greenhouses.

Farm owners and immediate family members must comply with some, but not all, of the requirements of the WPS.

Detailed information on the WPS for agricultural employers can be found in the EPA publication, *The Worker Protection Standard for Agricultural Pesticides - How to Comply*. To download this document go to: *http://www.pesticideresources.org/wps/htc/htcmanual.pdf*. If you have questions about the WPS, please contact your local Extension agent or your state Department of Agriculture. Information is also available on the web at: *https://www.epa.gov/pesticide-worker-safety*.

THE HAZARD COMMUNICATION STANDARD

All employers must adhere to restrictions under the OSHA Hazard Communications Standard. This standard is a worker right-to-know law which requires employers to train and inform all workers who may be potentially exposed to **any hazardous chemicals** in the workplace. The law especially targets operations, including agricultural operators, with 10 or more employees. These employers must file a Hazard Communication Plan in their offices and inform their employees of the content of this plan. They must obtain and file Safety Data Sheets (SDS) for all chemicals used by their employees. In addition, employers must provide training on the information in the plan, the SDS, and chemical labeling to each employee who may be potentially exposed to a chemical hazard. This training is very specific to each individual operation and so therefore must be conducted by the employer. Also, when new chemical hazards are introduced into the workplace, the employer must provide new training to protect the employee.

For agricultural operators with fewer than 10 employees, it is not necessary to develop and file a Hazard Communication Plan. However, MSDS and labeling should be maintained and employees must be informed of proper use and safe handling according to the MSDS and labeling information. OSHA does not enforce the standard on smaller operators unless there is an accident or a request to investigate unsafe working conditions on a site. However, this concern and a concern for liability would lead one to consider complying with the full requirements of the Standard anyway. In Virginia, for more information on the Standard, contact your local Extension office or the Virginia Department of Labor and Industry. A training manual explaining how to comply and develop a training program is available by contacting the Virginia Department of Labor and Industry, Main Street Center, 600 East Main Street, Suite 207, Richmond, VA 23219 (or email: webmaster@doli.virginia.gov), or for growers in West Virginia, the West Virginia University, Institute for Safety and Health Training, Occupational Safety and Health Extension, 3604 Collins Ferry Rd., Morgantown, WV 26505 (or email: SafetyandHealth@mail.wvu.edu).

TRANSPORTATION OF HAZARDOUS MATERIALS

The Transportation Safety Act of 1974 vests in the U.S. Department of Transportation (DOT) the authority to regulate the movement of all hazardous materials by any mode of transportation. Most, if not all, pesticides fall within materials characterized as hazardous in the regulations issued by DOT. The extensive DOT regulations govern the packing, labeling of containers and placarding of vehicles, and handling of pesticides for transportation by common, contract or private carriers. A commercial pesticide applicator transporting pesticides for application under contract would constitute either a contractor or private carrier and thus be subject to the regulations. Under certain circumstances, a private pesticide applicator (farmer) transporting pesticides for his or her own use may be considered a private carrier subject to regulations. Activities which may constitute private carriage of hazardous materials include crossing state lines while transporting pesticides and transporting pesticides for another person under an agreement to provide such transportation (with or without compensation).

Motor carriers transporting hazardous materials, including pesticides, across state lines must have special insurance coverage. Private carriers transporting purely within the borders of a single state are exempted from this requirement provided the transport vehicle has a gross vehicle weight of less than 10,000 lbs. If the vehicle is a tank truck it must have a tank of less than 3,500 water gallons capacity regardless of the actual quantity of material transported) to be exempted from the insurance requirement.

Carriers of hazardous materials must also keep shipping papers describing the cargo and its destination. Carriers of hazardous wastes must prepare a hazardous waste manifest as required by EPA regulations under Title 40 CFR part 262. Transporters of hazardous materials are required to immediately report to the DOT all incidents which result in death, injury requiring hospitalization, material damaged in excess of $50,000, fires or spills. Before hauling any pesticide on public highways, ask for assistance. You should contact your pesticide dealer, Department of Motor Vehicles or the State Police.

SECURITY REQUIREMENTS FOR TRANSPORTING CERTAIN HAZARDOUS MATERIALS

Agricultural producers who ship or transport certain hazardous materials in quantities that require placards must develop and implement a transportation security plan. This rule affects the transportation of hazardous materials needed to support commercial activities like farming and ranching. Its aim is to deter terrorist and other illegal acts while at the same time limiting a producer's exposure to liability in the event that an illegal act occurs.

For information on all hazmat safety, see *https://www.fmcsa.dot.gov/regulations/hazardous-materials*

U.S. Department of Transportation
Research and Special Programs Administration

TRANSPORTATION SECURITY EVALUATION & PLANNING FOR FARMERS, RANCHERS, & PRODUCTION AGRICULTURAL OPERATIONS

BACKGROUND

Farmers, ranchers and other agricultural operations can better secure the safe transport of hazardous materials, deter terrorist and illegal acts involving hazardous materials, and reduce their own exposure to liability by developing and implementing security plans that conform to Department of Transportation (DOT) requirements in 49 CFR Part 172, Subpart I. Agricultural operations commonly use many materials that are potential targets for terrorism and illegal activities, including: explosives like dynamite or detonators; certain poisonous pesticides; fertilizers like anhydrous ammonia and ammonium nitrate; and fuels like gasoline, diesel, and propane.

Examples of Types and Quantities of Materials Requiring Transportation Security Plan

(DOT Hazard Class Indicated in Parentheses)

Material	Quantity
Dynamite (Division 1.1 explosive)	
Detonators (Division 1.4 explosive)	
Propane (Division 2.1 material) Anhydrous ammonia (Division 2.2 with TIH hazard) Gasoline (Class 3) Ammonium nitrate fertilizer (Division 5.1) Pesticides or herbicides that bear a DOT poison label (Division 6.1)	More than 119 gallons in a single container OR More than 1,000 pounds in multiple containers in a single shipment
Diesel fuel (Class 3)	More than 119 gallons in a single container

To assist agricultural operations in assessing risk and transporting hazardous materials safely, this sample security plan contains three important components - personnel security, unauthorized access, and security while in transit. Most importantly, the plan conforms to DOT security requirements (49 CFR Part 172, Subpart I) for persons who offer or transport hazardous materials.

ASSESSING YOUR RISK

Explosion and Fire. Hazardous materials that are explosive, flammable or combustible can be used to attack large groups of people, buildings and critical infrastructure. Examples include explosives and bulk quantities of gasoline, diesel fuel, or propane. In addition, bulk quantities of ammonium nitrate and ammonium nitrate fertilizers can be used to make explosives. For agricultural operations transporting these hazardous materials, the greatest security risk is that a shipment may be highjacked or stolen.

"Toxic by Inhalation" Hazards (TIH). TIH materials, either as gases or volatile liquids, can be used to attack people in confined spaces such as buildings or subways. Bulk quantities present dangers to large areas and could affect a significant number of people. In agriculture, TIH includes the fertilizer anhydrous ammonia. For farmers transporting TIH materials, the greatest security risk is that a shipment may be highjacked or stolen or attacked while traveling in a populated area.

Poisonous Liquids or Solids. Materials with oral toxicity (i.e., poisonous if consumed) can be used to attack food or drinking water supplies. Also, liquids that are toxic via the inhalation of their vapors can be used to attack groups of people indoors or outdoors. In agriculture, certain pesticides are considered toxic and are labeled by DOT as "Poisons." For agricultural operations transporting toxic/poisonous materials, the greatest security risk is that a shipment may be highjacked or stolen or illegally released while traveling in a populated or vulnerable infrastructure area.

Hazardous Materials Transportation Security Plan for Agricultural Operations

Agricultural Operation Name: _____

Operation Contact Name Preparing Plan: _____

Town/Community of Operation: _____

Phone Number(s) of Operation & Contact(s): _____

Fully complete the following information based on this agricultural operation's transport of the hazardous materials:

This agricultural operation transports) the following materials for agricultural use in amounts that require placarding:

EXPLOSIVES

Any amount of:

- Dynamite ☐

More than 1,000 pounds (total, if in multiple containers) in a single shipment of:

- Detonators/Blasting Agents ☐

FLAMMABLE/COMBUSTIBLE LIQUIDS OR GASES

More than 119 gallons in a single container OR More than 1,000 pounds in multiple containers in a single shipment of:

- Gasoline ☐
- Propane/Liquified Petroleum Gas ☐
- Butane ☐
- Ammonium nitrate fertilizers ☐

More than 119 gallons in a single container of:

- Diesel Fuel ☐
- Fuel Oil ☐

TOXIC BY INHALATION

More than 119 gallons in a single container OR More than 1,000 pounds in multiple containers in a single shipment of:

- Anhydrous Ammonia ☐

Poisonous/Toxic Solids or Liquids with DOT "Poison Label"

- Pesticides/Herbicides (List below) ☐

Personnel Security

To the extent feasible and practical, references, employment history and immigration status will be checked for personnel hired after September 25, 2003, who will be responsible for transporting these listed hazardous materials from any supplier to this operation.

Personnel responsible for transporting the listed hazardous materials from any supplier to this agricultural operation will be instructed on how to adhere to this security plan.

Unauthorized Access

If it is necessary to stop during transportation of the listed hazardous materials, authorized personnel of this agricultural operation's (operation personnel) will to the extent practical prevent unauthorized persons from gaining access to the shipment by monitoring the shipment during the stop, locking the shipment inside the transport vehicle, securing the shipment to the transport vehicle, and/or securing closures on the containers) or package(s).

If it is necessary to stop during transportation of the listed hazardous materials, operational personnel will check the vehicle and the shipment after the stop to make evaluate whether tampering or illegal activity has taken place.

Operation personnel will report suspicious incidents or events to local law enforcement officials and/or the FBI as soon as is practical, using the contact information supplied below.

Local Police:

Local Fire/Emergency Rescue/HazMat Response:

Nearest FBI Field office:

Security During Transport

Operation personnel will to the extent practical minimize transit time for the listed hazardous materials by going directly from the supplier to the operation.

Operation personnel will report suspicious incidents or events to local law enforcement officials or the FBI as soon as is practical, using the contact information supplied above.

For your records and personnel use, keep a copy of this plan in an accessible, but secure location at the agricultural operation.

Prepared By:_____ Date: _____

Revised/Edited/Reviewed by: _____ Date: _____

Fungicides and Bactericides

(See Table 28 for safe interval between last application and harvest, and restricted entry intervals)

Fungicides and bactericides are often highly effective against some diseases and relatively ineffective against others. They tend to be specific rather than universal in their range of effectiveness. The following descriptions offer more complete information on the value and limitations of these materials than what is given in the schedule. Package labels also contain much valuable information. Read them carefully.

AZOXYSTROBIN (ABOUND 2.08 Flowable) may be applied for control of scab, brown rot, and powdery mildew on peaches and nectarines with use rates of 11.0 to 15.4 fl oz per acre. On peaches only, 9.2 to 15.4 fl oz may be used for scab control. Abound, like other strobilurin fungicides, must be alternated with other fungicides to prevent the development of resistance. For brown rot blossom blight and fruit rot, do not make more than two consecutive Abound applications before alternating with a fungicide with a different mode of action. For all other diseases, do not apply more than three sequential applications before alternating with a fungicide with a different mode of action. Do not alternate or tank-mix with a fungicide to which resistance has developed in your area (for example, the benzimidazoles, Benlate and Topsin-M). Do not make more than four applications or use more than 1.92 qt per acre per year. May be applied up to the day of harvest. **Because Abound has been shown to be extremely phytotoxic to certain apple varieties, it should not be applied where there is possibility of spray drift reaching apple trees.** Also, sprayers used to apply Abound should not be used to spray apple trees.

***BACILLUS SUBTILIS* (SERENADE MAX 14.6%, QST 713 strain)** is registered for powdery mildew control on apple at the rate of 1 to 3 lb per acre and for fire blight suppression at the rate of 2 to 4 lb per acre. Several Serenade/*Bacillus*-related formulations are available; Serenade Max is approved for certified organic production. Read the label for suggested application instructions. Serenade Max is being tested in an alternating program starting with streptomycin, hopefully to offset potential bacterial resistance and prolong the effectiveness of streptomycin. Serenade Max has given some suppression of powdery mildew; although registered for scab control, it has been weak in tests at Winchester. Tank-mix compatibility evaluation of this biological material is still in progress. Restrictions: REI = 4-hour; PHI = 0.

BENZOVINDIFLUPYR (APROVIA 0.83EC) fungicide is registered for control of a broad spectrum of diseases on pome fruits (Apple, azarole, crabapple, loquat, mayhaw, medlar, pear, Asian pear, quince, Chinese quince; Japanese quince, tejocote and cultivars, varieties, and/or hybrids of these). Diseases on the label include: apple and pear scab, powdery mildew, cedar-apple rust, quince rust, sooty blotch and flyspeck, bitter rot, black rot, white rot, Alternaria blotch, Brooks fruit spot. The addition of a spreading/penetrating type adjuvant such as organo-silicon blends with either non-ionic surfactants (NIS) or vegetable based crop oils (COC); or vegetable based COC (not mineral); or NIS with at least 90% concentration is recommended. Aprovia is a FRAC Group 7 (SDHI) fungicide. For resistance management, combine Aprovia with a protectant fungicide also registered to control the target diseases. Do not apply more than 2 consecutive applications before switching to a non-Group 7 fungicide. No more than two applications of Aprovia may be applied on a 7-day interval. All other applications must be applied no closer than a 14-day interval. Do not apply more than 27.6 fl oz/A/year of Aprovia per acre per year. Do not apply more than 0.184 lb ai/A per year of benzovindiflupyr-containing products. Do not apply within 30 days of harvest (30-day PHI). The REI= 12 hr.

CAPTAN 50W, 80W, or 80WDG formulations are used at 6.0-8.0 lb/A of Captan 50W or 3.75-5.0 lb/A of Captan 80W or Captan 80WDG for control of diseases on apple; other formulations should be used according to label direction. On apples Captan has proven effective in the control of apple scab, black rot, Brooks spot, Botryosphaeria rot, blotch, bitter rot, Botrytis blossom infection, fly speck, and sooty blotch. Captan's residual life is relatively short, consequently, sooty blotch, fly speck, and fruit rot control may not be satisfactory where sprays are discontinued more than 3 weeks prior to harvest. The higher indicated rates are for severe summer disease pressure. Captan is effective in the control of peach brown rot and cherry leaf spot.

Captan may produce frogeye-like spotting of the foliage of Delicious, Stayman, and Winesap early in the season. The small spots do not enlarge and are no cause for alarm. The inclusion of sulfur in the spray mixture may increase this type of injury. Captan produces a good finish on peaches and nectarines, but has caused injury to some varieties of plums.

Captan should not be used with lime or other alkaline materials. Do not use it with oil or within four days of an oil spray. Do not use in combination with EC formulations of parathion. Canada has more stringent residue tolerance requirements than the U.S.A. If shipping to Canada, do not apply Captan closer to harvest than two days on peaches and nectarines and do not use Captan in a postharvest fruit dip. No more than 64 lb of Captan 50W or 40 lb of Captan 80W or Captan 80WDG per acre per year. It should be used with caution in bloom sprays, especially on varieties which are hard to pollinate (e.g. Red Delicious). Captan has been shown to severely reduce pollen viability for 24-48 hours after application.

Although Captan labels permit application to apples, peaches, nectarines, cherries, plums and prunes up to the day of harvest, Captan has a 4-day re-entry interval on most labels which makes pre-harvest application more restrictive. A label exception is made for the last 48 hours of the re-entry interval during which workers may enter the treated area to perform hand labor or other tasks involving contact with anything that has been treated, without time limit, if they wear all of the

following: coveralls, waterproof gloves, shoes and socks, and protective eye wear. Some Captan 80WDG formulations are labeled with a more convenient 24-hr REI for apples, apricots, cherries, nectarines, plums/fresh prunes and peaches rather than the previously more restrictive 4 day REI.

CHLOROTHALONIL (BRAVO) is currently formulated as Bravo 720 flowable containing 720 grams per liter or 6 lb a.i. per gallon of flowable formulation and as 90% dry flowable (DF) and dispersible granule (DG) formulation. Bravo 720 is registered on peach, nectarine, apricot, cherry, plum and prune for control of brown rot blossom blight, peach leaf curl, scab, and cherry leaf spot. Use rates are 16-22 fl oz per 100 gal dilute or 4.1-5.5 pt/A for trees less than 20 ft tall. For blossom blight control on trees taller than 20 ft the maximum per acre rate is 5.5 pt. Bravo is not to be applied to any stone fruits between shuck split stage and harvest. On cherries, for control of leaf spot, additional applications may be made within 7 days after harvest and again 10-14 days later. Follow label directions for older containers of Bravo 500 or newer containers of Bravo 90DG or Bravo 90DF.

CYFLUFENAMID (TORINO) fungicide is registered for powdery mildew control in pome fruits and cherries. It has given good powdery mildew control in tests on apple at Winchester. Formulated as a 0.85 SC (soluble concentrate), this product is in Fungicide Resistance (FRAC) Group U6. On pome fruits the use rate is 6.8 fl oz per acre. On pome fruits, do not make more than one application per year and do not apply within 14 days of harvest. On cherries, the use rate is 6.0-6.8 fl oz per acre. Do not make more than two applications per year and do not apply within six days of harvest. The minimum retreatment interval on cherries is seven days. REI = 4 hr.

COPPERS. Fixed copper is a term that refers to several relatively insoluble forms of copper which are safer and more conveniently prepared than Bordeaux mixture. The addition of spray lime is usually necessary for applications on fruit crops, depending upon timing. Copper fungicides are effective against many diseases, however they must be limited to only certain sprays on specific fruit crops because of the potential for injury to fruit and foliage. Fixed coppers are especially useful on apples and pears as an early season spray (dormant to 1/2 inch green) to reduce overwintering fire blight inoculum. Fixed copper compounds are available under many trade names although they can be grouped into several general categories: copper oxychloride sulfate (C-O-C-S, 50% copper), copper tetra calcium oxychloride (45% copper), copper hydroxide (Kocide 101, 50% copper, Kocide DF, 40% copper), and tribasic copper sulfate (53% or 26% copper). Cuprofix Ultra 40 Disperss is basic copper sulfate formulated in gypsum.

Some pesticide labels warn about incompatibility with copper materials due to their alkalinity. Copper materials also have potential for phytotoxicity to leaves and fruit. Phytotoxic potential is generally increased if copper-containing spray mixtures are acidified. It is always a good idea to check the pH of spray mix to make sure it is close to 7.0.

Bordeaux mixture is a mixture in water of copper sulfate and hydrated spray lime and is usually used as a dormant application on apples and pears to reduce overwintering fire blight inoculum, on peaches for leaf curl, and on cherries in postharvest sprays for leaf spot. The recommended amount of each ingredient varies according to use and is designated by a three number formula, e.g. Bordeaux 8-8-100. The numbers represent the amounts of copper sulfate in pounds, spray lime in pounds, and water in gallons, respectively. To prepare the mixture: 1) fill spray tank about 1/3 to 1/2 with water; 2) add the copper sulfate, preferably through a screen with a wooden spoon to avoid getting large granules into the tank (hot water may help dissolve it better); 3) by the time the tank is 2/3 full, all the copper sulfate should be mixed in; now add the spray lime through the screen into the copper sulfate solution in the tank. The lime should be as diluted as possible before it meets the copper sulfate. Pre-soaking the lime before adding it to the tank may be preferred to washing powdered lime directly through the screen and into the tank. Bordeaux mixture is generally unsafe for use on fruit crops after the 1/4 inch green stage. Pears seem to tolerate copper better than apples, and it can be used during bloom for fire blight control if disease pressure is not severe. It also has some activity against collar rot. Bordeaux mixture has some compatibility problems, therefore, when used in combination with other materials, the labels of the pesticides involved should be examined thoroughly.

CYPRODINIL (VANGARD 75WG) is a systemic fungicide that is active against the pathogens Venturia spp. (scab) of apple and Monilinia spp. (blossom blight and brown rot) on stone fruit. A member of the anilinopyrimidine (AP) chemical class, Vangard 75WG should not be confused with an experimental sterol-inhibiting fungicide tested experimentally under the same name in the 1980's. Vangard is reported to have 24-48 hr curative action and 5-8 days preventive action but it is highly specific in its biochemical mode of action, putting it at risk for development of resistant strains of scab or other fungi. Label registration permits the use of 5 oz/A of Vangard alone pre-bloom or 3 oz/A in tank-mix combinations pre-bloom or postbloom, but, because of its potential for development of resistant strains and because other fungicides are needed to broaden the spectrum of control for powdery mildew, rusts and moldy core, we are encouraging that it be used primarily in suitable combinations rather than as the only fungicide in an application. Testing at Winchester has shown mancozeb to be a good mixing partner and this combination is tentatively rated as good for scab and fair for rusts. Do not apply more than 30 oz of Vangard 75WG per acre per year. The re-entry interval for Vangard is 12 hours and PHI = 0 days.

Vangard 75WG is also registered for control of brown rot blossom blight on stone fruits (peaches, nectarines, cherries, plums prunes and apricots) at the rate of 5 oz/A alone or in tank-mix combinations. Apply only at pink and full bloom and

do not apply more than 10 oz per acre per year. Vangard 75WG is not registered for fruit brown rot control and is not to be used on stone fruits after bloom.

DIFENOCONAZOLE + CYPRODINIL (INSPIRE SUPER) is registered on pome fruits, including apples and pears, for control of scab, powdery mildew, cedar-apple rust, quince rust, Alternaria blotch, Brooks fruit spot, sooty blotch, and flyspeck. Follow the mixing directions on the label. Restrictions: No more than 60 fl. oz/A of Inspire Super/year. Do not apply more than 0.33 lb. ai/A/season of difenoconazole-containing products. Do not apply more than 1.25 lb. ai/A/season of cyprodinil-containing products. Do not apply within 14 days of harvest. Restricted entry interval (REI) is 12 hours.

This product is a mix of an SI (Group 3) fungicide and a AP (Group 9) fungicide. Tentative effectiveness ratings for Inspire Super are: Scab – excellent (unless SI/DMI resistance develops); mildew – good; rusts – excellent; Brooks spot – good; sooty blotch and flyspeck – good. Although difenoconazole (like fenbuconazole, "Indar") may have higher intrinsic activity against scab than some earlier SI compounds, both compounds in this mixture (Group 3 and Group 9) are at risk for development of resistance. To help prevent resistance, it is recommended to make no more than 2 consecutive applications with Inspire Super or another Group 3 (SI) fungicide mixture before alternating to a different mode of action. A suggested use for Inspire Super is where mildew-susceptible trees are growing actively after sooty blotch and flyspeck are active in early summer.

Inspire Super is also registered for use on peaches, nectarines, tart cherries, plums, prunes, plumcot, and apricots, for control of blossom blight and fruit brown rot, peach scab, powdery mildew, anthracnose, and cherry leaf spot. Use rate is 16-20 fl oz per acre.

Restrictions: Do not apply to sweet cherries. No more than 80 fl oz of Inspire Super per acre per year. Do not apply more than 0.46 lb. ai/A/season of difenoconazole-containing products. Do not apply more than 1.4 lb. ai/A/season of cyprodinil-containing products. Do not apply within 2 days of harvest. Restricted entry interval (REI) is 12 hours.

DODINE (SYLLIT) is 3.4F flowable is registered at 1.5 pints per acre to control scab at green tip and 7 days later in tank mix with a captan-based formulation or a mancozeb-based formulation. It has been outstanding in its ability to control apple scab and cherry leaf spot however, it is not effective for control of rust infections, fruit rots, or powdery mildew. On apples, do not apply more than 1.5 pints per acre in any single application. Do not apply more than two applications per year. Do not apply within 7 days from the last application and do not apply after pink bud. In some areas under heavy usage for scab control over a period of years, tolerance to dodine has developed in the apple scab fungus. Resistance of the apple scab fungus to dodine has been shown in some areas of the eastern U.S. including some orchards in Clarke and Warren Counties, Virginia; therefore, DODINE SHOULD BE USED WITH CAUTION UNDER HEAVY SCAB CONDITIONS. For resistance management, tank-mix Syllit Fl with captan (1.5-2 lb ai per acre) or mancozeb (2.25 lb ai per acre).

Experience with previous dodine formulations has shown that dodine is not compatible with lime and other alkaline products. Physical incompatibilities with some pesticides have occurred when the combination has been mixed in hard water. A previous formulation, Dodine 65W has "buttered out" in some spray waters when mixed with oil. Be sure that Dodine is thoroughly suspended in the tank before adding oil or other potentially incompatible materials. Dodine-oil mixtures are not compatible with wettable powder malathion, carbaryl, ferbam and sulfurs. Dodine may russet yellow varieties, particularly Golden Delicious. It has sometimes caused fruit spotting of Stayman and some other red varieties, so excessive usage rates should be avoided. Do not apply within 7 days of harvest.

FENAZAQUIN (MAGISTER SC) is a miticide/fungicide registered for powdery mildew in pome fruits and stone fruits. It has given good powdery mildew control in several years of testing on apple at Winchester. Magister also has activity against European red mite, two-spotted spider mite, and rust mites on pome and stone fruit (see write-up in Insecticides). Formulated as a soluble concentrate (SC), this product is in Fungicide Resistance (FRAC) Group 39, and is currently the only tree fruit fungicide in Group 39. It is considered highly toxic to bees and other insect pollinators and must not be used until after petal-fall. Magister should be applied in at least 50 gallons of water per acre at a rate of 32 – 36 fl oz per acre in pome and stone fruit. Its seasonal maximum allowance is 36 fl oz per acre, restricting this product to one application per season. REI = 12 hours; PHI = 7 days in pome fruit and 3 days in stone fruit. Magister SC is also registered for non-bearing tree fruits at the rate of 24 – 36 fl oz per acre. Do not apply Magister SC through any type of irrigation system.

FENBUCONAZOLE (INDAR 2F or 75WSP) is a sterol-inhibiting fungicide registered for use on peaches, nectarines, cherries, plums, prunes, and apricots, for control of blossom blight and fruit brown rot, peach scab and cherry leaf spot. Use 6 fl oz of 2F per acre. Addition of a wetting agent such as Latron B-1956 is recommended. For blossom blight control begin applications at early bloom and repeat at full bloom and petal fall. For scab control begin applications at shuck split and make 2 to 3 subsequent applications at 10-14 day intervals. For fruit brown rot control begin applications 2 to 3 weeks before harvest using a 7 to 10 day spray interval. Indar may be applied up to the day of harvest. For all stone fruits, do not make more than 8 applications or 48 fl oz of Indar 2F per acre per season. Restricted entry interval is 12 hr, PHI 0 days.

Indar is registered on apples as a 2F formulations for scab, mildew, rusts, sooty blotch and flyspeck. Use rate of the 2F is 6-8 fl oz/acre. Do not make more than four applications or apply more than 32 fl oz of Indar 2F per acre per year, and do

not apply within 14 days of harvest. Do not graze livestock in treated areas or feed cover crops grown in treated areas to livestock. Recognize that fenbuconazole is an SI fungicide and use it in a resistance management strategy; considering its spectrum of activity, a suggested use would be where mildew-susceptible trees are actively growing in mid-season after sooty blotch and flyspeck have become active. Restricted entry interval is 12 hr. Do not apply within 14 days of harvest.

FENHEXAMID (ELEVATE 50WDG) is registered for control of fruit brown rot and blossom and twig blight on stone fruits (apricots, cherries, nectarines, peaches, plums, and fresh prunes). Formulated use rates are 1.0 to 1.5 lbs per acre. May be applied up to and including the day of harvest. Do not apply more than 6.0 lb of Elevate per acre per year. Elevate has a restricted entry interval of 4 hours.

FLUAZINAM (OMEGA 500F) is registered on apples at the rate of 10-13.8 fl oz per acre for control of scab and sooty blotch and flyspeck. The rate is 13.8 fl oz per acre for control of bitter rot, black rot, Brooks spot and cedar apple rust, and 13.8 fl oz for suppression of Alternaria blotch, white rot and quince rust. Limitations include no more than 10 applications or 8.625 pt per acre per year, REI 48 hours and PHI 28 days. **Caution**: Omega 500F may cause allergic skin reactions in a small number of sensitive individuals. Observe all precautions for protective clothing and avoid contact of unprotected skin with treated foliage. People who have been sensitized to Omega 500F should not use or have further contact with the product.

FLUDIOXONIL (SCHOLAR 50W, 1.92SC or EZ) is registered as a post-harvest fruit treatment for control of brown rot, Botrytis (gray mold), Rhizopus, and Gilbertella rots on stone fruits, including apricots, peaches, nectarines, plums, cherries, and fresh market prunes. It is also registered on apples and pears for control of Penicillium blue mold, Botrytis (gray mold), bull's-eye rot, and Rhizopus rot. Treatment on both pome and stone fruits may be applied as a dilute, high-volume (8-16 oz in 25-100 gal), or low-volume concentrate applications or as a dip application at 8-16 oz per 100 gal of water; dip for approximately 30 seconds and allow fruit to drain. Read the label for specific information on application methods on fruits, mixtures with waxes, etc. Dip solution should be replaced with fresh dip solution after 200,000 pounds of fruit have been treated. Do not make more than one post-harvest application to the fruit by any application method. Note: Scholar may be degraded by exposure to direct sunlight and treated fruit should not be stored in direct sunlight. Scholar EZ is a concentrated fludioxonil formulation available for thermal fogging on pome fruit. See the label for instructions.

Note: Scholar contains fludioxonil which is in the phenypyrrole (Group 12) class of chemistry. Fungal isolates with acquired resistance may eventually dominate the population if Group 12 fungicides are used repeatedly or in successive years as the primary method of control of targeted species.

FLUOPYRAM (LUNA TRANQUILITY 4.16SC and LUNA SENSATION 500SC) is registered on apples for several uses. Luna Tranquility contains fluopyram (Group 7) and pyrimethanil (Scala, Group 9) and is registered for apple scab and powdery mildew at the rate of 11.2 to 16 fl. oz. per acre. Label restrictions include a 54.7 fl. oz. maximum per acre per year, a 12-hour REI, and PHI = 72 days. Limit the number of applications per season to four, with no more than two applications made sequentially.

Luna Sensation contains fluopyram (Group 7) and trifloxystrobin (Flint, Group 11) and is registered for apple scab, powdery mildew, cedar apple rust, sooty blotch and fly speck, bitter rot, and white rot. Use rate for scab, rust, sooty blotch and fly speck, and bitter rot is 4.0 to 5.8 fl. oz. per acre and for mildew is 5.0 to 5.8 fl. oz. per acre. For white rot, combine Luna Sensation with 1.5 lb. per acre of Captan 80W.

Luna Sensation also is registered for use on sweet and tart cherry for control of brown rot blossom blight and fruit rot, powdery mildew, rusty spot, cherry leaf spot, scab, and anthracnose at the rate of 5.0 to 5.6 fl. oz. per acre. Label restrictions include a 21 fl. oz. maximum per acre per year, with a 12-hour REI and 14-day PHI.

FLUTIANIL (GATTEN 0.423EC) is registered for control of powdery mildew on apples and cherries at the rate of 6.0-8.0 fl oz/A. Flutianil is classified as in the FRAC Thiazolidine Group U13. On apples and cherries do not apply more than 8 fl oz per acre, do not exceed 0.16 lb ai per acre per year, and do not apply more than four applications per year, do not apply closer than 14 days to harvest. The REI is 12 hr. The PHI is 14 days for apples and 3 days for cherries.

FLUTRIAFOL (TOPGUARD 1.04SC, RHYME) is a sterol-inhibiting (Group 3) fungicide that is registered for control of scab, powdery mildew, and quince and cedar apple rusts on apples and for pear scab on pears. For apple scab control, formulated use rates are 8-13 fl oz per acre in combination with a protectant fungicide. For powdery mildew and rust diseases, formulated use rates are 8 to 12 fl oz per acre. For pear scab on pears, the use rate 13 fl oz per acre. The product can be used only once within any 14-day period and for a maximum of 4 applications per season. Additional restrictions on apples include a limit of 52 fl oz per acre per season, no single application exceeding 13 oz per acre, a 14-day pre-harvest interval, and a 12-hour restricted entry interval (REI). Do not add adjuvants to the spray solution.

FLUXAPYROXAD (MERIVON 4.18SC) formulated with pyraclostrobin as Merivon, is registered on stone fruits (apricot, sweet and tart cherries, nectarine, peach, plum and prune) for brown rot, rusty spot, scab, leaf spot, and anthracnose at the rate of 4.0 to 6.7 fl. oz. per acre. Label restrictions include 20.1 fl. oz. maximum per acre per year, a 12-hour REI, and PHI

= 0 days. Maximum number of applications per season is 3. Do not use emulsifiable concentrates (EC) or solvent-based formulation products, or crop oil concentrate (COC) or methylated seed oil (MSO) adjuvants with Merivon.

MERIVON is registered on pome fruits (apple, crabapple, Oriental pear, and pear) for Alternaria blotch, apple scab, bitter rot, Brooks spot, sooty blotch and fly speck, pear scab, powdery mildew, and white rot at 4.0 to 5.5 fl. oz. per acre. Merivon provides suppression only for rust diseases. Label restrictions include 22.0 fl. oz. maximum per acre per year, a 12-hour REI, and PHI = 0 days. Maximum number of applications per season is 4. Do not use emulsifiable concentrates (EC) or solvent-based formulation products, or crop oil concentrate (COC) or methylated seed oil (MSO) adjuvants with Merivon. For pears, do not use Merivon with horticultural mineral oil as foliage and/or fruit damage can occur under certain conditions.

SERCADIS 2.47SC formulation of fluxapyroxad (without pyraclostrobin) is registered on apples for control of Alternaria blotch, scab, black rot/frogeye leaf spot, flyspeck and powdery mildew, and for suppression of cedar-apple rust and quince rust. Use rate is 3.5 to 4.5 fl oz per acre per application. Label restrictions include 18.0 fl. oz. maximum per acre per year, a 12-hour REI, and PHI = 0 days. Maximum number of applications per season is four with only two sequential applications. Because **Sercadis** is a single mode of action SDHI product, we recommend always mixing it with a protectant fungicide to broaden the spectrum of activity, increase residual activity, and to manage development of fungicide resistance.

FOSETYL-AL (ALIETTE 80WDG) is registered for control of *Phytophthora* collar rot on bearing and non-bearing apple trees. Dilute rate per 100 gal is 2.5-5.0 lb. Begin applications at tight cluster. Use 3-4 foliar sprays during the season at 60 day intervals at the 5.0 lb per 100 gal rate or 6-8 applications at 2.5 lb per 100 gal on a 30 day interval. Do not apply more than 5.0 lb of Aliette per acre per application and no more than 20.0 lb per acre per year. DO NOT apply within 14 days of harvest. Can be applied to the tree after harvest but do not apply within 2-3 weeks of leaf senescence.

Aliette may be used in Virginia and West Virginia as a pre-plant tree root dip for control of Phytophthora root and collar rot at the rate of 3.0 lb per 100 gal. Mix the appropriate amount in the desired volume of water and dip the entire root system for 30-60 minutes prior to planting in the field. The Aliette label indicates that it can be used for fire blight control, but experience in the mid-Atlantic region and elsewhere indicates that it is not as effective as streptomycin and may give less than adequate control.

INPYRFLUXAM (EXCALIA 2.84 SC) is registered on apples for control of apple scab, powdery mildew, cedar apple rust and quince rust. Based on tests at Winchester, effectiveness is tentatively rated as: apple scab = good to excellent; cedar apple rust = good; powdery mildew = fair to good. Apply Excalia at a rate of 3 to 4 fl oz per acre. For greater effectiveness on powdery mildew, include an organosilicone adjuvant. Make no more than two applications of Excalia between pink and petal fall, and do not apply more than 4 fl oz per acre per application or more than 8 fl oz per acre per year. Do not apply after petal fall. REI = 12 hr.

IPRODIONE (ROVRAL 50WG OR 4F) is registered for control of brown rot blossom blight on cherries, peaches, and nectarines. The recommended rate is 2 lb or 2 pt per acre. For blossom blight control, apply at early bloom and repeat at full-bloom or petal fall if conditions are favorable for disease development. Effectiveness may be improved by the addition of a non-ionic spreader such as Latron CS-7. DO NOT APPLY AFTER PETAL FALL AND NO MORE THAN TWO TIMES PER SEASON.

KASUGAMYCIN (KASUMIN 2L) is now registered for control of fire blight on apple and pear at the use rate of 64 fl oz per acre. Do not apply more than 256 fl oz per acre per year, more than four applications per year, and no more than two consecutive applications. Do not apply after petal fall or within 90 days of harvest. Do not use alternate tree-row application method. Do not apply kasugamycin in orchards in which the soil has been fertilized with animal waste / manure.

KRESOXIM-METHYL (SOVRAN 50WG) is registered on apples and other prome fruits for the control of scab, powdery mildew, cedar-apple rust, frogeye leaf spot/black rot, Alternaria blotch, Brooks spot, sooty blotch, flyspeck, and white rot. Use rates are 4.0 to 6.4 oz per acre per application (1.0 to 1.6 oz per 100 gallons at a base rate of 400 gallons per acre) with a maximum use of 25.6 oz per acre per season. This is a strobilurin fungicide, as is Flint, and resistance to both is a concern. Limit use of Sovran to no more than two or three consecutive applications before alternating with a non-strobilurin fungicide for at least two applications. Do not make more than four applications of Sovran or another strobilurin fungicide per season. Do not apply within 30 days of harvest. Sovran also is registered for use on pears and other pome fruits for the control of powdery mildew and scab, with the same use restrictions as above. The restricted entry interval (REI) is 12 hours and 30 days PHI. *Although Sovran is registered for cedar-apple rust, it may be inadequate for quince rust control under heavy pressure. In orchards where quince rust may be a problem, we suggest including SI fungicides (Rally, Inspire Super, Procure) as planned alternations of full sprays or by selecting an SI fungicide soon after a potential infection period during the pink-petal fall sprays.*

MANCOZEB (DITHANE M-45, 75DF, MANZATE 75DF, PENNCOZEB 75DF, and/or VARIOUS WETTABLE AND FLOWABLE FORMULATIONS) is a coordinated product of zinc ion and manganese ethylene bisdithiocarbamate (EBDC). It differs from maneb, or maneb plus zinc ion products, and is safer for use on apples. It is formulated as an 80W

powder, flowable or 75DF dry flowable and when used at the rate of 1 lb per 100 gal (or equivalent rate of another formulation), it provides supplemental control against a broad range of apple diseases including: apple scab, apple rust, black rot, bitter rot, sooty blotch, and fly speck. Note that EBDC labels now permit the use of mancozeb and metiram (Polyram) interchangeably on the same crop, but the total amount applied per acre per year is now governed by the most restrictive label (usually a 75DF formulation). See discussion about registered use patterns for EBDC fungicides under 1/4" - 1/2" green spray, page 63.

MEFENOXAM (RIDOMIL GOLD SL and RIDOMIL GOLD GR) is registered as an aid in control of Phytophthora crown and root rot on bearing and nonbearing apple trees. Applications should be made before symptoms appear, especially in orchards favorable for disease development. Mefenoxam should not be expected to revitalize trees showing moderate to severe crown rot symptoms. To apply, Ridomil Gold SL is diluted at the rate of 0.5 pint per 100 gal and poured around the trunk of each tree. The amount of diluted mix applied per tree is based on the trunk diameter as follows: diameter less than 1 inch, 1 qt; 1-3 inch diam, 3 qt; greater than 5 inch diameter, 4 qt. Make one application at the time of planting or in the spring before growth starts. Make another application in the fall after harvest. On new plantings, delay the first application until 2 weeks after planting. Ridomil is highly specific and will not control other agents causing similar tree decline symptoms such as other root rots, graft union necrosis (Tomato Ring Spot Virus) and vole damage. Do not graze or feed cover crops in treated orchards.

RIDOMIL GOLD GR is a granular formulation of mefanoxam and can be used only on nonbearing deciduous fruits. Make the first application at the time of planting and 2 additional applications at 2 to 3-month intervals during the time when conditions are favorable for disease development. Do not use on trees that will bear a harvestable crop within 12 months. For established plantings, make the first application in the spring before growth starts. Read the label for additional cautionary statements.

MEFENTRIFLUCONAZOLE (CEVYA 3.34 SC) is a sterol inhibitor fungicide (FRAC 3). Cevya is registered for use on pome fruit for the control of apple scab, Alternaria blotch, black rot/frogeye leaf spot, cedar apple rust, sooty blotch, flyspeck, and white rot, and for the suppression of powdery mildew and quince rust. Based on two-year testing at Winchester, effectiveness is tentatively rated as good for apple scab, powdery mildew and cedar apple rust. Apply Cevya at a rate of 3 to 5 fl oz per acre (4-5 fl oz per acre for powdery mildew). Do not apply more than 5 fl oz of Cevya per application and do not apply more than 15 fl oz per acre per year. Cevya may be applied up to the day of harvest. REI = 12 hr.

METCONAZOLE (QUASH 50WDG) is a sterol inhibiting fungicide (Group 3) registered for the control of diseases of stone fruits, including apricot, cherries, peach, nectarine, and plum. Diseases controlled are brown rot blossom blight and fruit rot, scab, and powdery mildew. Use rate is 2.5 – 4 oz/A, although for brown rot fruit rot and powdery mildew, a minimum rate of 3.5 oz is needed. Do not apply within 14 days of harvest. Do not make more than 2 applications after petal fall. Do not make more than 3 applications per season. Do not apply more than 12 oz/A/season.

METIRAM (POLYRAM) an EBDC fungicide is formulated as an 80DF powder and is registered for the control of apple scab, cedar apple rust, fly speck, sooty blotch, and as an aid in reduction of European red mite. It has been effective in reducing the severity of leaf blotch defoliation on Golden Delicious. See discussion about registered use patterns for EBDC fungicides under 1/4" - 1/2" green spray, page 57. Note that EBDC labels now permit the use of mancozeb and metiram (Polyram) interchangeably on the same crop, but the total amount applied per acre per year is now governed by the most restrictive label (usually a 75DF formulation).

MYCLOBUTANIL (RALLY 40WSP, formerly NOVA) is a sterol-inhibiting fungicide which is highly effective for control of apple scab, powdery mildew, cedar apple rust, and quince rust. It can be used as a preventive or 96-hour post-infection treatment on scab. The dilute rate selection of 1.25 to 2.5 oz. per 100 gal, depending upon the target disease and time of treatment, is concentrated per acre according to tree size as indicated on the label.

When used on a post-infection schedule, reddish or yellowish, partially inhibited scab lesions may appear and a follow-up application should be made 7 days after the first post-infection application (totalling two complete applications within 11 days after the infection period) to inactivate such lesions which would appear 10 to 20 days after the infection period. When spraying on an alternate middle schedule, two half-sprays should be applied as soon as possible after the infection period, followed by two more half-sprays starting 7 days after the first half-spray following the infection period.

As with most sterol-inhibiting fungicides, Rally is not effective against all moldy core fungi and summer diseases and is less effective for scab control on fruit than on foliage. Also, there is evidence that the apple scab fungus can develop cross resistance to all sterol-inhibiting fungicides (Indar, Inspire Super, Rally, Procure) when used alone for scab control. To avoid these potential weaknesses and to lengthen the effective life of this class of fungicides, it is recommended that the sterol-inhibiting fungicides be used in conjunction with protectant fungicides (Captan, mancozeb, metiram, ziram, thiram, dodine, etc.), preferably as a tank-mix combination as permitted by the label.

Rally is sold in water-soluble PVA bags. Some precautions should be taken to assure that the material is properly suspended in the spray tank. The bag should be dissolved and the fungicide fully-suspended before adding other spray materials to the tank. This is particularly true with spray oils and Solubor (and other materials releasing boron) because these materials cause a reaction which prevents the bag from dissolving. Once in suspension, Rally is compatible with most common spray materials except basic copper-containing fungicides.

Do not apply Rally to apples within 14 days of harvest and do not apply more than 5 lb per acre per season. Do not graze livestock in treated areas or feed cover crops grown in treated areas to livestock.

Rally 40WSP is registered on cherries for brown rot blossom blight, powdery mildew and leaf spot control and on peaches and nectarines for brown rot blossom blight and powdery mildew control. Use rates on cherries, peaches and nectarines are 1.25 to 2.0 oz/100 gal dilute and 2.5 to 6.0 oz/A. Powdery mildew on peaches includes the "rusty spot" symptom believed to be caused by the apple powdery mildew fungus. Timing for rusty spot control is shuck split through 3rd cover. Rally 40WSP may be applied to stone fruits up to the day of harvest. Rally does not provide adequate control of scab on peaches and nectarines. Do not exceed 3.25 lb per acre per season.

OXYTETRACYCLINE (MYCOSHIELD, FIRELINE) antibiotic formulations are now also registered for control of fire blight on apples. Usage wording on the **FireLine** and **Mycoshield** product labels is different. REI for both products is 12 hr. Do not apply either **FireLine** or **Mycoshield** within 60 days of harvest. Both labels warn about the possibility of injury to the fruit or foliage of sensitive apple varieties. Begin **FireLine** applications at the start of bloom at a dosage of 50 to 150 gal per acre. Repeat applications at 3- to 6-day intervals until the end of bloom. One additional application is permitted at the end of bloom. Do not make more than **six applications** per year. Do not apply more than 150 gal of spray solution per acre and no more than **1.5 lb of FireLine per acre per application**. Begin **Mycoshield** applications at 10% bloom and continue at 3-6 day intervals, or apply when blight favorable weather is expected during apple bloom. Apply a 200 ppm solution which is equivalent to 0.5 lb of Mycoshield per 50 gal of water per acre. Do not make more than **five applications** per acre per year. Do not apply more than **1.0 lb of Mycoshield per acre per application**.

OXYTETRACYCLINE is also registered under the trade names FireLine, and Mycoshield for the control of bacterial spot on peaches and nectarines. They are the best available materials for this use. Do not apply either **FireLine** or **Mycoshield** to peaches or nectarines within 21 days of harvest.

PENTHIOPYRAD (FONTELIS 1.67SC) is registered on stone fruits (apricot, sweet and tart cherries, nectarine, peach, plum and prune) for brown rot and rusty spot, and pome fruits (apples and pears) for apple scab and powdery mildew at the rate of 16 to 20 fl. oz. per acre. Label restrictions include a 61fl. oz. maximum per acre per year, a 12-hour REI, PHI on pome and stone fruits are 28 and 0 days, respectively. Fontelis is in the same fungicide group (Group 7) as boscalid (Endura), which is one of the two components in Pristine; fluopyram, which is one of the two components in Luna Tranquility and Luna Sensation; and fluxapyroxad, which is one of the two components in Merivon. Group 7 fungicides are considered to be at risk for development of resistance. Limit the number of applications to four and utilize fungicides with other modes of action for different diseases throughout the season as appropriate. Limit the potential for resistance to all of these products by not exceeding the total number of sequential applications of Group 7 fungicides or their total number per season. Do not tank-mix Fontelis with thinning agents.

POTASSIUM PHOSPHITE (PROPHYT) is registered in a tank-mix combination with Captan for control of summer diseases, including Alternaria leaf blotch, sooty blotch, flyspeck and black pox. In North Carolina it is viewed as highly effective for Glomerella leaf spot, a new problem that causes defoliation of Gala apples. The tank-mix rate is ProPhyt 4 pt/acre + Captan 50WP 6 lb/acre. Observe all restrictions on the Captan label. This combination is useful as an alternating application with strobilurin fungicides (Pristine, Flint, Sovran) for management of Alternaria leaf blotch which causes defoliation of Red Delicious.

PROHEXADIONE-CALCIUM (APOGEE 27.5DF, KUDOS 27.5WDG) is a plant growth regulator registered for fire blight shoot blight management. See the plant growth regulator section and bloom sprays, and comments about the use of Apogee for shoot growth and fire blight suppression.

PROPICONAZOLE (TILT, PROPIMAX EC, BUMPER 41.8EC) is registered at the rate of 4 fl oz per acre for control of brown rot blossom blight and fruit brown rot, cherry leaf spot, and powdery mildew on peaches, nectarines, cherries, plums and prunes, and apricots (and, for Tilt and PropiMax, hybrids of these, i.e. plumcots, pluots, etc.). Three sprays of propiconazole may be applied during the bloom period (pink bud to petal full on peaches and nectarines). A maximum of two preharvest sprays may be applied during the period beginning 3 weeks before harvest through the day of harvest. Do not apply propiconazole to Stanley-type plums/prunes within 21 days of harvest.

PYRACLOSTROBIN (CABRIO 20EG), a strobilurin (Group 11) fungicide, is registered on cherries for brown rot and powdery mildew control at the rate of 9.5 oz per acre. Label restrictions include 47.5 oz maximum per season and 12 hour REI. May be applied day of harvest. Because this is a strobilurin fungicide at risk for development of resistance, limit the number of applications to five and utilize fungicides with other modes of action as appropriate.

PYRACLOSTROBIN + BOSCALID (PRISTINE 38WDG), a package mix of a strobilurin (Group 11) fungicide and a carboximide (Group 7) fungicide, is registered on stone fruits (apricot, sweet and tart cherries, nectarine, peach, plum and prune) for brown rot, powdery mildew, scab, cherry leaf spot, Alternaria leaf spot and anthracnose control at the rate of 10.5 – 14.5 oz per acre. Label restrictions include a 72.5 oz maximum per acre per year and a 12 hour REI. Pristine may be applied the day of harvest. Although Pristine is a mixture of two compounds with different chemical modes of action, it should be recognized that one of the compounds is a strobilurin at risk for development of resistance. Limit the number of applications to five and utilize fungicides with other modes of action for different diseases throughout the season as appropriate. Limit the potential for development of resistance to all of these products by not exceeding the total number of sequential applications of Group 7 or Group 11 fungicides or their total number of applications per season. Do not make more than two sequential applications of Pristine before alternating to a fungicide with another mode of action.

Pristine is now registered on pome fruits (including apples, pears, and oriental pears) for Alternaria blotch, apple scab, bitter rot, black rot/frogeye leaf spot, Brooks spot, sooty blotch, flyspeck, powdery mildew, and white rot and for suppression of cedar-apple and quince rusts. Under a separate label, Pristine is also registered for control of gray mold (Botrytis) and blue mold (*Penicillium*) when applied preharvest. Rate: 14.5 to 18.5 oz acre (no less than 14.5 oz per acre based on TRV). Restrictions: REI = 12-hour; PHI = 0. Both compounds in this package mixture (Group 7 and Group 11) are at risk for development of resistance, limit the number of applications to four per year; utilize fungicides with other modes of action for different diseases throughout the season as appropriate. Do not make more than two sequential applications of Pristine before alternating to a fungicide with another mode of action. It is suggested that the use of Pristine on apples be directed toward situations where Alternaria leaf blotch and summer diseases, especially rots, are difficult to control. Use no more than a 74-oz maximum per acre per year.

PYRIMETHANIL (SCALA 5SC) has a federal registration for apple and pear scab control. Use rates are 5 fl oz per acre in tank-mix combination with another fungicide effective for scab control, or 7-10 fl oz of Scala alone. Because Scala is an anilinopyrimidine (AP, Group 9) fungicide similar in action to Vangard and similarly at-risk for development of resistance in the apple scab fungus, the tank-mix combination of Scala 5 fl oz per acre + mancozeb 3.2 lb per acre is suggested on a trial basis. Do not use a fungicide from the AP group for more than 4 sprays in any one season as a solo product or 5 treatments in a tank-mixture against *Venturia spp*. (scab). If applying Scala alone on any crop, do not make more than two consecutive applications without alternating to an equal number of applications of a fungicide from a different resistance management group (see Table 2). Scala should not be alternated or tank-mixed with any fungicide to which resistance has already developed. Do not tank-mix Scala with captan 50 WP to be applied at less than 10 gallons spray volume per acre. Do not apply more than 40 fl oz of Scala 5SC per acre per year. Do not apply within 72 days of harvest. REI is 12 hours. Scala is also registered for control of brown rot blossom blight, shot hole, and gray mold on stone fruits except cherries. See the label for specific use instructions on stone fruits.

Pyrimethanil is also registered as **Shield-Brite Penbotec 400SC** for post-harvest treatment of pome fruits for control of blue and gray molds. Use rates are 16-32 fl oz per 100 gal for dips, wash tanks and drenchers; 32 fl oz per 100 gal as an aqueous line spray or 64 fl oz per 100 gal as a wax line spray. Check the label for other specific instructions.

REYNOUTRIA SACHALINENSIS (REGALIA 5%) is registered on pome fruits for control of powdery mildew, cedar-apple rust, apple scab (suppression only) fire blight, flyspeck, sooty blotch, Alternaria blotch, bitter rot, and white rot. Use rate is 1.0-4.0 qt/A. The active ingredient is an extract from (giant knotweed) and is classified in the FRAC plant extract group P5. The REI is 4 hr and the PHI is 0 days for apples. Research at Winchester has indicated protective and after-infection control of cedar apple rust and quince rust when used in combination with JMS Stylet-Oil. Regalia is also registered for an array of diseases on stone fruits, but without field testing experience at Winchester.

STREPTOMYCIN (AGRI-MYCIN, BACMASTER, FIREWALL), an antibiotic widely used against fire blight of apples and pears, is formulated as streptomycin sulfate 17W. It is commonly used at 60 to 100 ppm in blossom sprays and at 100 ppm in post-blossom sprays.

The effectiveness of streptomycin can be increased by including the adjuvant Regulaid at the rate of 1 pt per 100 gal of tank mix; however, the increased uptake of streptomycin with Regulaid is more likely to result in streptomycin injury.

STYLET-OIL (JMS STYLET-OIL) is registered for powdery mildew control on apple at the rate of 1 to 2 gal per 100 gal dilute. Stylet Oil has given slight suppression of some other fungal diseases. Two formulations are available, one of which is approved for certified organic production. Read and observe all label precautions regarding general compatibility of other products with oil products, including JMS STYLET-OIL. Specifically, do not tank-mix Stylet Oil with spreader stickers or tank mix or use within 10 days of a pinolene-based product or 14 days of a sulfur product. Do not tank mix or apply within 7 days of captan. Do not apply when freezing temperatures are anticipated within 48 hours of an application, above 90°F, or when plants are under heat or moisture stress. Restrictions: REI = 4-hour; PHI = 0.

SULFUR. Wettable sulfurs are finely divided, elemental sulfur particles with a wetting agent added so that the sulfur can be mixed with water and remain in suspension while being applied. The most readily available forms of sulfur are dry, wettable powder (95% sulfur) and fused bentonite sulfur (30% to 81% sulfur depending upon the brand). Sulfur dusts are available and generally are more finely divided and therefore more adherent and effective than the coarser wettable powders. Flowable sulfur products are available and their advantage over wettable sulfurs include being effective at lower rates and having better retention properties. Generally, sulfur is used in apple programs for the control of apple scab and powdery mildew. For scab, dry wettable sulfur (95WP) is used at a rate of 5 lbs. per 100 gallons in early-season sprays in a protective program. It can be used during bloom without reducing fruit set significantly, however fruit russetting and yield reduction may result if it is used under high temperature conditions. However, many orchardists growing fruit for the processing market routinely use sulfur in postbloom sprays without adverse economic effects. Sulfur is also the cornerstone for early-season and summer disease control in organic orchards. Sulfur is very effective against powdery mildew and can be combined at reduced rates (3 lbs/100 gallons) with most pesticides. On stone fruits, sulfur is effective against brown rot, although not as effective as Captan or some of the newer materials. It also has good activity against peach scab, fair activity against Rhizopus rot.

Do not use any sulfur products within two weeks before or after an oil spray. Copper, sulfur, and liquid lime-sulfur should be used by growers who intend to produce fruit for the "organic" market. Growers are cautioned to be aware of the disadvantages and limitations of these materials, compared to synthetic fungicides: sulfur is incompatible with oil, it has poor residual activity, it acidifies soil when used in seasonal programs, and it is phytotoxic to fruit and foliage when used in hot weather; liquid lime-sulfur is extremely caustic and may be dangerous to apply, it may also be phytotoxic to foliage and it may reduce leaf size and yield, several consecutive applications may need to be made to effectively eradicate scab lesions; copper sprays have better residual activity than sulfur sprays and some coppers can be used to tight cluster if surface russetting of the fruit is not a problem. Only a few copper formulations are registered for application after petal fall. Because of these problems, organic growers are best served by planting many of the excellent disease resistant cultivars that are available commercially.

TEBUCONAZOLE (TEBUSTAR 45WP, ORIUS 20AQ, TOLEDO 45WP), a sterol-inhibiting fungicide is registered for control of brown rot blossom blight and fruit rot on cherry, peach and nectarine and for leaf spot and powdery mildew control on cherry. Rates of Tebustar for these crops are 2 oz per 100 gal and 4 to 8 oz per acre (based on 200-400 gal dilute/acre). Read the label fo rates and crop restrictions for other tebuconazole products. Tebuconazole products may be applied to stone fruits up to and including the day of harvest (0 PHI). Do not apply more than 3 lb of tebuconazole 45WP products per acre per season.

TEBUCONAZOLE (Toledo 45WP), is registered on apples, pears, and oriental pears for control of scab, powdery mildew, and cedar-apple rust. Rates for these crops are 4 to 8 oz per acre or 2 oz per 100 gal dilute. Do not apply Toledo 45WP within 75 days of harvest (PHI). Do not apply more than 3 lb of Toledo 45WP per acre per year. Restricted entry interval is 5 days.

THIABENDAZOLE (MERTECT 340-F) is benzimidazole-type fungicide registered for postharvest treatment of apples and pears for control of Penicillium blue mold and several other rots. Use a suspension of 16 fl. oz. per 100 gal. water for application as a dip, flood, or spray to harvested fruit. Apples may be treated before and after storage; pears may be treated only once. Do not treat longer than 3 minutes. Because thiabendazole is a benzimidazole-type fungicide, it will not be effective on strains of fungi resistant to Topsin-M. To prevent infection of fruit in the dip tank by strains of resistant rot fungi, it is suggested that Captan be included in the postharvest treatment.

THIOPHANATE-METHYL (TOPSIN, TOPSIN-M) is formulated as a 70WP and is available in water-soluble bags. Topsin 4.5FL is a new flowable formulation. They are is formulated as a 70WP and is available in water-soluble bags. Topsin 4.5FL is a flowable formulation. They are registered for use in controlling several diseases of stone fruit. Thiophanate-methyl is registered for use on apricots, cherries, nectarines, peaches, plums, and prunes for control of brown rot, blossom blight, fruit brown rot, peach scab, powdery mildew, black knot, and cherry leaf spot.

Thiophanate-methyl (Topsin, Topsin-M) belongs to the same family of chemical compounds as benomyl (Benlate), a fungicide no longer registered. Generally, those disease-causing fungi that are resistant to Benlate also are resistant to Topsin-M. Brown rot strains resistant to these fungicides have been detected in Albemarle, Frederick, Montgomery and Patrick Counties and could be present in other areas also. Benzimidazole-resistant strains of peach scab are present in some areas of southern Virginia. Therefore, Topsin-M should be used only in combination with Captan, sulfur, or other fungicides for the control of brown rot and scab on peaches and nectarines and other stone fruit.

Thiophanate-methyl is also registered for apple scab, powdery mildew, apple black rot, sooty blotch, and fly speck. After using thiophanate-methyl as recommended, if the treatment is not effective, a tolerant strain of the fungus may be present therefore, call your Extension Specialist for another recommendation. Strains of apple scab resistant to thiophanate-methyl have been detected in many counties in Virginia and West Virginia.

Topsin-M (but not Topsin 4.5FL) is registered on pears at the rate of 4 oz per 100 gal or 1 lb per acre concentrate for control of several diseases. Use restrictions on pears include: REI – 3 days, PHI 1 day; do not apply more than 4 lb per acre per year.

Thiophanate-methyl appears to have no compatibility problems with those pesticides that commonly are used in stone-fruit or apple orchards. However, do not tank-mix with copper-containing chemicals or with highly alkaline pesticides such as Bordeaux mixture or lime sulfur.

TRIFLOXYSTROBIN (FLINT 50WG, GEM, GEM 500SC) Flint is registered for use on pome fruits for the control of scab, powdery mildew, sooty blotch, flyspeck, bitter rot and white rot. Use rates are 2.0 to 2.5 oz per acre for scab, powdery mildew, sooty blotch and flyspeck; and 3.0 oz per acre alone or tank mixed at 1.5 oz per acre with 1.2 lb a.i. per acre of captan. This is a strobilurin fungicide, as is Sovran, and resistance to both is a concern. Limit use of Flint to no more than two or three consecutive applications before alternating with a non-strobilurin fungicide for at least two applications. Do not make more than four applications of Flint or another strobilurin fungicide per season. Do not apply within 14 days of harvest. Do not apply more than 11 oz per acre per season. The restricted entry interval (REI) is 12 hours. Although Flint has some activity against cedar-apple rust, it may be inadequate for quince rust control under heavy pressure. In orchards where quince rust may be a problem, we suggest including SI fungicides (Rally, Inspire Super, Procure) as planned alternations of full sprays or by selecting an SI fungicide soon after a potential infection period during the pink-petal fall sprays. *Do not apply where spray may drift to Concord grapes or crop injury may occur. After applying Flint, carefully rinse spray equipment before applying other products to Concord grapes. Do not apply Flint in combination with an organosilicate surfactant or crop injury may occur.*

GEM and **GEM 500SC** are registered on stone fruits (apricots, cherries, nectarines, peaches, plums, plumcots and fresh market prunes) for control of cherry leaf spot, powdery mildew and scab. Gem is also labeled for control of shot hole and suppression of blossom blight. Consult labels for use rates and limits on amount to be applied in one season. Do not make more than two consecutive applications of Gem, Gem 500SC or another strobilurin fungicide before alternating with at least two applications of a non-strobilurin fungicide. Do not make more than four applications of Gem, Gem 500SC or another strobilurin fungicide per season. Do not apply Gem or Gem 500SC to stone fruits within a day of harvest (1 day PHI).

TRIFLUMIZOLE (PROCURE 50WS) is a recently registered sterol-inhibiting fungicide for control of powdery mildew, scab and cedar-apple rust on apples and powdery mildew and scab on pears. Formulated use rates on both apples and pears are 2-4 oz per 100 gal dilute and 8-16 oz per acre. Restrictions on both apples and pears are a limit of 4 lb per acre per year, a 14 day pre-harvest interval and a 24 hour restricted entry interval.

ZIRAM. Ziram is a dithiocarbamate fungicide registered as Ziram 76DF for use on apples, pears, peaches, nectarines and cherries. Diseases for which Ziram is labeled include scab, quince and cedar-apple rust, sooty blotch, flyspeck, bitter rot and necrotic leaf blotch on apples; pear scab, Fabraea leaf spot, sooty blotch, flyspeck, and bitter rot on pears, leaf curl on peach, brown rot on cherries, peaches and nectarines, scab on peach and nectarine, and cherry leaf spot. On apples and pears the registered rates for the 76DF formulation are 6 lb per acre per application and a limit of 42.4 lb per acre per year and no more than seven applications per year. Rates of 4.5-8 lb per acre per application, 48.2 lb per acre per year and four applications are permitted on peaches and nectarines. On cherries the use rate 5-6 lb per acre with a maximum of 24.2 lb per acre per year and 4 applications per year. The pre-harvest interval is now 14 days for Eastern U. S. apples, pears, peaches, nectarines, and cherries. Ziram dust may cause irreversible eye damage and irritation of nasal passages, throat and skin.

FUNGICIDE MODES OF ACTION (MOA) AND RESISTANCE MANAGEMENT

The following fungicides (Table 2), which are used or have been used on tree and small fruits, are prone to development of resistance in target fungi. Use pattern and history are important factors in development of resistance. This table is presented to show "at risk" resistance relationships within groups and is not intended to imply current registration on any fruit crop. Consult fungicide labels for information regarding registration and suggested rotations and mixtures to avoid potential resistance.

Table 2. Fungicide chemistry classes at risk for development of resistance

Fungicide class	Compound(s)	Trade name(s)	Risk*
Strobilurin (QoI)	azoxystrobin	Abound, Quadris	H
(Group 11)	kresoxim-methyl	Sovran	H
	pyraclostrobin	Cabrio	H
	pyraclostrobin + boscalid (not a strobilurin)	Pristine	H
	pyraclostrobin + fluxapyroxad (not a QoI)	Merivon	H
	trifloxystrobin	Flint, Gem	H
	trifloxystrobin + fluopyram (not a QoI)	Luna Sensation	H

Fungicide class	Compound(s)	Trade name(s)	Risk*
Carboximide (SDHI, anilide) (Group 7)	benzovindiflupyr	Aprovia	M
	boscalid	Endura	M
	boscalid + pyraclostrobin (not a carboximide)	Pristine	H
	fluopyram + pyrimethanil (not an SDHI)	Luna Tranquility	H
	fluopyram + trifloxystrobin (not an SDHI)	Luna Sensation	H
	fluxapyroxad + pyraclostrobin (not an SDHI)	Merivon	H
	fluxapyroxad	Sercadis	H
	inpyrfluxam	Excalia	M-H
	penthiopyrad	Fontelis	H
Benzimidazole (Group 1)	thiophanate-methyl	Topsin-M	H
	thiabendazole	Mertect	H
Guanidine	dodine	Syllit	L-M
Sterol inhibitors (Group 3)	difenoconazole + cyprodinil (not an SI)	Inspire Super	M
	fenbuconazole	Indar	M
	flutriafol	Topguard/Rhyme	M
	mefentrifluconazole	Ceyva	M
	metconazole	Quash	M
	myclobutanil	Rally	M
	propiconazole	Orbit, Tilt, PropiMax	M
	tebuconazole	Elite	M
	triflumizole	Procure	M
Hydroxyanilid (Group 17)	fenhexamid	Elevate	M
	fenhexamid + captan	Captevate	M
Dicarboximide (Group 2)	iprodione	Rovral	M
Anilinopyrimidine (Group 9)	cyprodinil	Vangard	M
	cyprodinil + difenoconazole (not an AP)	Inspire Super	M
	pyrimethanil	Scala, Penbotec	H
	pyrimethanil + fluopyram (not an AP)	Luna Tranquility	H
Phenylamide (Group 4)	mefenoxam	Ridomil Gold	H
Pyrrole (Group 12)	fludioxonil	Scholar, Maxim	L-M
U13	flutianil	Gatten	unknown
2, 6-dinitroanilines (Group 29)	fluazinam	Omega	M
P5	*Reynoutria sachalinensis*	Regalia	L
Quinazoline (Group 39)	fenazaquin	Magister SC	unknown
Phenylacetamide	cylufenamid	Torino	unknown

Laboratory assays and genetic tests show a significant shift toward resistance to the SI and QoI fungicide classes in the apple scab fungus sampled from West Virginia and Frederick County, Virginia. Practical control could be lost in a bad scab year. The use of mixtures of materials, rotations among classes of materials (Table 2), or both, is strongly advised.

*Risk of developing resistance: H = high; m = moderate; L = low.

Insecticides

(See Table 28, page 169 for safe interval between last application and harvest, and restricted entry intervals)

ABAMECTIN (ABBA, AGRI-MEK) is an insecticide/miticide formulated as a 0.15EC and a 0.8SC registered for use in both pome fruit (spider mites, spotted tentiform leafminer, white apple leafhopper, pear psylla, pear rust mite) and stone fruit (spider mites). Because of resistance problems commonly associated with many of these pests, abamectin should be rotated with other materials and must not be applied more than twice per season. The label rate for the 0.15EC formulation is 10 – 20 fl oz/acre, and a 40 fl oz/acre seasonal maximum. The rate for the 0.8SC product is 2.25 – 4.25 fl oz/acre, with a seasonal maximum of 8.5 fl oz /acre. Do not apply in less than 40 gal of water per acre. See label restrictions on spraying near bodies of water. Always apply these products in combination with horticultural spray oil (not a dormant oil) or a non-ionic surfactant that spreads on and/or penetrates the leaf cuticle, at a rate of 0.25% or not less than 1 gal per acre. Although other surfactants may be used, control is not as effective as with oils. While abamectin poses no incompatibility problems, be aware of compatibility problems involving oils. Proper timing is important, since the material must be absorbed by young foliage; recommended timing is within two weeks after petal fall on apples and pears. REI = 12 hours, PHI = 28 days for pome fruit, 21 days for stone fruit. Do not apply more than 2 abamectin-containing products per year.

ABAMECTIN and THIAMETHOXAM (AGRI-FLEX) are a miticide and a neonicotinoid pre-mixed in a soluble concentrate (SC) formulation registered for use in apples and pears and provide a broader spectrum of pest activity than either product alone. Pests labeled include spider mites, various aphids, mealybugs, European apple sawfly, leafhoppers, leafminers, pear psylla and plum curculio. Agri-Flex must be used in combination with at least 1 gal per acre of horticultural spray oil (not a dormant oil) in at least 40 gpa. Due to the toxicity of thiamethoxam to bees, Agri-Flex cannot be applied in apples or pears after pre-bloom or through bloom. Optimal timing for this product, applied at 5.5 to 8.5 fl oz per acre, is in the period between petal-fall through about first cover. Two applications per season and a maximum of 17 fl oz per acre are permitted. REI = 12 hours, PHI = 35 days. Do not apply more than 2 abamectin-containing products per year.

ACEQUINOCYL (KANEMITE) is a naphthoquinone derivative acaricide registered for the control of European red mite and twospotted spider mite on apple and pear. Formulated as a 15SC (suspension concentrate), it is used at the rate of 31 fl oz per acre. Kanemite acts as a mitochondrial electron transport inhibitor (METI), blocking cellular respiration, but at a different site than other compounds. Activity occurs primarily by contact and secondarily by ingestion. Kanemite should be applied at mite threshold, and rotated with acaricides having different modes of action to minimize development of resistance. It has been classified by EPA as a reduced risk compound. Two applications per year are permitted. REI = 12 hours, PHI = 14 days. Do not make more than two applications of Kanemite 15SC per year. Do not apply more than 62 fl oz per acre (0.6 lb ai) per season.

ACETAMIPRID (ASSAIL) is a member of the neonicotinoid class of chemicals with registration on pome and stone fruits. It has translaminar systemic activity and controls pests by contact and ingestion. Like other members of this chemical class, Assail is very effective against aphids, leafhoppers, leafminers, and pear psylla, but is unique in also providing control of internal worms. Available as a 30SG, it may be applied during the prebloom, bloom and postbloom periods at rates of 2.5 to 8.0 oz per acre, depending upon insect species. Use is limited to a maximum of 4 applications and 32 oz of product per acre per season, with a minimum finished spray volume of 80 gallons per acre. REI = 12 hours, PHI = 7 days. Do not make more than 4 applications per calender year. Do not exceed a total of 0.6 lb ai (32 oz product) per acre per calendar year.

AFIDOPYROPEN (VERSYS) is an insecticide registered for use in pome and stone fruit that is classified in resistance group 9D, due to its disruption of feeding and other behaviors in the target insects, which include aphids in both crop groups. Formulated as a dispersible concentrate, Versys is labelled at a rate of 1.5 fl oz per acre for pome and stone fruit (3.5 fl oz per acre for woolly apple aphid suppression in apples), with seasonal maximums of 7 fl oz and 3 fl oz per acre in pome and stone fruit, respectively. Versys is recommended for pre-bloom management of rosy apple aphid and the green apple aphid complex (tight cluster to open cluster) and for post-bloom management of aphid pests of stone fruit. Restrictions: REI = 12 hours, PHI = 7 days.

AZADIRACHTIN (AZA-DIRECT, NEEMIX) is a biological insecticide derived from nuts of the neem tree that is registered for the control of a variety of pests on all pome and stone fruits. This product is formulated as 0.082 lb (Neemazad), 0.0987 lb (Aza-Direct), or 0.34 lb (Neemix) of azadirachtin per gallon. Azadirachtin controls target pests on contact or by ingestion and acts by way of repellance, antifeedance, and interference with the molting process. These products are listed by the Organic Materials Review Institute (OMRI) as options for organic pest management. The application rate ranges from 4 to 72 oz per acre, depending upon the product and target pest. Azadirachtin has demonstrated good to excellent control of rosy apple aphids, plant bugs, spotted tentiform leafminer, codling moth and oriental fruit moth. REI = 4 hours, PHI = 0 days.

BACILLUS THURINGIENSIS is a bacterial insecticide formulated as a wettable powder and as an aqueous concentrate. It may be recommended in combination with either an adjuvant or another insecticide, so read the label very carefully.

Generally speaking, **B.t.** (various trade names) is most effective against newly hatched caterpillars. Death is slow because the material must be ingested and the biological action completed within the insect's gut before death occurs; however, larvae soon cease feeding after ingesting **B.t.** Rates are given on the label for each specific formulation. **B.t.** is particularly useful if an insecticide is required to control gypsy moth during bloom. REI = 4 hours, PHI = 0 days.

BETA-CYFLUTHRIN (BAYTHROID XL) is a pyrethroid insecticide formulated as a 1EC and registered for control of many pests of pome and stone fruits. Application rates range from 1.4 to 2.8 fl oz per acre, depending upon the targeted pest(s). Baythroid XL is limited to a seasonal maximum of 2.8 fl oz per acre on apple and pear, and 5.6 fl oz per acre on stone fruits. It is important to note that use of the high rate of Baythroid will preclude the use of other products containing either beta-cyfluthrin (Leverage 360; see write-up) or the closely related compound, cyfluthrin (Tombstone; see write-up) in the same season, since the seasonal maximum allowances for beta-cyfluthrin and cyfluthrin are cumulative. Do not apply more than the combined maximum seasonal total for both active ingredients. The minimum water volume for application is 100 gal per acre on pome fruit and 50 gal per acre on stone fruit. As with other pyrethroids, postbloom use may cause outbreaks of mites and secondary pests. REI = 12 hours, PHI = 7 days. Do not apply more than 2.8 fl oz/A (0.022 lb ai/A) per season for pome fruits, nor 5.6 fl oz/A (0.044 lb ai/A) for stone fruits.

BIFENAZATE (ACRAMITE, BANTER) is a miticide formulated as Acramite 50WS, Banter SC, and Banter WDG for control of European red mite and two-spotted spider mite in pome and stone fruit at 12.0 – 16 oz per acre or 12.0 – 16. fl oz per acre. It should be applied only once per season in a minimum of 50 gallons per acre. These products provide quick knockdown activity through contact and long residual control, but are not systemic, so thorough coverage of upper and lower leaf surfaces is necessary. The use of an adjuvant to improve coverage, and to lower the pH and reduce the hardness of spray water is recommended for these products. They are a good fit for summer use at low mite threshold, in rotation with other miticides. REI = 12 hours, PHI = 7 days (pome fruit) or 3 days (stone fruit). One application per season.

BIFENTHRIN (BIFENTURE, BRIGADE) is a pyrethroid insecticide registered for control of numerous insect pests of tree fruits, and known to be one of the strongest products against BMSB. It is important to recognize that **Bifenture** is labeled for use **only on pear**, while Brigade can be used on all pome fruit crops plus peach and nectarine. Bifenture is formulated as a 2EC and a 10DF, while Brigade is formulated as a 2EC and a WSB, however for brevity, we have included only the 2EC formulations in our recommendations. Application rates for the EC formulation of both products are 2.6 – 12.8 fl oz per acre (see labels for pest-specific rates). Also see labels for rates of the 10DF and WSB formulations. The seasonal maximum allowance for the EC formulation is 32.0 fl oz per acre, with not more than 28.8 fl oz per acre after petal fall. Minimum application interval is 20 days for all formulations. REI = 12 hours, PHI = 14 days.

BUPROFEZIN (CENTAUR) is an insect growth regulator registered for use on stone and pome fruits. Formulated as a 70WDG, Centaur is labeled for the control of scales, leafhoppers, and pear psylla. The active ingredient acts as a chitin biosynthesis inhibitor and, therefore, has primary activity on the nymphal stages of these pests. Although adult insects are not controlled, there is some reduction in egg laying and viability of eggs. Insect uptake of Centaur is primarily through contact with some vaporization for a period of time after application. Centaur is to be applied at 34.5 oz per acre, with a maximum per year of one application on apple, and two applications on pear and stone fruits. Restrictions: REI = 12 hours, PHI = 14 days.

CARBARYL (SEVIN) is formulated as a 50W and 80S powder and used at the rate of from 1.0 to 2.0 lb per 100 gal of spray. Carbaryl is effective in codling moth and Japanese beetle control. It is somewhat effective on several other insects, including aphids and leafrollers. Carbaryl reduces fruit set on some varieties of apple when applied within 30 days of bloom, and it is suggested as a chemical fruit thinner on Red Delicious, Winesap, and Rome. Mite populations have a tendency to increase following carbaryl sprays because of suppression of predatory species. Because of its low mammalian toxicity, carbaryl is one of the few insecticides that can be used to within 3 days of harvest. Formulations that are less toxic to honey bees, such as Sevin-XLR Plus, are available. Such formulations have increased residual activity. REI = 12 hours, PHI = 7 days. Up to 8 applications per season.

CHLORANTRANILIPROLE (ALTACOR eVo) is registered on pome and stone fruits for the control of Lepidopteran insects and European apple sawfly, with suppression of apple maggot, cherry fruit fly, plum curculio and white apple leafhopper. Altacor eVo is a member of the anthranilic diamide class of insecticides with a novel mode of action on insect ryanodine receptors. It has some contact activity, but is most effective through ingestion of treated plant surfaces. Insects exposed to Altacor eVo will rapidly stop feeding, become paralyzed, and die within 1-3 days. Altacor eVo has provided outstanding control of internal worms (codling moth, oriental fruit moth) and leafrollers in numerous tests conducted in the mid-Atlantic region. Available as a 70WDG, rate of application is 1.3-2.2 oz per acre on pome fruits and 1.5-2.2 oz per acre on stone fruits in a minimum of 100 gal of water per acre. For resistance management, make no more than 3 successive applications per generation of insect species, and treat the following generation with a product having a different mode of action. Do not use more than 4 applications and 9 oz per acre. Make no more than 4 applications per season. REI = 4 hours, PHI = 5 days (pome fruits), 10 days (stone fruits).

CLOFENTEZINE (APOLLO) (42% suspension concentrate) is registered on apple, pear, peach, nectarine and cherry, for European red mite and twospotted spider mite. Apollo is effective against eggs and very young mites. If active mites are present, include another miticide for control. Use at 4-8 fl oz per acre or 1-2 fl oz per 100 gal. Apply only one application per season. REI = 12 hours, PHI = 45 days (apples), 21 days (all others).

CLOTHIANIDIN (BELAY) is a neonicotinoid insecticide registered for use on pome fruit and peaches. Formulated as a 2.13SC, Belay is labeled at 4 to 12 fl oz per acre in pome fruits for aphids, leafhoppers, leafminers, plum curculio, apple maggot, codling moth, pear psylla, scale, plant bugs and stink bugs. In peaches, Belay is labeled at 3 to 6 fl oz per acre for aphids, leafhoppers, scale, plum curculio, plant bugs and stink bugs. The seasonal maximum per acre is 12 fl oz. REI = 12 hours, PHI = 7 days (pome fruit), 21 days (peaches).

CODLING MOTH GRANULOVIRUS (CYD-X, CYD-X HP, MADEX HP, VIROSOFT CP4) is an insecticidal virus for control of codling moth larvae (Cyd-X and Cyd-X HP) and oriental fruit moth larvae (Madex HP and Virosoft CP4). Cyd-X and Cyd-X HP are registered for use on apples, pears, and plums, while Madex HP and Virosoft are registered for all pome and stone fruits. All of these products are susceptible to UV-degradation when exposed to direct sunlight and are best applied in late afternoon or on cloudy days. This group of viruses has been found only in invertebrates and they do not infect vertebrates or plants. Product must be ingested to be effective. The virus spreads from gut cells to other tissues, killing larvae in 3 to 7 days, depending on dosage and temperature. Dead larvae eventually disintegrate and release billions of new infectious units, which can infect other larvae. Timing virus sprays to target young larvae at the beginning of each generation is important and two applications per generation are recommended. Although Madex and Virusoft can be used to control both codling moth and oriental fruit moth larvae, they do not need to be applied at timings that would affect both species simultaneously, rather it can be applied against one and/or the other at the appropriate timings (DD-based timings are the same as for products like Altacor and Delegate). These products should be refrigerated or frozen during storage as continuous exposure to temperatures above 86°F can inactivate the product. All products are listed by the Organic Materials Review Institute (OMRI) and approved for organic production. REI = 4 hours, PHI = 0 days.

CYANTRANILIPROLE (EXIREL) is registered on pome and stone fruits for the control of certain chewing and sucking insects. Exirel is a member of the anthranilic diamide class of insecticides (Group 28) with a novel mode of action on insect ryanodine receptors. It is the first chemical in its class to target sap-feeding aphids. Exirel has provided excellent control of Lepidopteran insects, rosy apple aphid and spotted wing drosophila. Formulated as a 0.83SE (suspoelmulsion; oil in water emulsion), application rates range from 8.5-20.5 fl oz per acre on pome fruits (100-150 GPA recommended spray volume) and 10-20.5 fl oz per acre on stone fruits (100-150 GPA recommended spray volume), depending upon the target pest. Because Exirel is chemically related to Altacor, this product should not be rotated against successive generations of the same insect species in order to avoid the development of resistance. Exirel is highly toxic to bees exposed to direct treatment or to residues on plant surfaces. Therefore, do not apply the product, or allow it to drift, to blooming crops or weeds while bees are foraging adjacent to the treated area. Total seasonal applications are limited to 0.48 gal of formulated product per acre. REI = 12 hours, PHI = 3 days.

CYANTRANILIPROLE AND ABAMECTIN (MINECTO PRO) is a premixture of 12.7% cyantraniliprole and 2.68% abamectin, formulated as a suspension concentrate (SC) and labelled for use in pome and stone fruit at a rate of 8.0 – 12.0 fl oz per acre. Because it contains abamectin, Minecto Pro must always be mixed with a non-ionic wetting, spreading, and/or penetrating adjuvant or horticultural oil (not a dormant oil) to avoid illegal residues. In pome fruit, Minecto Pro will provide excellent control of codling moth, oriental fruit moth, leafrollers, and larvae of other moth pests and, at the 10.0 – 12.0 fl oz rate, good control of plum curculio and pear psylla. In stone fruit, it is labelled for use against the same moth pests and peach twig borer, as well as cherry fruit fly at 8.0 – 12.0 fl oz. At the higher rates, it is labeled for spotted wing drosophila, black cherry aphid, Japanese beetle, and plum curculio in stone fruit. This product also will provide excellent control of spider mite pests in both crop groups. In pome fruit, Minecto Pro should be applied before the leaves have hardened, enabling abamectin to move into leaves for UV protection and residual effectiveness against spider mites. Minecto Pro is toxic to pollinators and the bee warning on its label must be followed to protect pollinators. Restrictions for both crop groups include a seasonal maximum allowance 24 fl oz/A/year; use only after petal fall, and a minimum 21-day reapplication interval. Do not make more than 2 sequential applications. Note that use of other products containing the same active ingredients (e.g. Agri-Mek, Abba, Agri-Flex, Exirel) will affect the seasonal maximum allowance for Minecto Pro. Because cyantraniliprole is related to chlorantraniliprole, Minecto Pro should not be rotated with products such as Altacor, Besiege, or Voliam Flexi against successive generations of the same pest species (e.g. codling moth) to avoid resistance development. REI = 12 hours, PHI = 28 days (pome fruit) or 21 days (stone fruit).

CYCLANTRANILIPROLE (VERDEPRYN) is registered for use on pome and stone fruits and has excellent activity against moth larvae and pear psylla. It is a member of the anthranilic diamide class of insecticides (Group 28) and related to Altacor and Exirel. For resistance management, it should be rotated with insecticides from other classes when controlling consecutive generations of the same pest(s). Formulated as a 100 SL (soluble liquid), application rates range from 5.5 – 11.0 fl oz per acre on both crop groups and a spray volume of 100 GPA is recommended. For codling moth, 8.2 – 11.0 fl oz per acre is recommended, and for pear psylla management, use 11.0 fl oz per acre. Verdepryn is highly toxic to bees and other

pollinators exposed to direct treatment or residues. Three applications per season are permitted, with a maximum seasonal rate of 33.0 fl oz per acre. REI = 4 hours, PHI = 7 days.

CYFLUMETOFEN (NEALTA) is a contact acaricide registered on pome fruits for the control of European red mite and twospotted spider mite. Nealta acts as a mitochondria complex II electron transport inhibitor, blocking cellular respiration, but at a different site than other compounds. Formulated as a soluble concentrate (SC), Nealta is used at the rate of 13.7 fl oz per acre (100 GPA minimum spray volume). Because Nealta is not systemic, thorough coverage of both upper and lower leaf surfaces is necessary for effective control. Applications should be applied at mite threshold, and rotated with acaricides having different modes of action to minimize development of resistance. Total seasonal applications are limited to 27.4 fl oz per acre. REI = 12 hours, PHI = 7 days.

CYFLUTHRIN (TOMBSTONE) is a pyrethroid registered for the control of many fruit pests on apple, pear and all stone fruits. Formulated as a 2EC, application rates range from 1.4 to 2.8 fl oz per acre, depending upon insect species. Tombstone is limited to a season maximum of 2.8 fl oz per acre on apple and pear, and 5.6 fl oz per acre on stone fruits. It is important to note that use of the high rate of Tombstone will preclude the use of other products containing the closely related compound beta-cyfluthrin (Baythroid 1EC or Leverage 360; see write-ups) in the same season, since the seasonal maximum allowances for beta-cyfluthrin and cyfluthrin are cumulative. Do not apply more than the combined seasonal maximum for both active ingredients. The minimum water volume for ground application is 100 gal per acre on apple and pear, and 50 gal per acre on stone fruits. As with other pyrethroids, postbloom use is likely to cause outbreaks of mites and secondary pests. REI = 12 hours; PHI = 7 days.

DIAZINON is formulated as a 50W powder, and used at the rate of 1.0 lb per 100 gal of spray. This organophosphate insecticide is registered for control of many tree fruit insects. It is moderately toxic to mammals. It has demonstrated efficacy against rosy apple aphid, San Jose scale and woolly apple aphid. REI = 96 hours, PHI = 21 days.

DIFLUBENZURON (DIMILIN) is a chitin biosynthesis inhibitor, disrupting the molting process. It is registered on pear for control of pear psylla and suppression of codling moth. Control of pear psylla is greatest during prebloom, and should be timed to oviposition periods; thereafter suppression only may be achieved. It may be applied post bloom, but avoid combinations with oil in such applications. It is also effective against codling moth. It is formulated as a 2L and a 25W product, and recommended at 40-48 fl oz and 2.5-3 lb per acre, respectively. Delayed dormant applications should include a horticultural mineral oil at the rate of 4-6 gallons per acre. After delayed dormant, through popcorn stage, add oil at 0.25%, not to exceed 1 gallon per acre. Do not make more than four applications per season, or exceed 64 fl oz per acre per year. REI = 12 hours, PHI = 14 days.

DINOTEFURAN (VENOM AND SCORPION) is a neonicotinoid insecticide registered for use on peaches and nectarines for control of stink bugs and plum curculio, among others. Venom is formulated as a 70SG and is labeled for use at 2-4 oz per acre, while Scorpion is formulated as a 35SL and used at rates from 3.5-7 fl oz per acre, depending on the target pest. A seasonal maximum of 8 oz of Venom and 10.5 fl oz of Scorpion can be applied per acre. REI = 12 hours; PHI = 3 days.

EMAMECTIN BENZOATE (PROCLAIM) is registered on apple and pear for the control of spotted tentiform leafminer and various leafroller species, and suppression of internal worms (codling moth, oriental fruit moth, lesser appleworm), pear psylla, and spider mites. It acts by interfering with the neurotransmitters in insects, which results in a loss of cell function and disruption of nerve impulses. Proclaim has translaminar systemic activity and provides control primarily through ingestion, with limited contact activity for a short period after application. Formulated as a 5SG, the application rate is 0.8 to 1.2 oz per 100 gal dilute and 3.2 to 4.8 oz per acre concentrate, with a season maximum of 14.4 oz per acre. Applications should be initiated at the beginning of egg hatch to target small larvae. Proclaim should be applied in a minimum of 40 gal of water per acre in combination with a horticultural spray oil or a nonionic surfactant (do not use a sticker/binder type adjuvant). Do not tank mix Proclaim with Bravo® Weather Stik®, Dithane® Rainshield™, or any other pesticide containing a sticker component in its formulation because this may drastically reduce pest control with Proclaim. REI = 48 hours; PHI = 14 days.

ESFENVALERATE (ADJOURN, ASANA XL) is a pyrethroid insecticide registered for use on apple, peach, and pear. Esfenvalerate is formulated as a 0.66 EC; it provides broad-spectrum insect control at low rates of application. Esfenvalerate is also highly toxic to beneficial insects. Postbloom application usually results in a severe mite outbreak. Esfenvalerate is only recommended for the prebloom control of pear psylla on pear. On apple, it is recommended for prebloom insect control and is occasionally used for late season (after mid-August) control of leafrollers and internal worms in blocks with low mite populations. REI = 12 hours, PHI = 21 days (apples), 18 days (pears), 14 days (stone fruit). Do not apply more than 0.525 lb/A/season.

ETOXAZOLE (ZEAL) is an acaricide/ovicide registered for mite control on pome and stone fruits. It is a growth regulator that inhibits the molting process through disruption of the cell membrane. It acts as an ovicide, stops the development of immature mite stages and sterilizes adult mites. Since Zeal does not kill adult mites it may take a week or more to cause a reduction in the mite population. Therefore, Zeal is best used in an early-season preventative approach or targeted against a low mite threshold. Formulated as a 72WDG, it is labeled for use at 2 to 3 oz per acre. One and two applications per season are permitted in pome and stone fruits, respectively, with maximum seasonal use of 3 oz in pome fruits and 6 oz per acre

in stone fruits. Zeal must not be used with an adjuvant or surfactant on stone fruits. REI = 12 hours, PHI = 14 days (pome fruit), 7 days (stone fruit).

FENAZAQUIN (MAGISTER) is a miticide registered for control of European red mite, two-spotted spider mite, and rust mites on pome and stone fruit, and also has activity against powdery mildew (see write-up in Fungicides). Formulated as a soluble concentrate (SC), this product is in Resistance Group 21A along with several others. It is considered highly toxic to bees and other insect pollinators and cannot be used until after petal-fall. Magister is recommended for use when spider mite populations have reached threshold (5 mites/leaf), and should be applied in at least 50 gallons of water per acre at a rate of 31 – 36 fl oz per acre in pome and stone fruit. Its seasonal maximum allowance is 36 fl oz per acre, restricting this product to one application per season. REI = 12 hours; PHI = 7 days in pome fruit and 3 days in stone fruit.

FENBUTATIN OXIDE (VENDEX) is an acaricide recommended in the 50W formulation; a 4L is also available. It is effective against European red mite and twospotted spider mite, though relatively safe for predatory mites. Rates are 4 to 8 oz./100 gal, or 1 to 2 lb per acre concentrate (1 to 3 lb in apple). On apple and pear, do not apply more than 4 sprays/season; on peach, plum, prune and cherry, not more than two sprays. REI = 48 hours, PHI = 14 days.

FENPROPATHRIN (DANITOL) is a pyrethroid insecticide-miticide registered as a 2.4EC (emulsifiable concentrate) for use on pome and stone fruits. It provides broad-spectrum insect control and has demonstrated activity against spider mites. Because it is also highly toxic to beneficial insects, its use in the post-bloom period can still result in mites outbreaks, depending upon the mite population level and the number of applications. In apple and pear, Danitol is currently recommended primarily for prebloom use and possibly for use late season (after mid-August) on apple for control of leafrollers, internal worms and stink bugs. In peach, Danitol is recommended for use in the prebloom through first cover. In cherry, Danitol is now labeled for control of cherry fruit fly. Applications are to be applied in a minimum of 100 gpa in both pome and stone fruits, at a rate of 10.7-21.3 fl oz/A and not to exceed 42.7 fl oz/A per season. REI = 24 hours, PHI = 14 days (pome fruit), 3 days (stone fruit).

FENPYROXIMATE (PORTAL) is a contact acaricide/insecticide registered on pome and stone fruit (Portal XLO formulation for both crops) for the control of various mite species, white apple leafhopper, and pear psylla. Like Nexter, its mode of action is to block cellular respiration by acting as a mitochondrial electron transport inhibitor (METI). It also acts to inhibit molting of immature stages. Mite feeding and oviposition stop soon after application, with death occurring in 4 to 7 days. Formulated as a 5EC, Portal is used at the rate of 2 pints per acre. It should not be applied more than once per season, and should be rotated with products having a different mode of action where additional control is needed. REI = 12 hours, PHI = 14 days (pome fruit), 7 days (stone fruit).

FLONICAMID (BELEAF) is a pyridinecarboxamide that is registered on all pome and stone fruits for the control of aphids and tarnished plant bug. It functions as a chordotonal organ modulator and acts through contact and ingestion to stop feeding, resulting in starvation. There is also some translaminar and systemic movement of the product into treated plant surfaces. Formulated as a 50SG, the application rate is 2.0 to 2.8 oz per acre in a minimum of 50 gallons of water per acre. A maximum of 3 applications and 8.4 oz per acre per season is permitted. REI = 12 hours, PHI = 14 days (stone fruit) , 21 days (pome fruit0.

FLUPYRADIFURONE (SIVANTO 200SL, SIVANTO PRIME) is in a new class of insecticides known as butenolides that are related to neonicotinoids and registered for use in pome and stone fruit against aphids (except woolly apple aphid) at rates of 7.0 - 14.0 fl oz/acre and pear psylla and scale at rates of 10.5 – 14.0 fl oz/acre. Sivanto Prime may be used only on stone fruits. Sivanto is formulated as a soluble liquid, has a Caution statement on the label and is considered relatively safe to bees. It is systemic, with translaminar movement through leaves and from points of contact to leaf tips from foliar applications. It is readily absorbed into leaf tissue and considered rainfast within 1 hour after the spray dries, but also has activity when applied before leaf flush. Since Sivanto is related to neonicotinoids (Resistance Group 4), it should be rotated with products in other resistance groups that have efficacy against the targeted pests. For early season applications targeting San Jose scale and pear psylla, it should be combined with horticultural oil. Maximum seasonal application is restricted to 28.0 fl oz per acre. REI = 4 hours, PHI = 14 days.

GAMMA-CYHALOTHRIN (DECLARE, PROAXIS) is a pyrethroid insecticide formulated as a 1.25CS and 0.5CS for controlling many pest insects on pome and stone fruits. Declare is labeled for use at 1.02 to 2.05 fl oz per acre, with a seasonal maximum of 10.2 fl oz per acre and not more than 8.2 fl oz per acre in the post-bloom period. Proaxis is labeled for use at 2.56 to 5.12 fl oz per acre, with a seasonal maximum of 25.6 fl oz per acre and not more than 20.5 fl oz per acre in the post-bloom period. It is important to note that use of products containing gamma-cyhalothrin will influence the use of other products containing the closely related compound, lambda-cyhalothrin (Warrior, Lambda-Cy, Silencer, Besiege, Endigo) in the same season, since the seasonal maximum allowances for gamma- and lambda-cyhalothrin are cumulative. Do not apply more than the combined seasonal maximum for both active ingredients. As with other pyrethroids, post-bloom use of these products may result in secondary pest outbreaks. REI = 24 hours, PHI = 21 days (pome fruit),14 days (stone fruit).

HEXYTHIAZOX (ONAGER, SAVEY) is an acaricide registered on apple, pear, peach, nectarine, cherry and apricot for the control of European red mite and twospotted spider mite. It has activity against eggs and very young mites, and should not

be used in the same season as clofentezine (Apollo). Include another miticide if older mite stages are present. Hexythiazox is available as 50DF Savey or Onager 1C for use as a single application. REI = 12 hours, PHI = 28 days.

IMIDACLOPRID (ADMIRE PRO, ALIAS) is a neonicotinoid insecticide registered for use on pome and stone fruit. Admire Pro and Alias are formulated as a 4.6SC and a 4F, respectively, for control of aphids (except woolly apple aphid), leafminers, San Jose scale, June beetle, Japanese beetle, plant bugs, cherry fruit fly. Mealybugs, and pear psylla. Application of these products is restricted to the post-bloom period when bees are not foraging. The labelled application rate for Admire Pro is 1.4 – 2.8 fl oz per acre in pome and stone fruit, although 7.0 fl oz per acre is allowed in pear for mealybugs and pear psylla. Alias 4F is labelled at rates of 1.6 – 3.2 fl oz per acre in pome and stone fruit, although 8.0 fl oz per acre can be used in pear (see labels for pest-specific rates). Seasonal maximum allowances for Admire Pro are 14.0 fl oz per acre in pome fruit, cherry, and plum, and 8.4 fl oz per acre in peach, nectarine, and apricot. Seasonal maximum allowances for Alias are 16.0 fl oz per acre in pome fruit, cherry, and plum, and 9.6 fl oz per acre in in peach, nectarine, and apricot. It is important to note that use of Leverage (see write-up) in the same season will influence the seasonal maximum allowance for these products. The minimum application interval for both products is 10 days in pome fruit, cherry, and plum, and 7 days in peach, nectarine, and apricot. Products containing imidacloprid may not be used in Lee County, VA, due to an endangered species restriction. REI = 12 hours, PHI = 7 days (pome fruit, cherry, plum), 0 days (peach, nectarine, apricot).

IMIDACLOPRID and BETA-CYFLUTHRIN (LEVERAGE) are neonicotinoid and pyrethroid insecticides, respectively, that are pre-mixed in a suspension emulsion formulation that provides a broader spectrum of activity than either ingredient alone. Leverage 360 is registered for use on all pome and stone fruits. Since the product contains imidacloprid, its use is restricted to the post-bloom period. Also containing a pyrethroid, use of this product in the post-bloom period may cause secondary pests to flare. Apply in a minimum of 100 gpa in pome fruit and 50 gpa in stone fruit at 2.4 – 2.8 fl oz per acre. See label for details on the spectrum of pests controlled by this product. The seasonal maximum is 2.8 fl oz per acre in pome fruit and 5.6 fl oz per acre in stone fruit, but it is important to note that use of other products containing the same or closely-related active ingredients (Admire Pro, Alias, Baythroid, Tombstone) in the same season will influence the seasonal maximum allowance for Leverage. REI = 12 hours, PHI = 7 days. REI = 12 hours, PHI = 7 days.

INDOXACARB (AVAUNT eVo) is the first member of the oxadiazine class of chemicals registered for insect control on pome and stone fruits. It is primarily effective against various lepidoptera, but also has activity against selected insects of other types. Avaunt eVo acts primarily through ingestion by inhibiting sodium ion entry into nerve cells, resulting in paralysis and death of the pest species. Avaunt results in rapid inhibition of insect feeding, pest knockdown within 1 to 2 days, and provides crop protection for 7 to 14 days. This product has low mammalian toxicity (caution label) and is intermediate between OPs and pyrethroids in toxicity to beneficial insects and mites. Avaunt is limited to a maximum of 4 applications per season and total of 24 oz per acre. REI = 12 hours, PHI = 14 days.

KAOLIN (SURROUND WP) is a specialized mineral that has been shaped, sized and formulated for use as an insecticide on pome and stone fruits. Applications of 25-50 lbs per 100-200 gals per acre form a white "particle film" barrier on treated surfaces. Thorough coverage must be maintained by multiple applications, usually every 7 to 10 days, for effective control. Possible modes of action may include repellency, deterrence to egg-laying, irritation, physical barrier and non-recognition of host. Surround has demonstrated good to excellent activity against pear psylla, leafhoppers, plum curculio, apple maggot and Japanese beetle. It is certified for organic fruit production and is exempt from tolerance requirements. Surround WP has a 4 hr REI and may be applied up to harvest. However, it should not be applied beyond fourth cover to fresh market fruit that will not be washed before sale, in order to minimize the particle film residue. Similarly, it should not be applied beyond second cover to processing fruit, due to the physical effects of residues on juice filtration systems. It should not be applied beyond fourth cover on fruit for the fresh market that will not be washed before sale, in order to minimize the particle film residue. Season-long programs of Surround WP have improved color and reduced cracking of Stayman, and have reduced sunburn damage to apple in hot climates. The specific size and shape of the mineral particles permits photosynthetically active radiation to reach the leaf surface so that photosynthesis in not reduced by the particle film barrier.

LAMBDA-CYHALOTHRIN (WARRIOR, LAMBDA-CY, SILENCER) is a pyrethroid registered for control of numerous insect species on all pome and stone fruits. It is available in two encapsulated suspension formulations (Warrior 1CS, Warrior II 2CS) and in two emulsifiable concentrate formulations (1EC, Lambda-Cy, Silencer). The application rate for Warrior II is 1.28 – 2.56 fl oz per acre (0.02-0.04 lb ai/acre), with a seasonal maximum of 12.8 fl oz per acre (0.2 lb ai/acre) and a postbloom maximum of 10.24 fl oz (0.16 lb ai/acre). For Warrior, Lambda-Cy and Silencer, apply at 2.56-5.12 fl oz per acre (0.02-0.04 lb ai/acre), with a seasonal maximum of 25.6 fl oz per acre (0.2 lb ai/acre) and a postbloom maximum of 20.48 fl oz per acre (0.16 lb ai/acre). It is important to note that use of products containing lamda-cyhalothrin will influence the use of other products containing the same active ingredient (Besiege, Endigo) and those containing the closely related compound, gamma-cyhalothrin (Declare, Proaxis) in the same season, since the seasonal maximum allowances for gamma- and lambda-cyhalothrin are cumulative. Do not apply more than the combined seasonal maximum for both active ingredients. REI = 24 hours, PHI = 21 days (pome fruit), 14 days (stone fruit).

LAMBDA-CYHALOTHRIN AND CHLORANTRANILIPROLE (BESIEGE) is a pre-mix combination of 4.63%

lambda-cyhalothrin and 9.26% chlorantraniliprole, and is available as a 1.25SC. The combination of these two active ingredients enables Besiege to provide broad spectrum control of over 25 sucking and chewing pests on pome fruits and over 15 pests on stone fruits. Application rate ranges from 6-12 fl oz per acre, with a seasonal maximum of four applications and 31 fl oz per acre. Apply in 75-150 gallons of water per acre, with a maximum of 200 gallons of water per acre for dilute applications. Besiege is highly toxic to bees exposed to direct treatment or to residues on blooming crops. Therefore, do not apply the product, or allow it to drift, to blooming crops or weeds while bees are foraging adjacent to the treated area. In addition, the pyrethroid insecticide in this pre-mix is considered highly toxic to mite predators and likely to result in an increase in mite populations if used postbloom on pome fruits and after shuck fall on stone fruits. For resistance management, do not use Besiege against more than one generation of a given pest species per growing season, and do not use immediately before or after other Group 3 or Group 28 insecticides. The best fit of this product is late season on apple for the control of internal worms, leafrollers and stink bugs. It is important to note that use of this product will influence the use of other products containing the same active ingredient (Warrior, Lambda-Cy, Silencer, Endigo) and those containing the closely related compound, gamma-cyhalothrin (Declare, Proaxis) in the same season, since the seasonal maximum allowances for gamma- and lambda-cyhalothrin are cumulative. Do not apply more than the combined seasonal maximum for both active ingredients. REI = 24 hours, PHI = 21 days (pome fruit), 14 days (stone fruit).

LAMBDA-CYHALOTHRIN AND THIAMETHOXAM (ENDIGO) is a pre-mix combination of these two active ingredients, formulated as an aqueous-based formulation, and labeled for use in pome and stone fruit against many pest insects. It is highly toxic to bees and may not be applied after early pre-bloom growth stages or before post-bloom (petal fall). Its labeled rate range is 5.0 to 6.0 fl oz, with a seasonal maximum of 28.0 fl oz in pome fruit and 19.0 fl oz in stone fruit. It is important to note that use of Endigo and other products containing lambda-cyhalothrin (Warrior, Lambda-Cy, Silencer, Besiege), gamma-cyhalothrin (Declare, Proaxis) or thiamethoxam (Actara, Voliam Flexi) in the same season will contribute to the seasonal maximum allowances for these active ingredients. REI = 24 hours, PHI = 35 days (pome fruit), 14 days (stone fruit).

MATING DISRUPTION is based on the use of formulated insect sex pheromones to interfere with the communication between males and females of the target species, resulting in a reduced incidence of mating, and therefore egg-laying. Mating disruption products are marketed by several companies under trade names including Isomate, Checkmate, Disrupt Microflake, and Cidetrack. There are several different kinds of hand-placed rope or clip-on dispensers that are specific for codling moth, oriental fruit moth, peach borers, or dogwood borer. For codling moth and oriental fruit moth, pheromone "Puffers" and laminated, sprayable microflake dispensers are also available, and for oriental fruit moth, a sprayable microencapsulated formulation. Some mating disruption formulations simultaneously affect codling moth and oriental fruit moth and another disrupts both peach borer species. The length of control provided by hand-placed dispensers for codling moth and oriental fruit moth vary according to the formulation. Some provide full season control while others are re-deployed during the season. The sprayable microencapsulated product for oriental fruit moth is applied against each generation. Products for peachborers and dogwood borer provide full season control. Mating disruption is best if initiated just before the beginning of adult flight of the target species each season or each generation. Regular monitoring of the target species with pheromone traps in disrupted orchard blocks is recommended; effective mating disruption should eliminate captures or reduce them substantially. Mating disruption may or may not be used as a "stand-alone" tactic, depending upon the species and the pest pressure, and supplemental use of insecticides or other tools (e.g. codling moth virus) may be required initially. It is important to consult a fruit entomologist or a company technical representative prior to using mating disruption for the first time, since the rates of dispenser deployment and other factors vary among different situations. For further information about specific mating disruption products, see the links below:

http://www.pacificbiocontrol.com/Pacific_Biocontrol_Corporation/Labels_%26_SDS.html
https://suterra.com/products/
www.trece.com/agcon.html
www.herconenviron.com/agriculture-stored-products.php#mating

METHOMYL (LANNATE) insecticide is registered for use on apple for control of aphid, codling moth, leafrollers, stink bugs, and leafhoppers, and on peach for oriental fruit moth control. A SLN 24(c) label is available for use on nectarines in Virginia. Two formulations are available, Lannate LV (2.4 lb/gal) and Lannate 90SP. Methomyl has demonstrated ovicidal activity against variegated leafroller and tufted apple budmoth. Do not make more than 5 applications per season. REI = 3 days (apple and nectarine), 4 days (peaches), 2 days (in all others), PHI see label.

METHOXYFENOZIDE (INTREPID) is an insect growth regulator that is the second molt accelerating compound (MAC) to receive registration. It has selective activity against lepidopterous pests, controlling the larval stage by initiating a premature molt that results in death from starvation and dehydration. Because this activity is expressed primarily through larval ingestion of treated surfaces, thorough coverage is necessary for effective control. Due to its low toxicity to beneficial insects, Intrepid has a good fit in IPM programs. It is registered on pome and stone fruits for control of oriental fruit moth, lesser appleworm, spotted tentiform leafminer and various leafroller species, with suppression of codling moth at the highest labeled rate. REI = 4 hours, PHI = 14 days (pome fruit), 7 days (nectarine, peach, and plum). Do not apply

more than 64 fl oz of Intrepid 2F (1 lb ai)/year.

NOVALURON (RIMON) is registered on apple for the control of codling moth, oriental fruit moth, leafminers, and various leafroller species. Rimon is an insect growth regulator that interferes with the insect's ability to form chitin, thus disrupting the molting process. Therefore, it is effective only against the immature stages of insects, and will not kill adults. Route of insect entry is primarily through ingestion with some contact activity. Toxicity to eggs has also been demonstrated for some insect species. For the most effective control, applications of Rimon should be initiated at the beginning of egg laying for codling moth and oriental fruit moth, and at the beginning of egg hatch for leafroller species. Rimon is available as a 0.83EC and applied at the rate of 20 to 40 oz per acre, with a maximum of 4 applications (150 oz per acre) per season. Restrictions: REI = 12 hours, PHI = 14 days.

OILS (SUPERIOR-TYPE) result from a high degree of refining. The minimum specifications for three weights of superior oil are:

	VISCOSITY		
PROPERTY*	**60 sec.**	**70 sec.**	**100 sec.**
Viscosity[1] at 100°F, sec. (max.)	63	75	90-120
Gravity,[2] API (minches)	35	34	31
Unsulfonated residue,[3] (minches)	94	92	90
Pour Point,[4] °F (max.)	20	20	30
Distillation,[5] 10 mm Hg. °F 50% point	412 + 8	435 + 8	
10 to 90% range °F (max.)	65	80	

*Determined according to the following ASTM Methods:
[1]D-445-65 and D-2161-66 [2]D-287-67 [3]D-483-63 [4]D-97-66 [5]D-1160-61

Some spray oils, when mixed with other materials and with water from certain water supplies, result in an uneven distribution of these materials in the spray tank. The oil appears to capture some materials and form large globules that separate from the water in the absence of vigorous agitation. Some mixtures cannot be made satisfactorily even with intense agitation. It is suggested that the compatibility of the oil with the other materials be tested by adding small amounts to water in a glass jar and stirring. If the mixture can be kept from separating by stirring, it should be all right for use. Some summer oils (Ultra Fine oil) have been shown to be effective against European red mites when three applications are made in the early post-bloom period.

OXAMYL (VYDATE L) is registered on apple and pear for the control of aphids, mites, white apple leafhopper and tentiform leafminer at the rate of 1 to 2 pts per 100 gal of dilute spray. Vydate L will thin fruit if applied within 30 days after full bloom and has a SLN 24 (c) registration for such use in Virginia and West Virginia. REI = 48 hours, PHI = 14 days. Do not apply more than 8 pts/season.

PERMETHRIN (PERM-UP, POUNCE) is a pyrethroid insecticide registered for use on apple, pear, peach, nectarine, and cherry. Applications are limited to dormant to prebloom on pear, and through petal fall on apple. It is recommended for the prebloom control of spotted tentiform leafminer (apple), plant bugs (apple, peach, nectarine, pear), and pear psylla (pear). Use of this product increases the risk of mite outbreaks, especially when applied after bloom. Permethrin is available as both 3.2EC (Perm-UP, Pounce) and 25WP (Perm-UP, Pounce) formulations. REI = 12 hours; PHI = 3 days (cherry), and 14 days (peach and nectarine). Do not apply more than 0.5 lb ai/A/season.

PHOSMET (IMIDAN) is a broad-spectrum organophosphate insecticide formulated as a 70W powder. It is registered for use on a number of fruit pests, including codling moth, plum curculio, redbanded leafroller, oriental fruit moth, apple maggot, and others. Imidan may not be used on sweet cherries. While phosmet is rated as good against native stink bugs, it is ineffective against brown marmorated sting bug. REI = 96 hours, PHI = 7 days (apple, pear, tart cherry, and plum), and 14 days (peach and nectarine). Do not apply more than 22 1/8 l Imidan 70W (15.5 lb ai)/A/season.

PROPARGITE (OMITE) is an acaricide that is available for **non-bearing** pome and stone fruits, and is used at the rate of 6 lb/A or 2 lb/100 gal of spray. It has performed well in mite control on apple. Omite is most effective during the warmer summer months, and its full effectiveness requires from 4 days to a week. It should not be used more than two times a season. REI = 48 hours.

PYRIDABEN (NEXTER) is a contact acaricide/insecticide that has a unique mode of action as a mitochondrial electron transport inhibitor (METI), blocking cellular respiration. It therefore has efficacy against mite populations resistant to other acaricides. In apples, no more than one application per season. In stone fruits, no more than two applications 30 days apart may be made per season; however control is fairly long-term, often exceeding 40 days. Nexter is moderately toxic to predators. Selection pressure toward resistance may be high because of the great mortality caused by Nexter. Application rate is 4.4-5.2 oz per acre for ERM, and 8.8-10.7 oz per acre for TSM. REI = 12 hours, PHI = 25 days (apple), 300 days

(cherries), and 7 days (all others).

PYRIPROXYFEN (ESTEEM) is an insect growth regulator that inhibits the development of eggs and immature stages and adult emergence of target insects. Although this product has no direct activity on adult insects, the hatching of eggs laid by treated adults is often suppressed. Because activity of this product depends on insect development, evidence of control will be slower than with typical contact insecticides. Available as a 35 WP, Esteem is registered on apple for the control of aphids, leafminers, San Jose scale and codling moth, and on stone fruits for San Jose scale. It is also registered on pear for the control of pear psylla, San Jose scale and codling moth. As a resistance management strategy, use is limited to two applications per season at a rate of 4-5 oz per acre. REI = 12 hours, PHI = 45 day (pome), and 14 days (stone fruit). Do ot apply more than 2 applications/season, or 10 of product/A/season.

SPINETORAM (DELEGATE) is related to spinosad, and is derived from the fermentation, followed by the chemical modification of a naturally occurring soil organism. This product affects the insect nervous system through both contact and ingestion, with excellent translaminar activity. Targeted pests in this area include internal worms (codling moth, oriental fruit moth), leafrollers, and leafminers on apple; pear psylla on pear; and oriental fruit moth, leafrollers, thrips, and cherry fruit fly on stone fruits. Addition of an adjuvant may improve control of thrips, leafminers, and pear psylla. Delegate will only provide suppression of apple maggot and plum curculio. This product has demonstrated excellent control of internal worms and leafrollers in tests conducted on apple in the mid-Atlantic region. Application rate is 4.5 to 7 oz per acre, with a seasonal maximum of four applications and 28 oz per acre. To reduce the potential for resistance development, Delegate should not be applied to consecutive insect generations, but rotated with other chemistries for the management of internal worms and leafrollers. REI = 4 hours, PHI = 14 days (apricot), 7 days (apple, pear, cherry, and plum), and 1 day (peach and nectarine).

SPINOSAD (ENTRUST) belongs to the Naturalyte class of insecticides, derived from a soil microorganism, and has been designated by EPA as a reduced risk pesticide because of low toxicity and environmental benefits. This product is listed by the Organic Materials Review Institute (OMRI) as an option for organic pest management. It is registered on apple at 6-10 fl oz/A and on stone fruits at 4-8 fl oz/A, and provides good control of tufted apple bud moth, variegated leafroller, obliquebanded leafroller, spotted tentiform leafminer, and western flower thrips. Entrust is a nerve poison that provides control by contact and ingestion, with fairly short residual activity. Leafminer control is enhanced by the addition of a penetrating agent. REI= = 4 hours, PHI = 7 days (apple, cherry, and plum), 1 day (peach).

SPIRODICLOFEN (ENVIDOR) is an acaricide registered for use on all pome and stone fruits for the control of European red mite, two-spotted spider mite, apple and pear rust mites, and peach silver mite. The active ingredient acts as a lipid biosynthesis inhibitor with contact activity against mite eggs, immature stages, and adult females; adult males are not affected. Due to its insect growth regulator properties, Envidor should be applied on a preventive basis or at a low mite threshold with performance evaluation conducted 4 to 10 days following application. Formulated as a 2SC, the application rate is 16 to 18 oz per acre, with a maximum of one application per season. Minimum application volume (ground application only) is 50 gal per acre on stone fruits and 100 gal per acre on pome fruits. REI = 12 hours, PHI = 7 days.

SPIROTETRAMAT (MOVENTO) is registered for the control of sucking insect pests on all pome and stone fruits. It is a systemic foliar insecticide that belongs to the tetramic acid chemical class (same class as Envidor®) and is classified as a lipid biosynthesis inhibitor. Movento is active by ingestion against the immature stages of aphids, scale, and pear psylla, and also has impact on exposed female adults by reducing fecundity and survival of offspring. Upon penetration of the leaf cuticle, Movento exhibits "2-way systemicity" by moving to all areas of the plant, including new shoot, leaf and root tissues. Formulated as a 2SC, rate of application is 6-9 fl oz per acre, with a seasonal maximum of 15.3 fl oz per acre on stone fruits and 25 fl oz per acre on pome fruits. Movento should not be applied prior to petal fall in order for sufficient leaf tissue to be present for uptake and translocation. In addition, Movento must be tank-mixed with a spray adjuvant/additive having spreading and penetrating properties to maximize leaf uptake and systemicity of the product within treated plants. However, the use of Induce® adjuvant in combination with Movento is prohibited on pome and stone fruits when fruits are present due to adverse plant compatibility. REI = 24 hours, PHI = 7 days. Do not apply more than 25 fl oz (0.39 lb ai)/A/season.

SULFOXAFLOR (CLOSER) is a systemic insecticide that is related to the neonicotinoid class of chemicals and registered for use in all pome and stone fruits and provides control through contact and ingestion. It is especially effective against aphids, leafhoppers and plant bugs. Closer is formulated as a soluble concentrate (SC) for use at rates ranging from 1.5 – 5.75 fl oz/acre, depending on the target pest. It can be used only after petal fall and up to four applications per season are permitted, with not more than two consecutive applications per crop and a seasonal maximum of 17 fl oz per acre. This compound has acute toxicity to bees via ingestion or direct contact and if blooming vegetation is present 12 feet out from the downwind edge of the field, a downwind 12-foot buffer must be observed. REI = 12 hours; PHI = 7 days.

THIAMETHOXAM (ACTARA) is a systemic insecticide in the neonicotinoid class of chemicals that is registered for insect control on all pome and stone fruits. It provides control through contact and ingestion, and is especially effective against aphids, leafhoppers, leafminers, and pear psylla. Actara is available as a 25WG and may be used during both the prebloom and postbloom periods at rates of 2.0 to 5.5 oz per acre, depending upon insect species. Prebloom use is limited to one application on all tree fruits. A season maximum of 8 oz per acre is permitted. It is important to note that use of Actara

and other products containing thiamethoxam (Agri-Flex, Endigo, Voliam Flexi) in the same season will contribute to the seasonal maximum allowance for this active ingredient. REI = 12 hours, PHI = 14 days (pome fruits up to 2.75 oz/A, and 35 days on pome fruits at higher rates), and 14 days (stone fruits).

THIAMETHOXAM AND CHLORANTRANILIPROLE (VOLIAM FLEXI) is a pre-mix combination of 20% of each active ingredient, and is available as a 40WDG. The combination of these two active ingredients enables Voliam Flexi to provide broad spectrum control of over 15 sucking and chewing pests on pome fruits and over 10 pests on stone fruits. Application rate ranges from 4-7 oz per acre, depending upon the target pest, with a seasonal maximum of four applications and 16 oz per acre on pome fruits, and three applications and 14 oz per acre on stone fruits. Apply in a minimum of 100 gallons of water per acre. Voliam Flexi is highly toxic to bees exposed to direct treatment or to residues on blooming crops. Therefore, do not apply after early pink through bloom in apple; after green cluster bud through bloom in pear; and from swollen bud through bloom in stone fruits. In addition, wait at least five days before placing beehives in a treated orchard. For resistance management, do not use more than two consecutive applications of Voliam Flexi, and do not use immediately before or after other Group 4A or Group 28 insecticides. The best fit of this product on apple is for first generation codling moth. This timing will also control plum curculio, spirea aphids, and early egg hatch of tufted apple bud moth. The best fit on peaches is from petal fall through shuck fall for the control of plum curculio, tarnished plant bug, stink bugs and green peach aphids. It is important to note that use of Voliam Flexi and other products containing thiamethoxam (Actara, Endigo) in the same season will contribute to the seasonal maximum allowance for this active ingredient. REI = 12 hours, PHI = 35 days (pome fruit), and 14 days (stone fruit). Do not exceed a total of 16 oz of Voliam Flexi or 0.25 lb ai of thiamethoxam containing products, or 0.2 lb ai of chlorantranilprole containing products/A/season.

TOLFENPYRAD (APTA) is a Group 21A insecticide registered for use on pome and stone fruits for control of aphids, leafhoppers, plum curculio, apple and cherry maggot, leafrollers, and pear psylla. Apta is formulated as a suspension concentrate (SC) for use at rates ranging from 14-27 fl oz per acre, depending upon the target pest. Complete sprays are recommended using a minimum of 50 GPA (stone fruits) or 100 GPA (pome fruits). Apta is highly toxic to bees exposed to direct treatment or to residues on plant surfaces. Therefore, do not apply the product, or allow it to drift, to blooming crops or weeds while bees are foraging adjacent to the treated area. A maximum of 2 applications and 53.5 fl oz per acre per season is permitted. Care should be taken when applying Apta in tank mixes with fungicide products in FRAC Group 3 (sterol biosynthesis inhibitors) and FRAC Group 11 (QoI) (see Table 2) if environmental conditions are known to be conducive to adverse crop response to those products. REI = 12 hours, PHI = 14 days.

ZETA-CYPERMETHRIN (MUSTANG MAXX) is a 0.8EC pyrethroid insecticide registered for the control of numerous insect species on pome and stone fruits. Rate of application is 1.28 to 4.0 fl oz per acre, with a seasonal maximum of 24 fl oz per acre. As with other pyrethroids, this product is highly toxic to mite predators, and postbloom use is more likely to result in an increase in mite populations. REI = 12 hours, PHI = 14 days.

ZETA-CYPERMETHRIN AND AVERMECTIN (GLADIATOR) are a pyrethroid insecticide and miticide premixed as an emulsifiable in water formulation. Gladiator is registered for use in stone and pome fruit against many pest insects and spider mites. Application rates are 1.5-4.75 fl oz per 100 gal dilute and 6-19 fl oz per acre concentrate, with a season maximum of 38 fl oz per acre in pome fruit and 57 fl oz per acre in stone fruit. Gladiator is highly toxic to bees exposed to direct treatment or to residues. Therefore, do not apply the product, or allow it to drift, to blooming crops or weeds while bees are foraging. As with other pyrethroids, this product is also highly toxic to mite predators, and postbloom use is more likely to result in an increase in mite populations. For resistance management, do not use immediately before or after other Group 3 or Group 6 insecticides. It is important to note that Gladiator and other products containing zeta-cypermethrin (Mustang Max) and avermectin (Abba, Agri-Flex, Agri-Mek, Temprano) in the same season will contribute to the seasonal maximum allowances for these active ingredients. REI = 12 hours, PHI = 14 days.

INSECTICIDE MODES OF ACTION (MOA) AND RESISTANCE MANAGEMENT

Recommendations are increasingly made for growers to rotate materials of different modes of action in order to forestall the development of resistance. The following list is to facilitate this planning, and is modified from a list by the Insecticide Resistance Action Committee. (http://www.irac-online.org/documents/moa-classification/?ext=pdf)

Table 3. Insecticides certified by Organic Materials Review Institute (OMRI) for organic pest control.

Common name	Trade name	Target Insects
azadirachtin	Aza-Direct, Neemix	Rosy apple aphid, spotted tentiform leafminer, codling moth, oriental fruit moth
Bacillus thuringiensis	various	Leafrollers, defoliating caterpillars, gypsy moth
CM granulovirus	Virusoft CP4, Cyd-X, Madex	Codling moth (and oriental fruit moth; Madex and Virusoft CP4 only)
kaolin	Surround	Leafhoppers, plum curculio, apple maggot, Japanese beetle, pear psylla
Pheromones (mating disruption)	Isomate and Puffer products	Codling moth, oriental fruit moth, peach borers, dogwood borer
spinosad	Entrust	Leafrollers, spotted tentiform leafminer, thrips

Table 4. Insecticide chemistry classes for rotation purposes*

Insecticide class	Compound(s)	Trade name(s)
Acetyl choline esterase inhibitors (Resistance Group 1)	carbamates (Group 1A)	
	carbaryl	Sevin
	methomyl	Lannate
	oxamyl	Vydate
	organophosphates (Group 1B)	
	diazinon	Diazinon
	phosmet	Imidan
Sodium channel modulators (Resistance Group 3) (pyrethroids, pyrethrins)	beta-cyfluthrin	Baythroid XL, Leverage 360
	bifenthrin	Bifenture, Brigade
	cyfluthrin	Tombstone
	esfenvalerate	Asana, Adjourn
	fenpropathrin	Danitol
	gamma-cyhalothrin	Declare, Proaxis
	lambda-cyhalothrin	Warrior, Lambda-Cy, Silencer, Besiege, Endigo
	permethrin	Perm-UP, Pounce
	zeta-cypermethrin	Mustang Maxx, Gladiator
Acetyl choline receptor agonists/antagonists (Resistance Group 4) (chloronicotinyls or neonicotinoids)	clothianidin	Belay
	imidacloprid	Admire Pro, Alias
	thiamethoxam	Actara, Agri-Flex, Endigo, Voliam Flexi
(Resistance Group 4C)	acetamiprid	Assail
	sulfoxaflor	Closer
(Resistance Group 4D)	flupyradifurone	Sivanto, Sivanto Prime
Acetyl choline modulators (Resistance Group 5)	spinetoram	Delegate
	spinosad	Entrust
Chloride channel activators (Resistance Group 6)	abamectin	Abba, Agri-Flex, Agri-Mek, Minecto Pro, Gladiator
	emamectin benzoate	Proclaim

*Some commercial products contain combinations of active ingredients from different resistance groups.

Table 4. Insecticide chemistry classes for rotation purposes* (cont.)

Insecticide class	Compound(s)	Trade name(s)
Juvenile hormone mimics (Resistance Group 7)	pyriproxyfen	Esteem **(cont.)**
Chordotonal organ modulator (Resistance Group 9D)	afidopyropen	Versys
Unknown (Resistance Group 10)	clofentezine hexythiazox etoxazole	Apollo Savey, Onager Zeal
Microbial disruptors of midgut membranes (Resistance Group 11)	*Bacillus thuringiensis*	Dipel
Inhibition of oxidative phosphorylation (Resistance Group 12B)	organotins fenbutatin oxide	 Vendex
Inhibition of oxidative phosphorylation (Resistance Group 12C)	propargite	Omite
Inhibitors of chitin biosynthesis, type O, lepidopteran (Resistance Group 15)	novaluron diflubenzuron	Rimon Dimilin
Inhibitors of chitin biosynthesis, type I, homopteran (Resistance Group 16)	buprofezin	Centaur
Ecdysone agonist/disruptor (Resistance Group 18A)	methoxyfenozide	Intrepid
Mitochondrial Complex III electron transport inhibitors (Resistance Group 20)	acequinocyl	Kanemite
Mitochondrial Complex I electron transport inhibitors (Resistance Group 21 and 21a)	pyridaben fenpyroximate tolfenpyrad fenazaquin	Nexter Portal Apta Magister
Voltage dependent sodium channel blockers (Resistance Group 22)	oxadiazines indoxacarb	 Avaunt eVo
Inhibitors of lipid synthesis (Resistance Group 23)	spirodiclofen spirotetramat	Envidor Movento
Neural inhibitors (unknown mode of action) (Resistance Group 25)	cyflumetofen	Nealta
Ryanodine receptor activator (Resistance Group 28)	chlorantraniliprole cyantraniliprole cyclaniliprole	Altacor eVo, Besiege, Voliam Flexi Exirel, Minecto Pro Verdepryn

*Some commercial products contain combinations of active ingredients from different resistance groups.

Table 4. Insecticide chemistry classes for rotation purposes*

Insecticide class	Compound(s)	Trade name(s)
Chordotonal organ modulator (Resistance Group 29)	flonicamid	Beleaf
Unknown	azadirachtin bifenazate	Aza-Direct Acramite
Other pathogens	CM granulovirus	Cyd-X, Madex, Virusoft

*Some commercial products contain combinations of active ingredients from different resistance groups.

Pesticide Hazard to Honey Bees

James W. Wilson, Extension Apiculturist

Bee losses can be minimized or eliminated if these simple rules are followed:

1. Do not apply insecticides to crops or ground vegetation in bloom.
2. Remove all bees from orchards before applying petal-fall sprays.
3. Suppress flowering weeds and ground cover plants in the orchard by mowing and/or the use of herbicides.
4. Follow label directions closely.
5. Notify the beekeeper at least 24 - 48 hours before applying an insecticide if hives are in or near the orchard.
6. Whenever possible, make pesticide applications in the early morning or in the late evening when few bees are active.
7. Choose the least hazardous formulations when possible. Dusts and encapsulated insecticides are more toxic than other formulations of the same material. Wettable powder sprays tend to have a longer residual effect (and are thus more toxic) than emulsifiable concentrate sprays.

PESTICIDES RELATIVELY NONTOXIC TO BEES [1]

Acequinocyl (Kanemite), afidopyropen (Versys), azadirachtin (Aza-Direct, Neemix), *Bacillus thuringiensis,* buprofezin (Centaur), Captan, clofentezine (Apollo), chlorantraniliprole (Altacor eVo), cyclaniliprole (Verdepryn), CM granulovirus (Cyd-X, Madex, Virusoft), cyflumetofen (Nealta), diflubenzuron (Dimilin), dodine (Syllit), etoxazole (Zeal), fenbutatin oxide (Vendex), fenpyroximate (Portal), ferbam, flonicamid (Beleaf), flupyradifurone (Sivanto), hexythiazox (Onager, Savey), kaolin (Surround), maneb, methoxyfenozide (Intrepid), novaluron (Rimon), Ovex (Ovotran), pheromones, pyriproxyfen (Esteem), sethoxydim (Poast), streptomycin (Firewall and others), thiram, and wettable sulfur. Most herbicides are relatively non-toxic to bees.

PESTICIDES MODERATELY TOXIC TO BEES [1]

Acetamiprid (Assail), clothianidin (Belay), oxamyl (Vydate), and spirotetramat (Movento). Do not apply to open blossom, directly on bees, or near colonies. These materials should be applied only during the late evening or early morning. They should not be applied directly on bees in the field or on colonies.

PESTICIDES HIGHLY TOXIC TO BEES

Severe losses of bees may be expected if they are present during spraying, or become active in the orchard within a few days after spraying with the following: abamectin (Abba, Agri-Mek), beta-cyfluthrin (Baythroid XL, Leverage 360), bifenazate (Acramite, Banter), bifenthrin (Bifenture, Brigade), carbaryl (Sevin), cyantraniliprole (Exirel, Minecto Pro), cyfluthrin (Tombstone), diazinon, emamectin benzoate (Proclaim), esfenvalerate (Adjourn, Asana XL), fenazaquin (Magister), fenpropathrin (Danitol), gamma-cyhalothrin (Proaxis, Declare), imidacloprid (Alias, Admire Pro, Leverage), indoxacarb (Avaunt eVo), lambda-cyhalothrin (Endigo, Lambda-Cy, Silencer, Besiege, Warrior), methomyl (Lannate), paraquat, permethrin (Perm-UP, Pounce), phosmet (Imidan), pyridaben (Nexter), spinetoram (Delegate), spinosad (Entrust), spirodiclofen (Envidor), sulfoxaflor (Closer), thiamethoxam (Actara, Agri-Flex, Endigo, Voliam Flexi), tolfenpyrad (Apta), and zeta-cypermethrin (Mustang Maxx, Gladiator).

[1] Provided label directions governing application are followed.

A Note on Protecting Pollinators in Virginia

James Wilson, Extension Apiculturist
Virginia Tech Department of Entomology

Federal guidelines mandate that each state develop a plan for the mitigation of pesticide exposure to managed pollinators in their own state. This mandate came through the United States Environmental Protection Agency and was directed to the pesticide regulatory office of each state. The Virginia Department of Agriculture and Consumer Services (VDACS) has fulfilled that role here. Through 7 regional listening sessions, input from approximately 450 stakeholders, 169 written comments from producers, beekeepers, professional pesticide applicators, and other stakeholders, VDACS developed a representative advisory committee of stakeholders and drafted a plan. The plan is known as the "Voluntary Plan to Mitigate the Risk of Pesticides to Managed Pollinators" and was finalized in May of 2017.

This voluntary plan encourages an increase in communication between pesticide applicators and the managers of pollinators in an effort to reduce the potential for damaging pesticide exposure. Since this plan is voluntary there are additional guiding documents for the majority of involved stakeholders. This plan has been adopted by the Commonwealth of Virginia and can be found in its entirety at the 1st link provided below. A specific list of best management practices appropriate for this pest management guide is provided below. Questions and comments should be directed to VDACS with the contact information given below. Virginia has employed a communications tool to encourage access and communication between beekeepers and insecticide applicators. This tool is known as Bee Check. For more information on this tool and how you may use it to help prevent the exposure of bees to pesticides please visit http://www.vdacs.virginia.gov/pdf/BeeCheck-Fact-Sheet.pdf, or http://www.vdacs.virginia.gov/plant-industry-services-beekeeping-apiary-inspection.shtml.

Virginia is currently developing a strategy for managing all pollinators. This strategy is focused on identifying the strengths and weaknesses of the conservation and pollinator management efforts in Virginia. Once identified, this plan will outline how we can best manage Virginia's resources for pollinators. Future developments with that plan will be made available by VDACS, and updated here accordingly.

Virginia's Voluntary Plan to Mitigate the Risk of Pesticides to Managed Pollinators

http://www.vdacs.virginia.gov/pdf/BMP-plan.pdf

Agricultural Commercial Applicators:

http://www.vdacs.virginia.gov/pdf/BMP-Ag-Commercial-Applicator.pdf

Agricultural Producers:

http://www.vdacs.virginia.gov/pdf/BMP-Ag-Producer.pdf

Horticultural Industry:

http://www.vdacs.virginia.gov/pdf/BMP-Horticultural-Industry.pdf

VDACS Contact Points:

Liza Fleeson Trossbach, Program Manager, Office of Pesticide Services

liza.fleeson@vdacs.virginia.gov 804.371.6559

Keith Tignor, State Apiarist, Office of Plant Industry Services

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THE NEW EPA BEE ADVISORY BOX

On EPA's new and strengthened pesticide label to protect pollinators

PROTECTION OF POLLINATORS

APPLICATION RESTRICTIONS EXIST FOR THIS PRODUCT BECAUSE OF RISK TO BEES AND OTHER INSECT POLLINATORS. FOLLOW APPLICATION RESTRICTIONS FOUND IN THE DIRECTIONS FOR USE TO PROTECT POLLINATORS.

Look for the bee hazard icon in the Directions for Use for each application site for specific use restrictions and instructions to protect bees and other insect pollinators.

This product can kill bees and other insect pollinators.

Bees and other insect pollinators will forage on plants when they flower, shed pollen, or produce nectar.

Bees and other insect pollinators can be exposed to this pesticide from:

- Direct contact during foliar applications, or contact with residues on plant surfaces after foliar applications
- Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, soil, tree injection, as well as foliar applications.

When Using This Product Take Steps To:

- Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site.
- Minimize drift of this product on to beehives or to off-site pollinator attractive habitat. Drift of this product onto beehives can result in bee kills.

Information on protecting bees and other insect pollinators may be found at the Pesticide Environmental Stewardship website at:
http://pesticidestewardship.org/pollinatorprotection/Pages/default.aspx

Pesticide incidents (for example, bee kills) should immediately be reported to the state/tribal lead agency. For contact information for your state/tribe, go to: www.aapco.org. Pesticide incidents can also be reported to the National Pesticide Information Center at: www.npic.orst.edu or directly to EPA at: beekill@epa.gov

Alerts users to separate restrictions on the label. These prohibit certain pesticide use when bees are present.

The new bee icon helps signal the pesticide's potential hazard to bees.

Makes clear that pesticide products can kill bees and pollinators.

Bees are often present and foraging when plants and trees flower. EPA's new label makes it clear that pesticides cannot be applied until all petals have fallen.

Warns users that direct contact and ingestion could harm pollinators. EPA is working with beekeepers, growers, pesticide companies, and others to advance pesticide management practices.

Highlights the importance of avoiding drift. Sometimes, wind can cause pesticides to drift to new areas and can cause bee kills.

The science says that there are many causes for a decline in pollinator health, including pesticide exposure. EPA's new label will help protect pollinators.

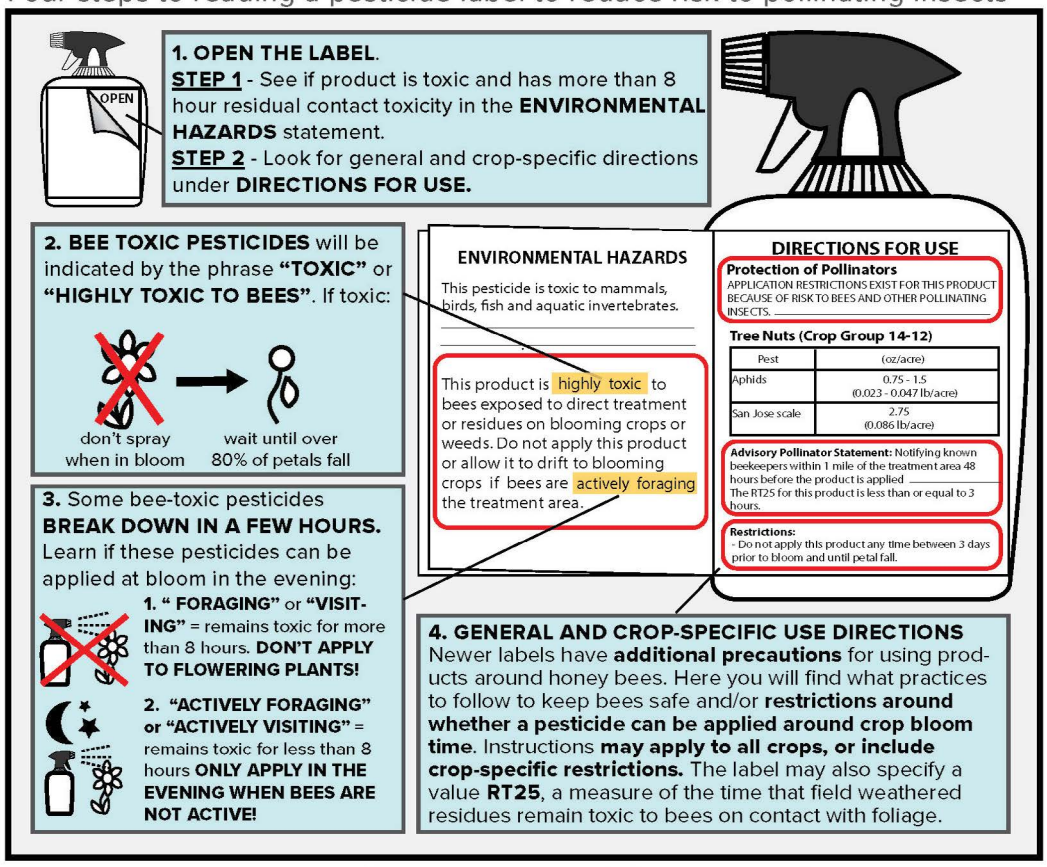
EPA

Read EPA's new and strengthened label requirements: http://go.usa.gov/jHH4

PROTECT POLLINATORS READ PESTICIDE LABELS

NAPPC

Four steps to reading a pesticide label to reduce risk to pollinating insects



www.pollinator.org/pesticide-education

Graphic by Iris Kormann and Andony Melathopoulos - Oregon State University; Rose Kachadoorian and Gilbert Uribe - Oregon Department of Agriculture
Text on reverse of card by the NAPPC Pollinator Health Task Force

MINIMIZING PESTICIDE EXPOSURE TO BEES

Understanding pesticide label information on the hazard and risks of bees is an important first step to protecting bees. Insecticides and some fungicides are of concern for bees. Here are a few actions to help minimize pesticide exposure to bees while managing pests and diseases.

1. Avoid sprays during bloom when possible. Bees face the highest exposure when pesticides are applied to the bloom of bee-attractive crops and weeds. When possible, use sprays before bloom to control pests and diseases to reduce the need for treatments at bloom.

2. If you must treat during bloom, choose products carefully and apply in the evening. Choose insecticides that are not labeled as 'Toxic' or 'Highly Toxic' to bees (front of card, Point 2). Avoid insecticides where residues remain toxic to bees for longer than 8 hours (Point 3). Always look to the Directions for Use for more specific information on when a product can be applied at reduced risk to bees (Point 4)

3. Cooperate and communicate with beekeepers in a timely manner. Contact beekeepers at least 48 hours prior to applying insecticides or fungicides to blooming bee-attractive crops. The beekeeper may choose to cover or move colonies, or may leave colonies in place depending on the toxicity of the product being sprayed.

4. Avoid spraying bee colonies and bee habitat. Avoid placing bees directly in the crop. In cases where colonies can only be set in the crop, turn sprayers off as you pass over the colonies. Reduce drift onto adjacent flowering habitat by using coarser droplet sizes, drift reducing agent, or intelligent sprayer technology.

5. Mow blooming weeds. If there are bee-attractive blooming weeds (e.g., mustard, clover or dandelion), mow them before spraying.

6. Review Pollinator Protection Plans and use IPM. Many states and industries provide information on how to protect bees and other pollinators. Contact your Department of Agriculture to obtain these plans. Integrated Pest Management (IPM) can also reduce bee pesticide exposure. Contact your regional IPM Center for details.

7. Report pesticide incidents with bees. Let EPA know as soon as you think bees have been killed by a pesticide (beekill@epa.gov). Also reach out to your state or tribal pesticide regulatory agency - contact information can be found at: http://npic.orst.edu/incidents.

www.pollinator.org/7things

HELPFUL LINKS

The **North American Pollinator Protection Campaign (NAPPC)** is a growing collaborative body of more than 170 diverse partners, including respected scientists, researchers, conservationists, government officials and dedicated volunteers. NAPPC's mission is to encourage the health of resident and migratory pollinating animals in North America.

The SARE Sustainable Agriculture Research & Education FFAR North Central IPM Center USDA National Institute of Food and Agriculture U.S. DEPARTMENT OF AGRICULTURE

Table 5. Effectiveness of peach fungicides

Fungicide	Rate per 100 gal dilute	Leaf Curl	Scab	Brown Rot		Rhizopus Rot	Rusty Spot/ Powdery Mildew
				Blossom	Fruit		
Botran 75W + Captan 50W	1 lb 1 lb	–	–	G	G	G	–
Bravo 720	16-22 fl oz	E	E	G	–	–	–
Captan 50W	2 lb	–	G	G	G	S	–
Coppers		E	–	–	–	–	–
Elevate 50WDG	(1.0 - 1.5 lb/A)	G	–	–	G	–	–
Tebustar 45WSP	2.0 oz	–	–	E	E	S	–
Gem	(4.0 - 8.0 oz/A)	_	E	E	E	_	G
Indar 2F	(6 fl oz/A)	–	G	E	E	–	E
Liquid lime sulfur	4 gal	E	–	–	–	–	–
Pristine	(10.5 - 14.5 oz/A)	–	F-G	–	E	–	–
Quash 50WDG	4 oz/A	–	G	E	E	–	–
Rally 40WSP	1.25 - 2.0 oz	–	–	E	–	–	E
Rovral 50W	(2 lb/A)	–	N	E	–	F	–
Sulfur 95W	6 lb	–	G	G	G	S	F
Tilt 3.6E	(4 fl oz/A)	–	–	E	E	S	–
Topsin-M 70W + Captan 50W[1]	4-6 oz + 1-2 lb	–	G	E	E	S	F
Topsin-M 70W + Sulfur 95W[1]	4-10 oz + 4-6 lb	–	G	E	E	S	G
Vangard	5 oz/A	–	–	E	–	–	–
Ziram 76DF	2.0 lb	E	G	G	–	–	–

Rating Scale: E = excellent; generally good disease control under heavy disease pressure; G = good; good control under moderate disease pressure; F = fair; fair control under moderate disease pressure; S = slight; some control under light disease pressure; N = none; little or no effect on indicated disease; - = Information lacking or not applicable.

[1] CAUTION: Combinations involving Topsin-M may become ineffective for scab or brown rot if resistance to this fungicide develops. If resistance is suspected, switch to a fungicide program not involving Topsin-M until the fungus has been tested for benzimidazole sensitivity.

Table 6. Effectiveness of Apple Fungicides

Fungicide	Rate/100 gal dilute	Scab	Powdery Mildew	Rusts	Brooks Spot	Black Rot	White Rot	Bitter Rot	Sooty Blotch & Fly Speck	Fruit Finish: Golden Delicious	Fruit Finish: Red Delicious
Aprovia + Mancozeb	5.5-7 fl oz/A 3 lb /A	E	G	G	E	-	-	-	-	-	-
Captan 50W	2 lb	G	N	S	G	G	G	G	G	E	E
(or equivalent rate of other formulation)											
Captan 50W	1.5 lb	G	N	S	G	G	G	F	F	E	E
(or equivalent rate of other formulation)											
Captan 80WDG + Prophyt	3.75 lb/A 4 pt/A	G	N	N	G	G	G	G	E	G	G
Captan 50W+ Ziram 76DF+ Topsin M 70W	1 lb + 1-1.5 lb + 2 oz	?[1]	G	F	E	E	E	G-E	E	G	G
EBDC+ Captan or Ziram 76DF	1 lb + 1-2 lb or 1-1.5 lb	G	-	G	G	G-E	G-E	E	G-E	G	G
Flint 50WG + Mancozeb	2.0 oz/A 3lb	E[1]	G-E	F-G	G-E	G	G	G	E	G	G
Fontelis 1.67SC + Mancozeb 75DF	16-20 fl oz/A + 3 lb/A	E	G	G	G	-	-	-	-	G	G
Indar 2F + Captan 50W	2.0 fl oz + 1 lb	E[1]	G	E	G	-	G	G	E	G	G
Indar 2F + Mancozeb 75DF	2.0 fl oz + 1 lb	E[1]	G	E	G	-	E	G	E	G	G
Indar 2F + Polyram 80DF	2 fl oz + 1 lb	E[1]	G	E	G	-	E	G	E	G	G
Indar 2F + Ziram 76DF	2 fl oz + 1 lb	E[1]	G	E	G	-	G	G	E	G	G
Inspire Super 2.82EW	12 fl oz/A	E[1]	G	E	G	-	E	G	G	G	G
Inspire Super + Mancozeb 75DF	8-12 fl oz/A 3 lb/A	E[1]	G	E	E	-	E	G	G	G	G
Luna Sensation + Mancozeb 75DF	4-5.8 fl oz/A + 3 lb/A	E[1]	E	G	G	-	-	-	-	G	G
Luna Tranquility + Mancozeb 75DF	11.2-16 fl oz/A + 3 lb/A	E[1]	E	G	G	-	-	-	-	G	G
Mancozeb 75DF	1 lb	F	N	F	G	F	F	G	G	G	G
(or equivalent rate of other formulation)											
Merivon + Mancozeb 75DF	4-6.7 fl oz/A + 3 lb/A	E[1]	E	G	E	-	-	-	-	G	G
Omega 500F	10-13.8 fl oz/A	G	N	N	G	F	F	F-G	F-G	G	G
Polyram 80DF	1 lb	F	N	F	F	F	F	G	F	E	E
Pristine 38WG	14.5 oz/A	G-E[1]	G	F	E	E	E	E	G-E	G	G
Procure 50WS+ Captan 50W	3 oz + 1 lb	E[1]	G	G	F	-	-	-	-	G	G
Procure 50WS+ Mancozeb 75DF	3 oz + 1 lb	E[1]	G	E	G	-	-	-	-	G	G
Procure 50WS+ Polyram 80DF	3 oz + 1 lb	E[1]	G	E	F	-	-	-	-	G	G

E = excellent; generally good disease control under heavy disease pressure; G = good; good control under moderate disease pressure; F = fair; fair control under moderate disease pressure; S = slight; some control under light disease pressure; N = none; little or no effect on indicated disease; (?) = Information lacking or (-) not applicable.

[1] RESISTANCE WARNING: These ratings assume that the target fungus has not developed resistance to listed fungicides. However, we know that this may have occurred in many locations. Combinations involving Topsin-M are ineffective where resistant strains of the apple scab fungus developed in many Virginia and West Virginia counties in the 1980s. Dodine (Syllit) will become less effective where resistance occurs. Scab resistance to dodine was confirmed in Clarke and Warren Counties, Virginia. Scab resistance to the SI fungicides was confirmed in Frederick county in 2004. SI resistance is currently suspected in the powdery mildew fungus in some locations. Resistance to the strobilurin (QoI) fungicides is likely to occur in the scab fungus and possibly in powdery mildew. If resistance is suspected, use of the suspect "at-risk" fungicide should be discontinued and replaced by full rates of other effective fungicides. The use of mixtures of materials, rotations among classes of materials (Table 2, p. 36), or both, is strongly advised.

[2] CAUTION: Ziram may be less effective than Captan on apple cultivars that are more susceptible to scab.

Table 6. Effectiveness of Apple Fungicides (cont.)

Fungicide	Rate/100 gal dilute	Scab	Powdery Mildew	Rusts	Brooks Spot	Black Rot	White Rot	Bitter Rot	Sooty Blotch & Fly Speck	Fruit Finish: Golden Delicious	Fruit Finish: Red Delicious
Procure 50WS+ Ziram 76DF	3 oz + 1.5 lb	E[1]	G	E	F	-	-	-	-	G	G
Rally 40WSP + Captan 50W	1.25 oz 1 lb	E	E	E	F	-	-	-	-	G	G
Rally 40WSP+ Mancozeb 75DF	1.25 oz + 1 lb	E	E	E	G	-	-	-	-	G	G
Rally 40WSP + Polyram	1.25 oz + 1 lb	E	E	E	F	-	-	-	-	G	G
Rally 40WSP + Ziram 76DF	1.25 oz + 1 lb	E	E	E	F	-	-	-	-	G(?)	G(?)
Scala 5SC + Mancozeb 75DF	5 fl oz/A 3.2 lb/A	G	N	F	-	-	-	-	-	G(?)	G(?)
Serenade Max	1-3 lb/A	S	F	F	F	-	-	-	S	F	F
Sovran 50WG + Mancozeb	4.0 oz/A 3lb	E	G-E	F-G	G-E	?	G	G(?)	E	G	G(?)
Stylet Oil	1-2 gal	F	F	F	F	-	-	-	S	F	F
Sulfur	2-3 lb	F	G	N	N	N	N	N	S	G	F
Sulfur	5 lb	G	G	N	N	N	N	N	S	F	F
Syllit 3.4F	8 fl oz	E	N	N	F	N	N	N	F	F	G
Topguard 1.04SC + Captan 50W	3.2 fl oz + 1 lb	G	E	E	-	-	-	-	-	-	-
Topguard 1.04SC + Mancozeb 75DF	3.2 fl oz + 1 lb	G	E	E	-	-	-	-	-	-	-
Topsin-M 70W + Captan 50W	2-3 oz + 1 lb	?[1]	G	N	E	E	E	F	E	G	G
Topsin-M 70W + Mancozeb 75DF	2-3 oz + 1 lb	?[1]	G	F	E	G	G	G	G	G	G
Topsin-M 70W + Polyram 80DF	2-3 oz + 1 lb	?[1]	G	F	E	G	G	G	G	G	G
Topsin-M 70W + Ziram 76DF	2-3 oz + 1 lb	?[1]	G	F	G	G	G	F	E	G	G
Vangard 75WG+ Mancozeb 75DF	3 oz/A+ 3 lb/A	G	N	F	-	-	-	-	-	G?	G?
Ziram 76DF	1.5 lb	F-G[2]	N	G	G	F	F	G	G	G	G

E = excellent; generally good disease control under heavy disease pressure; G = good; good control under moderate disease pressure; F = fair; fair control under moderate disease pressure; S = slight; some control under light disease pressure; N = none; little or no effect on indicated disease; (?) = Information lacking or (-) not applicable.

[1] RESISTANCE WARNING: These ratings assume that the target fungus has not developed resistance to listed fungicides. However, we know that this may have occurred in many locations. Combinations involving Topsin-M are ineffective where resistant strains of the apple scab fungus developed in many Virginia and West Virginia counties in the 1980s. Dodine (Syllit) will become less effective where resistance occurs. Scab resistance to dodine was confirmed in Clarke and Warren Counties, Virginia. Scab resistance to the SI fungicides was confirmed in Frederick county in 2004. SI resistance is currently suspected in the powdery mildew fungus in some locations. Resistance to the strobilurin (QoI) fungicides is likely to occur in the scab fungus and possibly in powdery mildew. If resistance is suspected, use of the suspect “at-risk” fungicide should be discontinued and replaced by full rates of other effective fungicides. The use of mixtures of materials, rotations among classes of materials (Table 2, p. 36), or both, is strongly advised.

[2] CAUTION: Ziram may be less effective than Captan on apple cultivars that are more susceptible to scab.

Table 7. Relative Effectiveness of Chemicals for Apple Insect Control[1]

(E = excellent; G = good; F = fair; P = poor)

	Aphids & Leafhoppers				Internal Worms				Leafrollers			Other Insects									Mites	
Chemicals	**RAA**	**SA**	**WAA**	**LH**	**CM**	**OFM**	**AM**	**PC**	**TBM**	**RBL**	**OBL**	**SJS**	**GFW**	**TPB/ SB**	**MB**	**TLM**	**JB**	**DB**	**C**	**EAS**	**ERM**	**TSM**
Abba, Agri-Mek	-	-	-	F-G	-	-	-	-	-	-	-	G[3]	-	-	-	E	-	-	-	-	E	G
Acramite, Banter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	G-E	G-E
Actara	E	E	-	E	P	P	-	G	-	-	-	-	-	G	G	G	-	-	F	G	-	-
Admire Pro, Alias	E	E	-	E	-	-	-	-	-	-	-	G[3]	-	-	-	E	F-G	-	-	F	-	-
Agri-Flex	E	E	-	E	-	-	-	G	-	-	-	-	-	G	G	G	-	-	F	G	E	E
Altacor eVo	-	-	-	-	E	E	-	-	E	E	E	-	-	-	-	E	-	-	-	-	-	-
Apollo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	E	E
Apta	-	-	-	-	-	-	-	G-E	G-E	G-E	G-E	-	-	-	-	-	-	-	-	-	-	-
Asana XL, Adjourn	G-E	F-G	-	G-E	G	G	G	G	E	E	E	F	G-E	E	-	E	E	G	E	G	-	-
Assail	E	E	-	E	G-E	G-E	G	G	P	P	P	G	-	G	E	E	G	F-G	G	E	-	-
Avaunt eVo	-	P	-	F-G	F-G	F-G	F-G	G-E	F	F	P	-	-	-	-	P	-	-	P	F	-	-
Aza-Direct	G-E	F	-	-	G	G	-	-	-	-	-	-	-	-	-	G	-	-	P	-	-	-
B.t.	-	-	-	-	P-F	P-F	-	-	G	G	G	-	E	-	-	-	-	-	-	-	-	-
Baythroid XL	G-E	F-G	-	G-E	G	G	G	G	E	E	E	-	G-E	E	-	E	E	-	E	G	-	-
Belay	E	E	-	E	F-G[5]	F-G	-	G	P	P	P	-	G	-	-	E	-	-	-	-	-	-
Beleaf	E	E	-	-	-	-	-	-	-	-	-	-	-	G	-	-	-	-	-	-	-	-
Besiege	G-E	F-G	-	G-E	E	E	G	E	E	E	E	-	G-E	E	-	E	E	-	E	G	-	-
Bifenture, Brigade	G-E	F-G	-	G-E	G	G	G	G	E	E	E	-	G-E	E	-	E	E	-	G	G	-	-
Centaur	-	-	-	E	-	-	-	-	-	-	-	E	-	-	-	-	-	-	-	-	-	-
CM virus[6]	-	-	-	-	G	G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Closer	E	E	F	G	-	-	-	-	-	-	-	-	-	G	-	-	-	-	-	-	-	-
Danitol	G-E	F-G	-	G-E	G	G	G	G	E	E	E	-	G-E	E	-	E	E	-	E	G	G	-
Declare, Proaxis	G-E	F-G	-	G-E	G	G	G	E	E	E	E	-	G-E	E	-	E	E	-	E	G	-	-
Delegate	-	-	-	-	E	E	-	-	E	E	-	-	-	-	-	E	-	-	-	-	-	-
Diazinon	F-G	G	E	F	G	G	E	G	F	P	P-F	G[3]	G	-	G	F	G	-	-	G	-	-
Endigo	E	E	-	E	G	G	G	E	E	E	E	-	-	G	-	E	E	-	E	G	-	-
Entrust	-	-	-	-	F	-	F-G	-	E	-	E	-	-	-	-	E	-	-	-	-	-	-
Envidor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	E	E
Esteem	G-E	G	-	-	G	-	-	-	-	-	-	E	-	-	-	E	-	-	-	-	-	-
Exirel	E	-	-	-	E	E	-	F-G	E	E	E	-	E	-	-	E	-	-	-	-	-	-
Gladiator	G-E	F-G	-	G-E	G	G	G	G	E	E	E	-	G-E	E	-	E	E	-	E	G	E	E
Imidan	P	P	-	P	E	E	E	E	G	G	P-G	F	G	F	-	F	G	-	-	G-E	P	P
Intrepid	-	-	-	-	F	F	-	-	E	E	F	-	G	-	-	G	-	-	-	-	-	-
Kanemite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	E	E
Lannate	F	G	-	E	G	G	G	F-G	E	E	G	F-G[3]	F-G	G	-	G	G	-	F	F	P	P
Lannate + Imidan	F	F	-	G	E	E	G	E	E	E	-	-	-	-	-	F	G	-	P	G	-	-
Leverage	E	E	-	E	G	G	G	G	E	E	E	G[3]	G-E	E	-	E	E	-	E	G	-	-
Magister	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	E
Minecto Pro	-	G	-	G	E	E	-	G	-	-	-	-	-	-	-	-	-	-	-	-	E	E
Movento	E	E	F-G	-	-	-	-	-	-	-	-	G	-	-	-	-	-	-	-	-	-	-
Mustang Maxx	G-E	F-G	-	G-E	G	G	G	G	E	E	E	-	G-E	E	-	E	E	-	E	G	-	-
Nealta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	E	E

Table 7. Relative Effectiveness of Chemicals for Apple Insect Control[1] (cont.)

(E = excellent; G = good; F = fair; P = poor)

	Aphids & Leafhoppers				Internal Worms				Leafrollers			Other Insects									Mites	
Chemicals	**RAA**	**SA**	**WAA**	**LH**	**CM**	**OFM**	**AM**	**PC**	**TBM**	**RBL**	**OBL**	**SJS**	**GFW**	**TPB/ SB**	**MB**	**TLM**	**JB**	**DB**	**C**	**EAS**	**ERM**	**TSM**
Neemix	G-E	F	-	-	G	G	-	-	-	-	-	-	-	-	-	G	-	-	P	-	-	-
Nexter	-	F	-	G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	E	G
Oil	F	F-G	-	-	-	-	-	-	-	-	-	E	-	-	-	-	-	-	-	-	E[2]	P
Perm-UP, Pounce	G-E	F-G	-	G-E	-	G	-	G	E	E	E	P	G-E	E	-	E	E	-	E	G	P	P
Pheromones (CM)[7]	-	-	-	-	G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pheromones (OFM)[7]	-	-	-	-	-	E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pheromones (DB)[7]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	G	-	-	-	-
Portal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	E	E
Proclaim	-	-	-	-	F	F	-	-	E	E	-	-	-	-	-	-	-	-	-	-	-	-
Rimon	-	-	-	-	E	G	-	-	E	E	-	-	-	-	-	E	-	-	-	-	-	-
Savey, Onager	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	E	E
Sevin	P	F	F	G	G	G	E	G	F-G	F-G	P-F	F	F	-	P-F	F	E	-	G	F-G	P	P
Sivanto	E	E	-	E	-	-	-	-	-	-	-	G	-	-	-	-	-	-	-	-	-	-
Surround	-	F	-	G	F	-	G	G	-	-	F	P	-	-	-	F	G-E	-	G	F-G	-	-
Tombstone	G-E	F-G	-	G-E	G	G	G	G	E	E	E	-	G-E	E	-	E	E	-	E	G	-	-
Vendex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	G	G
Verdepryn	-	-	-	-	E	E	-	-	E	E	E	-	E	-	-	E	-	-	-	-	-	-
Versys	E	E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Voliam Flexi	E	E	-	E	E	E	-	G	E	E	E	-	-	G	G	E	-	-	F	G	-	-
Vydate	F-G	G	-	F-G	P	-	F	P	F	P	P	-	-	-	G-E	E	-	-	-	-	G	G
Warrior, Lambda-Cy, Silencer	G-E	F-G	-	G-E	G	G	G	E	E	E	E	-	G-E	E	-	E	E	-	E	G	-	-
Zeal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	E	E

[1] Compiled from data collected in Virginia, West Virginia and other states. Intended only as a guide. Different results may be obtained in individual orchards as a result of resistance (or lack of it), application methods, and weather conditions. AM=Apple maggot; C=Cicada; CM=Codling moth; DB=Dogwood borer, EAS=European apple sawfly; ERM=European red mite; GFW=Green fruitworm; JB=Japanese beetle; LH=White apple leafhopper and rose leafhopper; MB=Mullein bug; OBL = Obliquebanded leafroller; OFM=Oriental fruit moth; PC=Plum curculio; RAA=Rosy apple aphid; RBL=Redbanded leafroller; SA=Spirea aphid; SB=Stink bugs; SJS=San Jose Scale; TBM=Tufted apple bud moth + variegated leafroller; TLM=Tentiform leafminers; TPB=Tarnished plant bug; TSM=Twospotted spider mite; WAA=Woolly apple aphid.

[2] Overwintering eggs.

[3] Crawler stage.

[4] Pink application.

[5] Belay is considered stronger for first brood CM than subsequent broods.

[6] Madex HP and Virusoft CP4 are isolates of CM granulosis virus with activity against CM and OFM larvae.

[7] For further information on pheromone-based mating disruption, see note on page 44.

Table 8. Relative Effectiveness of Chemicals for Peach Insect Control[1] (cont.)

(E = excellent; G = good; F = fair; P = poor)

	Internal Worms		Borers		Others							
Chemicals	**OFM**	**PC**	**LPTB**	**PTB**	**GPA**	**TPB/SB**	**S**	**LR**	**JB**	**C**	**WFT**	**M**
Acramite, Banter	-	-	-	-	-	-	-	-	-	-	-	G-E
Actara	-	E	-	-	E	G	-	-	-	F	-	-
Admire Pro, Alias	-	-	-	-	E	-	-	-	F-G	-	-	-
Agri-Mek, Abba	-	-	-	-	-	-	-	-	-	-	-	E
Altacor eVo	E	-	-	-	-	-	-	E	-	-	-	-
Apollo	-	-	-	-	-	-	-	-	-	-	-	E
Apta	-	G-E	-	-	G	-	-	G-E	-	-	-	-
Asana XL, Adjourn	E	G	G[3]	-	P	E	-	E	E	E	-	-
Assail	G	F	-	-	E	G	G	-	G	G	G	-
Avaunt eVo	F-G	G-E	-	-	-	F	-	F	-	-	-	-
Baythroid XL	E	G	G[3]	-	P	E	-	E	E	E	-	-
Belay	-	G	-	-	E	G	-	-	-	-	-	-
Beleaf	-	-	-	-	E	G	-	-	-	-	-	-
Bifenture, Brigade	E	G	-	-	-	E	-	E	E	-	-	-
Besiege	E	G	G[3]	-	P	E	-	E	E	E	-	-
Centaur	-	-	-	-	-	-	E	-	-	-	-	-
Closer	-	-	-	-	E	G	-	-	-	-	-	-
CM Virus[5]	G	-	-	-	-	-	-	-	-	-	-	-
Danitol	E	G	G[3]	-	P	E	-	E	E	E	-	G
Delegate	E	-	-	-	-	-	-	E	-	-	E	-
Diazinon	G	G	-	-	-	-	G	F	G	-	-	-
Endigo	E	E	G[3]	-	E	G-E	-	E	E	E	-	-
Entrust	-	-	-	-	-	-	-	E	-	-	E	-
Envidor	-	-	-	-	-	-	-	-	-	-	-	E
Esteem	-	-	-	-	-	-	E	-	-	-	-	-
Exirel	E	F-G	-	-	-	-	-	E	-	-	-	-
Gladiator	E	G	G[3]	-	-	E	-	E	E	E	-	E
Imidan	E	E	-	-	-	G	-	G	-	-	-	-
Intrepid	G	-	-	-	-	-	-	E	-	-	-	-
Lannate	E	F	-	-	G	G	-	E	G	F-G	G	-
Magister	-	-	-	-	-	-	-	-	-	-	-	E
Movento	-	-	-	-	E	-	G	-	-	-	-	-
Mustang Maxx	E	G	G[3]	-	P	E	-	E	E	E	-	-
Nexter	-	-	-	-	-	-	-	-	-	-	-	E
Oil	-	-	-	-	-	-	E	-	-	-	-	E[2]
Perm-UP, Pounce	E	G	G[3]	-	P	E	-	E	E	E	-	-
Pheromones (OFM)[4]	E	-	-	-	-	-	-	-	-	-	-	-
Pheromones (PTB/LPTB)[4]	-	-	E	E	-	-	-	-	-	-	-	-t
Portal	-	-	-	-	-	-	-	-	-	-	-	E
Proaxis	E	G	G[3]	-	P	E	-	E	E	E	-	-
Savey, Onager	-	-	-	-	-	-	-	-	-	-	-	E
Sevin	G	F	-	-	-	-	-	F	E	G	-	-
Sivanto	-	-	-	-	E	-	G	-	-	-	-	-
Tombstone	E	G	G[3]	-	P	E	-	E	E	E	-	-
Vendex	-	-	-	-	-	-	-	-	-	-	-	G
Verdepryn	E	-	-	-	-	-	-	E	-	-	-	-
Versys	-	-	-	-	E	-	-	-	-	-	-	-
Venom, Scorpion	-	G	-	-	-	G-E	-	-	-	-	-	-
Voliam Flexi	E	E	-	-	E	G	-	E	-	F	-	-
Warrior, Lambda-Cy, Silencer	E	G	G[3]	-	P	E	-	E	E	E	-	-

[1] Compiled from data collected in Virginia, West Virginia, and other states. Intended only as a guide. Different results may be obtained in individual orchards as a result of resistance (or lack of it), application methods, and weather conditions. C=Cicada; GPA=Green peach aphid; JB=Japanese beetle; LPTB=Lesser peachtree borer; LR=Leafroller; M=Mites; OFM=Oriental fruit moth; PC=Plum curculio; PTB=Peachtree borer; S=scale; TPB/SB=Tarnished plant bug and Stink bugs; WFT=Western flower thrips.
[2] Overwintering eggs. [3] Adult stage. Use pheromone trap for proper timing. [4] For further information on pheromone-based mating disruption, see note on page 44. [5] Madex HP and Virusoft CP4 are isolates of CM granulovirus with activity against OFM.

Table 9. Relative Toxicity of Pesticides to Orchard Predators[1]

(N=nontoxic; L=low; M=moderate; H=high; - = information is lacking)

	Mite Predators						Aphid Predators & Parasites				
	Stethorus										
Chemical	**L**	**A**	***Amblyseius***	***Zetzellia***	***Leptothrips***	***Orius***	**Syrphids**	**Midge**	**Lady Beetles**	**Lacewings**	***Aphelinus***
Acramite, Banter	N	N	M	L	-	N	-	N	N	N	-
Actara	M	M	N	N	-	M	M	M	M	M	-
Admire Pro, Alias	M	M	N	N	-	M	M	L	M	L	H
Agri-Flex	M	M	N	N	-	M	M	M	M	M	-
Agri-Mek, Abba	M	M	M	L	-	-	-	-	-	-	-
Aliette	-	-	-	-	-	-	H	-	-	-	-
Altacor eVo	L	L	L	L	L	L	L	L	M	M	M
Apollo	N	N	L	L	L	N	L	N	N	N	-
Apta	-	-	-	-	-	-	-	-	-	-	-
Asana, Adjourn[4]	H	H	H	M	-	M	L	L-M	M-H	H	H
Assail	M	M	L	L	-	M	L	M	M	M	-
Avaunt eVo	L	L	L	L	-	L	H	L	L	L	-
B.t.	L	L	L	L	L	L	L	L	L	L	L
Baythroid XL	H	H	H	M	-	M	L	L-M	M-H	H	H
Belay	M	M	L	L	-	M	L	L-M	M-H	H	H
Beleaf	-	-	-	-	-	-	-	-	-	-	-
Besiege	H	H	M	M	-	M	L	L-M	M-H	-	-
Bifenture, Brigade	H	H	H	M	-	M	L	L-M	M-H	H	H
Captan[2]	L	L	L	-	-	L	-	L	-	L	-
Centaur	-	-	-	-	-	-	-	-	-	-	-
Closer	-	-	-	-	-	-	-	-	-	-	-
CM Virus	N	N	N	N	N	N	N	N	N	N	N
Danitol[4]	H	H	H	M	-	M	L	L-M	M-H	H	H
Declare, Proaxis[4]	H	H	H	M	-	M	L	L-M	M-H	H	H
Delegate	N	N	L	N	N	N	M	L	L	-	H
diazinon	M	M	M	L	-	L	M	H	M	M	H
dodine	-	-	-	-	-	-	-	L	-	-	-
Endigo	H	H	H	M	-	M	M	M	M-H	H	H
Entrust	N	N	N	N	N	N	M	L	L	L	-
Envidor	-	-	M	-	-	-	-	-	-	-	-
Esteem	M	N	N	N	-	M	-	N	M	M	-
Exirel	L	L	L	L	L	L	L	L	M	H	M
Gladiator	H	H	H	M	-	M	L	L-M	M-H	H	H
Goal	-	-	H	-	-	-	-	-	-	-	-
Imidan	L	L	N	N	H	L	-	L	L	L	L
Intrepid	N	N	N	N	N	N	N	N	N	N	N
Kanemite	-	-	L-M	-	-	-	-	-	-	-	-
Lannate	M	M	H	M	-	M	-	H	H	M	-

[1] Pesticides that are not directly toxic to a predator may still reduce its numbers indirectly by reducing prey densities. Stethorus L and A refer to larvae and adults.
[2] Although Captan is not toxic to predators, it is repellant to *Amblyseius fallacis*.
[3] Pheromones includes all mating disruption products.
[4] These pesticides may also increase mite populations by stimulating reproduction.

Table 9. Relative Toxicity of Pesticides to Orchard Predators[1] (cont.)

(N=nontoxic; L=low; M=moderate; H=high; - = information is lacking)

	Mite Predators					Aphid Predators & Parasites					
	Stethorus								Lady		
Chemical	**L**	**A**	***Amblyseius***	***Zetzellia***	***Leptothrips***	***Orius***	**Syrphids**	**Midge**	**Beetles**	**Lacewings**	***Aphelinus***
Leverage	H	H	H	M	-	M	M	L-M	M-H	H	H
Magister	-	-	H	H	-	-	-	-	-	-	-
mancozeb	-	-	-	-	-	M-H	H	-	M-H	-	-
malathion	-	-	L	-	-	M	M	M-H	-	H	-
metiram	-	-	-	-	-	-	L	-	-	-	-
Minecto Pro	M	M	M	L	-	L	L	L	-	-	M
Movento	L	L	L	L	L	L	L	L	L	L	L
Mustang Maxx	H	H	H	M	-	M	L	L-M	M-H	H	H
Nealta	N	N	N	N	N	N	-	-	N	N	-
Nexter	M	M	M	L	-	M	-	L	M	L	-
oil	L	L	L	L	-	-	-	-	-	-	-
paraquat	-	-	H	-	-	-	-	-	-	-	-
Perm-UP, Pounce[4]	H	H	H	M	-	M	L	L	M-H	H	H
Pheromones[3]	N	N	N	N	N	N	N	N	N	N	-
Portal	-	-	M	-	-	-	-	-	-	-	-
Proclaim	-	-	-	-	-	-	-	-	-	-	-
Rely	-	-	H	-	-	-	-	-	-	-	-
Ridomil	-	-	-	-	-	-	-	H	-	-	-
Rimon	H	L	M	-	-	-	-	-	H	H	M
Round-Up	L	L	H	-	-	-	-	-	-	-	-
Savey, Onager	N	N	L	L	L	N	L	N	N	N	-
Sevin	H	H	M	L	-	M	H	H	H	M	H
simazine	-	-	L	-	-	-	-	-	-	-	-
Sivanto	-	-	-	-	-	-	L	-	L	L	-
sulfur	L	L	M	-	-	M	-	-	-	L	-
Surround	-	-	-	-	-	-	-	-	L	-	-
thiram	-	-	-	-	-	-	-	L	-	-	-
Tombstone	H	H	H	M	-	M	L	L-M	M-H	H	H
Topsin-M	L	L	H	M	-	-	-	L	-	-	-
Vendex	L	L	L-M	H	-	-	-	L	-	H	-
Versys	-	-	-	-	-	-	-	-	-	-	-
Venom, Scorpion	H	H	-	-	-	-	-	-	H	-	H
Verdepryn	L	L	L	L	L	L	L	L	M	H	M
Voliam Flexi	M	M	L	L	L	M	M	M	M	M	L
Vydate	L	L	M-H	H	-	-	-	M	-	-	-
Warrior, Lambda-Cy, Silencer[4]	H	H	H	M	-	M	L	L-M	M-H	H	H
Zeal	L	L	M	-	-	M	-	-	L	M	-

[1] Pesticides that are not directly toxic to a predator may still reduce its numbers indirectly by reducing prey densities. Stethorus L and A refer to larvae and adults.
[2] Although Captan is not toxic to predators, it is repellant to *Amblyseius fallacis*.
[3] Pheromones includes all mating disruption products.
[4] These pesticides may also increase mite populations by stimulating reproduction.

Methods of Spray Volume Calculation and Sprayer Calibration

THE AMOUNT OF DILUTE PESTICIDE NEEDED

The recommended rates are given in the amounts to be used per 100 gal of dilute spray and the amounts to be used per acre with low-volume spraying. The amount of dilute spray needed for pest control on an acre of mature apple trees cannot be exact for all conditions. It is suggested that calculations for airblast sprays for apples be based upon 400 gal of dilute spray per acre for mature standard trees pruned to a height of 20 to 22 ft. The amount of spray for stone fruits is from 150 to 250 gal per acre. Lesser amounts may be used for smaller trees. After the sprayer has been calibrated to this standard, it can be adjusted for tall trees or small trees by turning the nozzles on or off in the upper or lower ends of the manifold of conventional sprayers or by adjusting the output per acre on mist-type sprayers. In general, a sprayer properly calibrated for use on apples at 2 mph will deliver the suggested amount of spray on stone fruit when moved at 3 mph (this depends on the size of the trees in both cases).

THE AMOUNT OF SPRAY MIXTURE NEEDED FOR LOW VOLUME

In low-volume spraying, the quantity of pesticide used per acre should be based on the amount of dilute spray needed to completely cover the trees to the point of runoff. When low-volume sprays are applied, use disks that have small orifices in the nozzles; no spray should be lost in runoff, and the spray deposit will appear as a series of small droplets of concentrated chemical. A reduction of approximately 20% in the amount of chemical used per acre can be made with low-volume sprays. The amount of water used may vary from 20 to 100 gal per acre, but the amount of chemical used per acre should remain the same after the initial reduction is made. Spraying at rates of less than 40 gal per acre is only satisfactory for trees 15 ft or less in height. This is particularly true with apple varieties susceptible to powdery mildew. Unless the trees are pruned to allow the proper penetration of the spray droplets, low-volume spraying of trees taller than 22 ft is not recommended because it may result in low chemical deposits in the treetops. Sprayer type influences the amount of spray deposited, so the one selected should have the capacity appropriate to the task. Spray coverage should be checked frequently. The spray droplets must reach all parts of the trees; if they don't, adjust or change the nozzles.

SPRAYER CALIBRATION

Every sprayer must be accurately calibrated to deliver the appropriate amount of material. In the case of airblast sprayers, the distribution of the material is an integral part of calibration. Sprayer manufacturers publish a manual or bulletin giving information and instructions on how to calibrate their sprayers. Tables are issued to show the amount of spray that a given orifice will deliver at a given nozzle pressure. Be sure the dealer or company representative provides the instruction manual and shows you how to use it. *The sprayer should be calibrated at the beginning of the season and re-checked regularly throughout the season.*

Several factors are involved, some of which are:

1) ground speed,
2) gallons per acre,
3) nozzle pressure,
4) nozzle output (orifice size and whirl plate influence this), and
5) spray distribution from top to bottom of outlet manifold.

The tree size and density of foliage will influence the degree of coverage obtained. Consequently, the sprayer and its calibration should be tailored to the job to be done. Penetration to the center of the tree is essential for satisfactory mite and scale control. This should be checked carefully. A large proportion of the spray should be delivered by the top nozzles. Approximately 50 percent should be delivered by the top third of the nozzles, 35 percent by the middle third, and 15 percent by the bottom third. The orifices should be arranged so they give a gradual reduction of material from top to bottom of the manifold delivery arc. Some sprayers have devices for adjusting the airstream along the manifold arc; these should be properly adjusted. Terrain and orchard surface will influence ground speed. In general, speeds from 2 to 3 miles per hour are appropriate for most situations.

Adequate coverage is the objective. Any arrangement that accomplishes this is appropriate as long as excessive material is not off-target.

ALTERNATE-ROW-MIDDLE SPRAYING

Intervals between half-sprays must be shortened to accommodate alternate-row-middle systems of spraying. For effective insect and disease control, growers must meet three requirements:

(a) Have an airblast sprayer capable of partial coverage of the non-sprayed side of each tree row. Sprayers with less than 90,000 cfm and 180 psi are not likely to be successful in this program unless trees are no more than 12 feet high. Sprayers of intermediate airflow capabilities can be used when they are properly matched with the size trees to be sprayed, but good pruning that permits free air passage through the tree is essential.

(b) Adjust the interval between half-sprays when pest pressures increase or decrease.

(c) Follow weather conditions closely, and adjust spray programs to take advantage of favorable situations or compensate for unfavorable periods.

When weather conditions remain unfavorable for disease development, and disease and insect pressure are light during the cover spray period, the rates for insecticides and fungicides are frequently slightly lower for alternate-row spraying than those suggested for low-volume sprays in standard apple programs. This can be done because more frequent applications provide deposits of fresh toxic materials. **However, where insect pests or apple scab, powdery mildew, or other diseases were present the previous year, or if weather conditions become favorable for outbreaks, use exactly one-half of the acceptable pesticide rate per acre given for every middle spraying as a guide for minimum rate for half-sprays per acre**.

CHEMICAL CONTROL OF DISEASES AND INSECTS

Bearing Apple Orchards

The following calendar recommendations are intended only as a general guide. For more effective pest management, choice of pesticides, timing of sprays and rates should be based on systematic orchard scouting. Dilute spray is based on 400 gal per acre for a mature orchard on standard rootstock.

Spray combinations suggested are considered the best available for most situations. They are intended to be used in orchards bearing fruit that will be processed or sold fresh. These suggestions do not imply that other materials are not useful or satisfactory under some conditions. Past experience and knowledge of specific orchard situations should be relied upon in the selection and development of a spray program. New registrations or cancellations of pesticides may occur during the season. Follow extension announcements in Fruit Notes, Virginia Fruit Web Site (*http://www.virginiafruit.ento.vt.edu*), newspaper columns, newsletters, and radio programs. Where pH levels are indicated on pesticide label, determine pH of the finished mixture in the tank; adjust accordingly.

DORMANT SPRAYS

Effectiveness rating: E = excellent, G = good, F = fair

Disease	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Fireblight	G = 1, 2, 3, 4, 5	1. C-O-C-S 50WDG	2-4 lb	-
		2. Kocide DF	2-4 lb	-
		3. Cuprofix Ultra 40	-	5.0-7.55 lb
		4. Bordeaux mixture (copper sulfate + agricultural spray lime) 325 Mesh[2]	8 lb + 8 lb	-
		5. Various copper formulations	See label	See label

[1] Suggested where fireblight was difficult to control in the previous year or on young blocks of susceptible cultivars such as York Imperial, Fuji, Jonathan, Rome Beauty, Idared, Gala, and crabapple pollinizers and orchards planted on M.9, M.26 and Mark rootstock. Other coppers may also be suitable and may be easier to handle than Bordeaux mixture. DO NOT APPLY COPPER AFTER FOLIAGE APPEARS BECAUSE OF POTENTIAL FOR RUSSETING. Where there is less economic risk due to russeting as in fruit grown for processing, copper sprays applied from silver tip to half-inch green will protect against an early scab infection period.
[2] Particles larger than those produced by 325 mesh will clog and damage sprayer pump. See p. 28 for mixing instructions.

SILVER TIP - GREEN TIP SPRAY

Insects/Mites	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
San Jose Scale (SJS)	E = 1, 2, 3, 4	1. [2]Superior oil	2 gal	6 gal
Rosy apple aphid (RAA)[1]	E= 2, 4 G = 1	2. Esteem 35W	-	3-5 oz
		3. Centaur 70WDG	-	34.5 oz
Green aphid (SA/AA)[1]	E= 4 G = 1, 2	4. Sivanto 200SL or Sivanto Prime	-	7-14 fl oz
Mite eggs (ERM)	E=1			

[1] Aphids are best controlled with the silver-tip or 1/4-1/2" green spray, otherwise they will be within curled leaves and protected from insecticides. “Green aphids” are a complex of two species, spirea aphid (SA) and apple aphid (AA) .
[2] Do not apply oil when the temperature is higher than 85°F or lower than 35° F. Use only oil having specifications that meet the standards for a superior oil. Always test such oil for physical compatibility before using it. See page 45 for details. Dilute applications of oil are more effective.

1/4 – 1/2 INCH GREEN SPRAY : Diseases

Disease	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Scab	E = 1, 3, 4, 5, 6, 7, 8, 9,10, 12, 13, 14, 15, 17, 18, 20, 21, 22, 23, 25, 26 G = 2, 11, 16, 19, 24	1. [1]Syllit 3.4F	8 fl oz	1.5 pt
		2. [1]Captan 50W	1.5 lb	6.0 lb
		3. Fontelis 1.67SC + Mancozeb 75DF	-	16 to 20 fl oz + 3 lb
		4. Luna Sensation 500SC + Mancozeb 75DF	-	4.0 to 5.8 fl oz + 3 lb
		5. Luna Tranquility 4.16SC + Mancozeb 75DF	-	11.2 to 16 fl oz + 3 lb
		6. [2]Merivon 4.18SC + Mancozeb 75DF	-	4 to 6.7 fl oz + 3 lb
		7. [2]Rally 40WSP + [1]Captan 50W	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3.25 lb
		8. [2]Rally 40WSP + Ziram 76DF	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3.25 lb
		9. [2]Rally 40WSP + [3]mancozeb 75DF	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3 lb
		10. [2]Rally 40WSP + [3]Polyram 80DF	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3 lb
		11. Ziram 76DF	1.5 lb	6 lb
		12. Procure 50WS + Captan 50W	3 oz + 1 lb	12 oz + 3.25 lb
		13. Procure 50WS + mancozeb 75DF	3 oz + 1 lb	12 oz + 3 lb
		14. Procure 50WS + Polyram 80DF	3 oz + 1 lb	12 oz + 3 lb
		15. Procure 50WS + Ziram 76DF	3 oz + 1 lb	12 oz + 3 lb
		16. Vangard 75WG + mancozeb 75DF	- -	3 oz + 3.2 lb
		17. [4]Sovran 50WGm + mancozeb	1.0-1.6 oz -	4.0-6.4 oz 3 lb
		18. [4]Flint 50WG + mancozeb	- -	2.0-2.5 oz 3 lb
		19. Scala 5SC + mancozeb 75DF	- -	5 fl oz 3.2 lb
		20. Indar 2F + Captan 50W	-	8 fl oz + 3.25 lb
		21. Indar 2F + mancozeb 75DF	-	8 fl oz + 3 lb
		22. Indar 2F + Polyram 80DF	-	8 fl oz + 3 lb
		23. Indar 2F + Ziram 76DF	-	8 fl oz + 3 lb
		24. Inspire Super 2.82EW	-	12 fl oz
		25. Inspire Super + mancozeb 75DF	-	8.5 fl oz + 3 lb
		26. Aprovia + mancozeb	- -	5.5-7 fl oz 3 lb

[1] CAUTION: Do not use Captan or combinations involving Captan, with oil or within 4 days of an oil application. Check for tank-mix compatibility of dodine with oil. Some sporadic resistance of scab to dodine has occurred where used heavily for several years.

[2] See Rally label for rate per acre adjustment based on tree height. When used in an after-infection strategy a follow-up application should be made a week later to kill the fungus in the lesion. Do not combine Merivon with emulsifiable concentrate solvent-based formulation products. Do not combine Merivon with crop oil concentrate or methylated seed oil adjuvants.

[3] CAUTION: The EBDC fungicides (mancozeb and Polyram) are registered for limited usage on apples for control of scab, rusts and some summer diseases. The grower is given the option of using one of two schedules: A. Apply 6.0 lb of the 75DF or 80DF formulations per acre per application from green tip stage through bloom, maximum 24 lb per acre per year. or B. Apply 3.0 lb per acre from green tip stage through second cover or up to 77 days to harvest, maximum 21 lb per acre per year.The above schedules are not to be combined, so you must decide before the first spray which schedule best fits your needs. Because EBDCs have been most beneficial for summer disease control (especially bitter rot) and in applications which require a broad spectrum fungicide which is compatible with oil, the second option (3 lb per acre up to 77 days to harvest) is listed here as the preferred usage pattern. When used in the early cover sprays (or up to 77 days to harvest) EBDCs may have benefits for residual early summer disease control and compatibility in programs where oil is used with Sevin as a thinner. The 3.0 lb per acre EBDC rate cannot be relied on by itself for early season or summer disease control. Combinations with sterol-inhibiting fungicides (Indar, Inspire Super, Rally, Procure and Topguard) have been well tested and are recommended for early season disease control (apple scab, rusts, powdery mildew); the benzimidazoles (Topsin and Topsin-M) are compatible with EBDCs and provide supplemental control for Brooks spot, sooty blotch, fly speck, black rot and white rot, but not for bitter rot. Captan and ziram are protectant fungicides that provide supplemental summer disease control. Incompatibilities among combinations of Captan, ziram, mancozeb or Polyram are not anticipated but are not well tested. Captan is incompatible with oil. See the additional note about EBDCs under the second cover spray, p. 73.

[4] CAUTION: Sovran, Flint, Luna Sensation, and Merivon are strobilurin fungicides that will require a selected use strategy because of concern about development of resistance. These fungicides have benefits for early season and summer disease management; however, they should not be used in more than two consecutive sprays. They should be tank mixed with a protectant fungicide and alternated with two or three applications of non-strobilurin fungicides from other chemical classes for control of all diseases concerned. These fungicides may not provide curative activity under heavy rust pressure. Areas with heavy rust pressure will need to rely on sterol-inhibiting fungicides during periods of peak rust activity.

[5] Do not combine Merivon with emulsifiable concentrate or solvent-based formulation products. Do not combine Merivon with crop oil concentrate or methylated seed oil adjuvants.

1/4 – 1/2 INCH GREEN SPRAY[1] : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
San Jose Scale (SJS)	E = 1 G = 17	1. Superior Oil	2 gal	6 gal
		2. Lannate 90SP or Lannate LV	4 oz -	0.5-1 lb 1.5-3 pt
Rosy apple aphid (RAA)[2]	E = 16, 17 G = 6, 7, 8, 12, 13, 14, 15, 18	3. Checkmate OFM-F	-	1.3-2.9 fl oz
		4. Imidan 70WSB	12-16 oz	2.1-5.75 lb
Green aphid (SA/AA)	E = 16, 17 G = 6, 7, 8, 13, 14, 15	5. *Bacillus thuringiensis*	See label	See label
		6. Perm-UP 3.2EC or Pounce 3.2EC	-	4-16 fl oz
Mite eggs (ERM)[3]	E = 1, 9, 10			
Redbanded leafroller eggs (RBLR)[4]	G = 2	7. Perm-UP 25DF	-	6.4-17.6 oz
Defoliating caterpillars[5]	E = 6, 7, 8, 11, 13, 14, 15, 18 G = 2, 4, 5	8. Asana XL or Adjourn 0.66EC	2.0-5.8 fl oz	4.8-14.5 fl oz
		9. [6]Apollo 42SC	-	4-8 fl oz
Oriental fruit moth (OFM)	E = 3	10. [7]Savey 50DF or Onager 1EC	See label	3-6 oz or 12-24 fl oz
		11. Danitol 2.4EC	-	11-21 fl oz
		12. Aza-Direct or Neemix	-	1-2 pt
		13. Warrior 1CS, Lambda-Cy 1EC, Silencer 1EC, or Warrior 2CS	-	2.6-5.1 fl oz or 1.3-2.5 fl oz
		14. Declare 1.25CS or Proaxis 0.5CS	-	1.02-7.05 fl oz or 2.6-5.1 fl oz
		15. Mustang Maxx 0.8EC	-	1.3-4 fl oz
		16. Beleaf 50SG	-	2-2.8 oz
		17. Sivanto 200SL or Sivanto Prime	-	7-14 fl oz
		18. Bifenture 2EC or Brigade 2EC	-	2.6-12.8 fl oz

[1] See notes (silver tip - green tip spray).
[2] RAA is the most important aphid to control at this time. SA can be controlled effectively later in the season (by natural enemies and/or sprays). But action taken now for RAA will also control SA.
[3] Where ERM eggs are abundant and *Stethorus punctum* is present, *Stethorus* adults will begin to move into trees.
[4] RBLR eggs are killed only if in direct contact with Lannate spray.
[5] Defoliating caterpillars include tent caterpillars, cankerworms, and cutworms.
[6] May be applied once per season, until 45 days before harvest; petal fall application is preferred.
[7] May be applied once per season, until 28 days before harvest; petal fall application is preferred. Do not apply in less than 50 gal/A.

TIGHT CLUSTER - PREPINK SPRAY[1] : Diseases

Disease	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Scab	E = 1, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 17, 18, 21, 22, 23, 24, 28, 29 G = 2, 11, 16, 20, 25, 26, 27 F = 19	1. Syllit 3.4F	8 fl oz	1.5 pt
		2. Captan 50W	1.5 lb	6.0 lb
		3. Fontelis 1.67SC + Mancozeb 75DF	-	16 to 20 fl oz + 3 lb/A
		4. Luna Sensation 500SC + Mancozeb 75DF	-	4.0 to 5.8 fl oz + 3 lb
Powdery Mildew[2]	E = 4, 5, 6, 7, 8, 9, 10, 17, 18, 25, 26 G = 3, 12, 13, 14, 15, 19, 21, 22, 23, 24, 27, 28, 29	5. Luna Tranquility 4.16SC + Mancozeb 75DF	-	11.2 to 16 fl oz + 3 lb
		6. Merivon 4.18SC + Mancozeb 75DF	-	4 to 6.7 fl oz + 3 lb
Rusts	E = 7, 8, 9, 10, 14, 15, 21, 22, 23, 24, 25, 26, 27, 28 G = 3, 4, 5, 6, 11, 12, 29	7. Rally 40WSP + Captan 50W	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3.25 lb
		8. Rally 40WSP + Ziram 76DF	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3.25 lb
		9. Rally 40WSP + mancozeb 75DF	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3 lb
		10. Rally 40WSP + Polyram 80DF	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3 lb
		11. Ziram 76DF	1.5 lb	6 lb
		12. Procure 50WS + Captan 50W	3 oz + 1 lb	12 oz + 3.25 lb
		13. Procure 50WS + mancozeb 75DF	3 oz + 1 lb	12 oz + 3 lb
		14. Procure 50WS + Polyram 80DF	3 oz + 1 lb	12 oz + 3 lb
		15. Procure 50WS + Ziram 76DF	3 oz + 1 lb	12 oz + 3.25 lb
		16. Vangard 75WG + mancozeb 75DF	- -	3 oz 3.2 lb
		17. Sovran 50WGm + mancozeb	1.0-1.6 oz -	4.0-6.4 oz 3 lb
		18. Flint 50WG + mancozeb	- -	2.0-2.5 oz 3 lb
		19. Sulfur	2-3 lb	7-10 lb
		20. Scala 5SC + mancozeb 75DF	- -	5 fl oz 3.2 lb
		21. Indar 2F + Captan 50W	-	8 fl oz + 3.25 lb
		22. Indar 2F + mancozeb 75DF	- -	8 fl oz + 3 lb
		23. Indar 7F + Polyram 80DF	-	8 fl oz + 3 lb
		24. Indar 2F + Ziram 76DF	-	8 fl oz + 3 lb
		25. [3]Topguard 1.04SC + Captan 50W	3.2 fl oz + 1 lb	13 fl oz + 3.25 lb
		26. [3]Topguard 1.04SC + mancozeb 75DF	3.2 fl oz + 1 lb	13 fl oz + 3 lb
		27. Inspire Super 2.82EW	-	12 fl oz
		28. Inspire Super+ mancozeb 75DF	- -	8.5-12 fl oz + 3 lb
		29. Aprovia + mancozeb	- -	5.5-7 fl oz 3 lb

[1] See cautions under 1/4-1/2 inch green spray, p. 65 .

[2] Excellent powdery mildew control is expected when the Rally is used on a 7-10 day interval for scab control. See also comments about disease management on pages 54-55 and Table 10. Do not combine sulfur with oil or apply within 14 days of an oil spray.

[3] Topguard use is restricted to one application every 14 days. Do not combine Merivon with emulsifiable concentrate or solvent-based formulation products. Do not combine Merivon with crop oil concentrate or methylated seed oil adjuvants.

TIGHT CLUSTER - PREPINK SPRAY : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Rosy apple aphid (RAA)	E = 18, 19, 21 G = 5, 6, 7, 10, 11, 12, 13, 14, 20, 22	1. Lannate 90SP or Lannate LV	4 oz -	0.5-1 lb 1.5-3 pt
		2. [8]Mating disruption	See label	See label
Green aphid (SA/AA)	E = 14, 18 G = 1, 5, 6, 7, 10, 12, 13, 20	3. Imidan 70WSB	12-16 oz	2-3 lb
		4. *Bacillus thuringiensis*	See label	See label
Mites (ERM)[1]	E = 8, 9, 15, 18 G = 10, 17	5. [4]Pounce 3.2EC or Perm-UP 3.2EC	-	10 fl oz
		6. Perm-UP 25DF	-	6.4-17.6 oz
Green fruitworms (GFW)[2]	E = 5, 6, 7, 10, 12, 13, 19, 20, 22 G = 1, 3, 4, 15	7. [4]Asana XL or Adjourn 0.66EC	2.0-5.8 fl oz	4.8-14.5 fl oz
Tarnished plant bug (TPB)	E = 5, 6, 7, 10, 12, 13, 15, 19, 20, 22 G = 1, 24	8. [5]Apollo 42SC	-	4-8 fl oz
		9. [6]Savey 50DF or Onager 1EC	See label	3-6 oz or 12-24 fl oz
Tentiform leafminers (TLM)[3]	E = 5, 6, 7, 10, 12, 13, 17, 18, 19, 20, 22 G = 11, 15	10. [4]Danitol 2.4EC	-	11-21 fl oz
		11. Aza-Direct or Neemix	-	1-2 pt
Oriental fruit moth	E = 2	12. [4]Warrior 1CS, Lambda-Cy 1EC, Silencer 1EC or Warrior 2CS	-	2.6- 5.1 fl oz or 1.3-2.5 fl oz
		13. [4]Declare 1.25CS or Proaxis 0.5CS	- -	1.02-2.05 fl oz or 2.6-5.1 fl oz
		14. Versys	-	1.5 fl oz
		15. Gladiator	-	19 fl oz
		16. Vydate L	1 pt	2-4 pt
		17. [7]Agri-Mek or Abba 0.15EC or Agri-Mek 0.8SC	2.5-5 fl oz or 0.5-1.0 fl oz	10-20 fl oz or 2.25-4.25 fl oz
		18. Assail 30SG	-	2.5-4.0 oz
		19. [4]Baythroid XL 1EC or Tombstone 2EC	-	1.4-2.8 fl oz or 0.9-1.9 fl oz
		20. [4]Mustang Maxx 0.8EC	-	1.3-4 fl oz
		21. Beleaf 50SG	-	2-2.8 oz
		22. Bifenture 2EC or Brigade 2EC		2.6-12.8 fl oz

[1] Where ERM eggs are abundant and *Stethorus punctum* is present, *Stethorus* adults will begin to move into trees.
[2] Early detection of GFW is important. Tap tree limbs over sheet beginning at prepink. GFW larvae will curl up (grub-like) when dislodged from tree.
[3] Adult leafminers may be controlled at tight cluster, or larvae controlled at pre-pink or at petal fall.
[4] Pyrethroids (e.g. Ambush, Adjourn, Asana XL, Baythroid XL, Danitol, Declare, Lambda-Cy, Mustang Maxx, Perm-UP, Pounce, Proaxis, Silencer, Tombstone, Warrior) are highly toxic to predators. Do not use if *Stethorus punctum* have appeared in orchard.
[5] See note (6), 1/4-1/2 inch green spray (p. 65).
[6] See note (7), 1/4-1/2 inch green spray (p. 65).
[7] See comments on p. 38.
[8] See note on mating disruption on page 44.

PINK AND BLOOM SPRAYS[1]

Diseases:	
Scab	See recommendations under 1/4-1/2 inch green spray. Do not extend intervals between sprays during a prolonged pre-bloom period.
Rusts and mildew	See recommendations under tight cluster-prepink spray. PINK THROUGH PETAL FALL STAGE IS A VERY CRITICAL PERIOD TO PROTECT AGAINST QUINCE RUST IN PROBLEM ORCHARDS. Under heavy quince rust pressure, control with the strobilurin fungicides, Sovran and Flint, may be inadequate. For this reason we suggest including SI fungicides (Indar, Inspire Super, Rally, Procure, Topguard).
Fireblight	Fireblight is most active during warm weather. Blossom infection is aggravated by showers which splash the blight bacteria. Apply streptomycin as needed at 0.5 lb per 100 gal dilute or 1.5 lb per acre concentrate. Streptomycin remains effective for 3 to 5 days. The effectiveness of streptomycin can be increased by including the adjuvant Regulaid at the rate of 1 pint per 100 gal of tank mix, however, the increased uptake of streptomycin with Regulaid is more likely to result in streptomycin injury. Kasugamycin (Kasumin, see p. 31) and oxytetracycline products (see p. 33) are alternative antibiotics to consider as possibilities with different modes of action than streptomycin. The plant growth regulator, Apogee (prohexadione-calcium), is registered for suppression of fire blight shoot blight. Shoot blight suppression results from hardening off of vegetative shoot growth starting about 10 days after the initial Apogee application, which should be made at late bloom when active shoot growth is 1-3 inches long. Recent studies at Winchester indicate that Apogee may be tank-mixed with Agri-Mycin and Regulaid, allowing Apogee to take effect while there is residual protection from streptomycin. Apogee is not to be considered a replacement for streptomycin sprays for blossom blight control. Registered rates for Apogee are 6-12 oz/100 gal dilute or 24-48 oz/acre. To reduce interference from naturally occurring calcium in the water used for spraying, ammonium sulfate should be added to the tank **before** Apogee, at the same rate per 100 gal of spray mix as for Apogee. Based on research at Winchester, the combination of 6 oz of Apogee plus 6 oz of ammonium sulfate per 100 gal is suggested for moderately vigorous trees. An adjuvant such as Regulaid should be included to increase systemic uptake of Apogee. Vigorous trees might be more responsive to the 12 oz Apogee rate than to the 6 oz rate. Shoot blight suppression is related to early hardening off of shoot tip growth within 10-14 days after bloom. Vigorous trees might benefit from further protection with additional Apogee applications in mid-season if shoot growth is resumed. Studies in WV showed that Apogee reduced shoot blight infections that occurred with hail injury in June. Do not apply more than 48 oz/A within a 21-day period. Practical usefulness of Apogee for shoot blight suppression in a given year might be estimated by the potential severity of fire blight based on the number of infection days that occurred during the bloom period, as well as tree vigor, varietal susceptibility, and disease history. Apogee treatment for shoot blight suppression would be most strongly suggested for vigorous young trees that have nearly filled their tree space. See page 139 in the plant growth regulator section for additional comments about the use of Apogee for shoot growth and fire blight suppression.

[1] See comments on fireblight under petal fall and first cover sprays pp. 69, 72. Captan has been shown to severely reduce pollen viability in hard-to-pollinate varieties for 24-48 hours after application.

PINK SPRAYS AND MATING DISRUPTION THROUGH BLOOM[1]

Insects/Mites	**Effectiveness**	**Suggested Chemicals**	**100 gal Dilute**	**Acre Concentrate**
Defoliating caterpillars[2]	E = 2	1. Imidan 70WSB	12-16 oz	2-3 lb
		2. *Bacillus thuringiensis*	See label	See label
Mites (ERM)	E = 3, 4	3. [3]Apollo 42SC		4 - 8 fl oz
European apple sawfly (EAS)[5]	E = 1, 5, 7	4. [4]Savey 50DF or Onager Optek	See label	3-6 oz or 12-24 fl oz
		5. [6]Assail 30SG	-	2.5-8.0 oz
Oriental fruit moth (OFM)	E = 1 G = 7	6. [7]Mating disruption	See label	See label
		7. Avaunt eVo 30DG	-	5-6 oz
Mullein bug (MB)	E = 5			
Dogwood Borer (DB)	G = 5, 6			
Codling moth (CM)	G = 6			
Green fruitworm (GFW)	E = 2 G = 1			

[1] Insecticides should not be applied during bloom. Install pheromone trap and inspect for male San Jose scale. Begin monitoring for gypsy moth.
[2] If defoliating caterpillars become a problem, sprays of *Bacillus thuringiensis* are acceptable, affecting neither pollination nor fruit set. However, residual life is short.
[3] See note (6), 1/4-1/2 inch green spray (p. 65).
[4] See note (7), 1/4-1/2 inch green spray (p. 65).
[5] Apply at pink only if damage was severe in preceding year. Otherwise treat at petal fall if threshold is exceeded.
[6] 2.5-4.0 oz/A for MB; 5-8.0 oz/A for EAS, OFM; 8.0 oz/A for DB as a drench to lower tree trunk.

PETAL FALL SPRAY (when most petals have fallen)[1] : Diseases

Disease	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Scab	E = 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 26, 27 G = 1, 10, 23, 24, 25 F = 17	1. Captan 50W	1.5 lb	6.0 lb
		2. Fontelis 1.67SC + Mancozeb 75 DF	-	16-20 fl oz + 3 lb
		3. Luna Sensation 500 SC + Mancozeb 75DF	-	4.0-5.8 fl oz + 3 lb
Powdery Mildew[2]	E = 3, 4, 5, 6, 7, 8, 9, 15, 16, 23, 24 G = 2, 11, 12, 13, 14, 17, 19, 20, 21, 22, 25, 26, 27	4. Luna Tranquility 4.16SC + Mancozeb 75DF	-	11.2-16 fl oz + 3 lb
		5. Merivon 4.18SC + Mancozeb 75DF	-	4.0-6.7 fl oz + 3 lb
		6. Rally 40WSP + Captan 50W	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3.25 lb
Rusts[4]	E = 6, 7, 8, 9, 12, 13, 14, 19, 20, 21, 22, 23, 24, 25, 26 G = 2, 3, 4, 5, 10, 11, 12, 27	7. Rally 40WSP + Ziram 76DF	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3.25 lb
		8. Rally 40WSP + mancozeb 75DF	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3 lb
		9. Rally 40WSP + Polyram 80DF	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3 lb
Fireblight	E = 18	10. [3]Ziram 76DF	1.5 lb	6 lb
Rots and frogeye leaf spot	G = 1, 2, 3, 4, 5,10, 15, 16, 19, 20, 21, 22, 26 F = 6, 7, 8, 9, 23, 24	11. Procure 50WS + Captan 50W	3 oz + 1 lb	12 oz + 3.25 lb
		12. Procure 50WS + mancozeb 75DF	3 oz + 1 lb	12 oz + 3 lb
		13. Procure 50WS + Polyram 80DF	3 oz + 1 lb	12 oz + 3 lb
		14. Procure 50WS + Ziram 76DF	3 oz + 1 lb	12 oz + 3.25 lb
		15. Sovran 50WGm + mancozeb	1.0-1.6 oz -	4.0-6.4 oz 3 lb
		16. Flint 50WG + mancozeb	- -	2.0-2.5 oz 3 lb
		17. Sulfur	2-3 lb	7-10 lb
		18. Streptomycin	0.3 lb	1.2 lb
		19. Indar 2F + Captan 50W	-	8 fl oz + 3.25 lb
		20. Indar 2F + mancozeb 75DF	-	8 fl oz + 3 lb
		21. Indar 2F + Polyram 80DF	-	8 fl oz + 3 lb
		22. Indar 2F + Ziram 76DF	-	8 fl oz + 3 lb
		23. Topguard 1.04SC + Captan 50W	3.2 fl oz + 1 lb	13 fl oz + 3.25 lb
		24. Topguard 1.04SC + mancozeb 75DF	3.2 fl oz + 1 lb	13 fl oz + 3 lb
		25. Inspire Super 2.82EW	-	12.0 fl oz
		26. Inspire Super + mancozeb 75DF	- -	8.5-12 fl oz 3 lb
		27. Aprovia + mancozeb	- -	5.5-7 fl oz 3 lb

[1] See cautions 1, 2 and 3 under 1/4-1/2 inch green spray (diseases). Do not combine Merivon with emulsifiable concentrate or solvent-based formulation products. Do not combine Merivon with crop oil concentrate or methylated oil adjuvants.

[2] Excellent powdery mildew control is expected when the Rally or Topguard is used on a 7-10 day interval for scab control. See also comments about disease management in Table 10, page 95. Do not apply more than 60 lb of Captan 50W per acre per year.

[3] Do not apply more than 42.4 lb Ziram DF per acre per year.

[4] See cautions about quince rust under pink and bloom sprays.

[5] Topguard use is restricted to one application every 14 days.

Carefully inspect flower cluster leaves for primary scab lesions. If scab lesions are present, include fungicides that have antisporulant activity against scab (Dodine or combinations of Topsin-M with other fungicides if resistance is not present. Repeated applications of Dodine 65W at 12 oz per 100 gal (2 lb per acre) can be used to inhibit sporulation).

Severity of powdery mildew is directly related to the amount of overwintering inoculum in shoot and blossom buds and the length of the spray interval. Check blocks of highly susceptible cultivars (Jonathan, Ginger Gold, Rome Beauty, Stayman Winesap, Idared, Paulared, Granny Smith) to determine the amount of overwintering inoculum. Mildew is active during periods of dry weather; maintaining short spray intervals (not over 7 days) more effectively reduces mildew infection than increasing fungicide rates. In serious cases, special mildew sprays applied between the regular sprays from pink through the cover sprays may be the most economical way to achieve the desired control and prevent a repeated buildup of mildew for the following year.

Late bloom is frequently the site of fireblight blossom infection. Maintain streptomycin applications to assure that the late blossoms are protected to the end of an extended bloom period on susceptible cultivars such as Jonathan, Rome Beauty, York Imperial, Golden Delicious, Idared and Gala and on trees on M. 9 and M. 26 rootstocks.

When streptomycin is combined with other pesticides it should be used at 80 PPM (0.4 lb/100 gal or 1.5 lb/A concentrate). To avoid the development of resistance to streptomycin, limit the number of applications to no more than four.

PETAL FALL SPRAY[1]: Insects

Insects/MIte	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Redbanded leafroller (RBLR)[3]	E = 1, 21 G = 2, 3	1. [2]Lannate 90SP or Lannate LV	4 oz -	0.5-1 lb 1.5-3 pt
Curculio (PC)[3]	E = 2, 13 G = 11, 22	2. Imidan 70WSB	16-21 oz	3-4 lb
		3. *Bacillus thuringiensis*	See label	See label
Rosy apple aphid (RAA)	E = 4, 11, 17 G = 1, 7, 9	4. [18]Movento 2SC	–	6-9 fl oz
		5. Apollo 42SC	–	4-8 fl oz
Oriental fruit moth (OFM)	E = 2, 21 G = 1, 3, 7, 8, 11, 13, 18, 21	6. Savey 50DF or Onager Optek	–	3-6 oz or 12-24 fl oz
		7. Aza-Direct or Neemix	–	1 qt
Mites (ERM)	E = 5, 6, 10, 12, 14, 24, 25, 26, 27 G = 9, 15, 20, 23	8. Madex	-	0.5-3 fl oz
		9. [7]Vydate L	1 pt	3 pt
Green fruitworms (GFW)[4]	G = 1, 2, 3, 18, 21	10. [13]Agri-Mek or Abba 0.15EC or Agri-Mek 0.8SC	2.5 fl oz 0.5-1.0 fl oz	10-20 fl oz 2.25-4.25 fl oz
Defoliating caterpillars[5]	E = 3 G = 1, 2	11. [16]Assail 30SG	–	2.5-8.0 oz
Tentiform leafminers (TLM)	E = 9, 10, 11 G = 7	12. Nealta	–	13.7 fl oz
		13. Avaunt eVo 30DG	–	5-6 oz
		14. [9]Nexter SC	–	11-17 oz
White apple leafhopper (WALH)[6]	E = 1, 11 G = 9, 10, 16, 18, 22, 28	15. Vendex 50W	6 oz	18 oz
		16. [11]Sevin 50W	2 lb	6 lb
Codling moth (CM)	E = 28 G = 8	17. Beleaf 50SG	-	2-2.8 oz
		18. [11]Sevin XLR PLUS	2 pt	6 pt
European apple sawfly (EAS)[10]	E = 2, 11,13 G = 16, 18	19. Mating disruption	-	See label
		20. [14]Ultra Fine oil	2 gal	
Mullein bug (MB)	E = 11	21. [15]Intrepid 2F	–	8-16 fl oz
		22. Surround WP	-	25 lb
Dogwood borer (DB)[12]	G = 11, 19	23. [8]Acramite 50WS or Banter SC	-	12-16 oz
San Jose Scale (SJS)	G = 4	24. Zeal 72WDG	-	2-3 oz
		25. Portal 5EC	10 fl oz	2 pt
		26. Kanemite 15SC	-	21-31 fl oz
		27. Envidor 2SC	-	16-18 fl oz
		28. Rimon 0.83EC	-	20-40 fl oz

PETAL FALL SPRAY[1]: Insects

[1] CAUTION: To avoid killing bees, do not spray pesticides on open blooms of trees or ground vegetation. See pesticide hazard to bees (page 50).
[2] Lannate used alone does not provide control beyond 3-4 days.
[3] Monitor orchards carefully for newly hatched leafroller larvae and inward migration of curculio.
[4] GFW, if present, must be controlled at this time to prevent fruit injury (see note under tight cluster spray for monitoring method).
[5] Climbing cutworms (a type of defoliating caterpillar) hide in ground litter during the day and feed in trees at night. Heaviest damage occurs in tree tops and ends of limbs. Cutworms may severely injure young trees. Gypsy moths hatch beginning at bloom and are dispersing into orchards at this time.
[6] Examine undersides of leaves for newly hatched WALH nymphs. Nymphs move rapidly forward, or backward when disturbed.
[7] Likely to thin fruit when used at this time.
[8] See comments on p. 39.
[9] See comments on p. 46
[10] Control EAS if a problem last year, or if 5.5 adults are captured between pink and petal fall on white sticky traps if a prebloom insecticide was applied. If no prebloom insecticide was applied, use a threshold of 4.7 adults.
[11] Caution should be exercised in the use of Sevin because of the potential to cause mite outbreaks. Preliminary research indicates that the XLR PLUS formulation may be less disruptive to mite management programs than other formulations.
[13] See comments on page 38.
[14] Good control of ERM may be achieved by 3 applications of Ultra-Fine oil at 2-week intervals starting at petal fall.
[15] Use 12-16 fl oz/A for OFM control.
[16] 2.5-4.0 oz/A for RAA, TLM, WALH, MB; 5.0-8.0 oz/A for PC, OFM, EAS. The addition of 0.5% oil will improve control of OFM if using less than 8.0 oz/A.
[18] Movento must be applied with a horticultural oil or a non-ionic spreading and penetrating adjuvant (not a sticker).

FIRST COVER SPRAY[1] : Diseases

Disease	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Scab	E = 3, 5, 6, 7, 8, 10, 11, 12, 14, 15, 16, 17, 19, 20, 30, 31, 32, 33, 37, 38 G = 2, 13, 34, 35, 36 F = 22	2. Captan 50W	1.5 lb	6.0 lb
		3. Fontelis 1.67SC + Mancozeb 75DF	-	16 to 20 fl oz + 3 lb
		5. Luna Sensation 500SC + Mancozeb 75DF	-	4.0 to 5.8 fl oz + 3 lb
Powdery mildew[2]	E = 5, 6, 7, 8, 10, 11, 12, 19, 20, 34, 35 G = 3, 14, 15, 16, 17, 22, 30, 31, 32, 33, 36, 37, 38	6. Luna Tranquility 4.16SC + Mancozeb 75DF	-	11.2 to 16 fl oz + 3 lb
		7. Merivon 4.18SC + Mancozeb 75DF	-	4 to 6.7 fl oz + 3 lb
		8. Rally 40WSP + Captan 50W	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3.25 lb
Rusts	E = 8, 10, 11, 12, 15, 16, 17, 30, 31, 32, 33, 34, 35, 36, 37 G = 3, 5, 6, 7, 13, 14, 38	10. Rally 40WSP + Ziram 76DF	1.25-2.0 oz + 1 lb	5.0-7.5 fl oz + 3.25 lb
		11. Rally 40WSP + mancozeb 75DF	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3 lb
Fireblight[3]	E = 23	12. Rally 40WSP + Polyram 80DF	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3 lb
Rots and frogeye leaf spot	G = 2, 3, 5, 6, 7, 13, 19, 20, 30, 31, 32, 33, 37 F = 8, 10, 11, 12, 34, 35	13. Ziram 76DF	1.5 lb	6 lb
		14. Procure 50WS + Captan 50W	3 oz + 1 lb	12 oz + 3.25 lb
		15. Procure 50WS + mancozeb 75DF	3 oz + 1 lb	12 oz + 3 lb
		16. Procure 50WS + Polyram 80DF	3 oz + 1 lb	12 oz + 3 lb
		17. Procure 50WS + Ziram 76DF	3 oz + 1 lb	12 oz + 3.25 lb
		19. Sovran 50WG + mancozeb	1.0-1.6 oz -	4.0 oz 3 lb
		20. Flint 50WG + mancozeb	- -	2.0-2.5 oz 3 lb
		22. Sulfur	2-3 lb	7-10 lb
		23. Streptomycin	0.3 lb	1.2 lb
		30. Indar 2F + Captan 50W	-	8 fl oz + 3.25 lb
		31. Indar 2F + mancozeb 75DF	-	8 fl oz + 3 lb
		32. Indar 2F + Polyram 80DF	-	8 fl oz + 3 lb
		33. Indar 2F + Ziram 76DF	-	8 fl oz + 3 lb
		34. [4]Topguard 1.04SC + Captan 50W	3.2 fl oz + 1.0 lb	13 fl oz + 3.25 lb
		35. [4]Topguard 1.04SC + mancozeb 75DF	3.2 fl oz + 1.0 lb	13 fl oz + 3 lb
		36. Inspire Super 2.82EW	-	12 fl oz
		37. Inspire Super + mancozeb 75DF	- -	8.5-12.0 fl oz + 3 lb
		38. Aprovia + mancozeb	- -	5.5-7 fl oz 3 lb

[1] CAUTION: Do not extend the interval between sprays more than 7 days. See cautions under 1/4-1/2 inch green spray, p. 64, and petal fall spray against using Captan with oil. See cautions under petal fall spray, p. 69, about scab and mildew control. In rust problem areas, maintain control for rusts until spore horns on cedar galls no longer expand when wetted.

[2] Excellent powdery mildew control is expected when the Rally or Topguard is used on a 7-10 day interval for scab control. See also comments about disease management in Table 10, page 95. Do not combine sulfur with oil or apply within 14 days of an oil spray.

[3] Streptomycin applications can reduce the incidence of fire blight in green shoots during the early cover spray period. It does not effectively reduce spread in woody shoots. Do not apply streptomycin to apples closer than 50 days to harvest. Observe the 50 day application timing on summer cultivars such as Lodi, Ginger Gold and Gala. Where fireblight blossom and/or shoot infections are being removed during the early season cover spray period, apply streptomycin 1-3 days prior to cutting cankers. In cutting out blight infections, pruning equipment should be sterilized and all pruned cankers should be removed from the orchard. This operation may need to be repeated on a weekly basis. Better results are achieved if the pruning operation is conducted during dry weather. Good potato leafhopper control may help to reduce the spread of shoot blight. See pink and bloom spray for information about use of Apogee for shoot blight management.

[4] Topguard use is restricted to one application every 14 days.

FIRST COVER SPRAY[1] : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Curculio (PC)	E = 3, 13 G = 2,10, 11, 21, 32, 36	1. Lannate 90SP or Lannate LV	4 oz -	0.5-1 lb 1.3-5 pt
		2. [9]Minecto Pro	-	8-12 fl oz
Mites (ERM)[2]	E = 2, 4, 5, 9, 14, 19, 23, 24, 25, 26 G = 8, 15, 20, 22, 34	3. Imidan 70WSB	16-21 oz	3-4 lb
		4. Apollo 42 SC	-	4-8 fl oz
		5. Savey 50DF or Onager Optek	-	3-6 oz or 12-24 fl oz
White apple leafhopper (WALH)	E = 1, 7, 10, 33 G = 2, 8, 9, 13, 16, 18, 32, 33, 35	6. Aza-Direct or Neemix	-	1 qt
		7. Sivanto 200SL or Sivanto Prime	-	7-10.5 fl oz
Codling moth (CM)[3, 11]	E = 2, 3, 11, 27, 29, 31, 36 G = 1, 6, 10, 13, 16, 18, 28, 32	8. [5]Vydate L	1 pt	3 pt
		9. [6]Agri-Mek or Abba 0.15EC or Agri-Mek 0.85C	2.5-5 fl oz or 0.5-1.0 fl oz	10-20 fl oz or 2.25-4.25 fl oz
Periodical cicada (C)[12]	G = 1, 10, 16, 18, 21	10. [4]Assail 30SG	-	2.5-8.0 oz
		11. Exirel	-	8.5-17 fl oz
Green aphid (SA/AA)	E = 7, 10, 11, 12, 17, 30, 32, 33 G = 1, 2, 8, 36	12. Versys	-	1.5 fl oz
		13. Avaunt eVo 30DG	-	5-6 oz
		14. [7]Nexter SC	-	11-17 fl oz
Woolly apple aphid (WAA)	G = 30, 33	15. Vendex 50W	6 oz	18 oz
		16. [13]Sevin 50W	2 lb	6 lb
		17. Beleaf 50SG	-	2-2.8 oz
		18. [8]Sevin XLR PLUS	2 pt	6 pt
		19. Nealta	-	13.7 fl oz
		20. [10]Ultra-Fine oil	2 gal	
		21. Surround WP	-	25 lb
		22. Acramite 50WS or Banter SC	-	12-16 oz
		23. Zeal 72WDG	-	2-3 oz
		24. Portal 5EC	10 fl oz	2 pt
		25. Kanemite 15SC	-	21-31 fl oz
		26. Envidor 2SC	-	16-18 fl oz
		27. Rimon 0.83EC	-	20-40 fl oz
		28. CM Virus	-	0.5-3.0 fl oz (Cyd-X HP) 0.5-3 fl oz (Madex HP) 1.6-3.2 fl oz (Virosoft CP4)
		29. Delegate 25WG	-	4.5-7 oz
		30. [14]Movento 2SC	-	6.0-9.0 fl oz
		31. Altacor eVo 70WDG	-	1.3-2.2 oz
		32. [15]Belay 2.13EC	-	6.0-12.0 fl oz
		33. Closer 2SC	-	1.5-2.75 fl oz
		34. Magister SC	-	32-36 fl oz
		35. [16]Apta	-	14-27 fl oz
		36. Verdpryn	-	5.5-11 fl oz

[1] The insects listed under the petal fall spray will still be present if they were not controlled at the optimum time during petal fall. Pest development varies with the conditions of each season.
[2] Mites develop resistance quickly. Rotate materials; avoid using the same or related compounds repeatedly.
[3] See notes on mating disruption, p. 44.
[4] 2.5-4.0 oz/A for WALH and SA/AA; 5.5-8.0 oz/A for PC and CM. Addition of 0.5% oil will improve control of CM if using less than 8.0 oz/A.
[5] Likely to thin fruit when used at this time.
[6] See comments on p. 38.
[7] See comments on p. 46.
[8] See note 11, p. 71.
[9] Use 10-12 fl oz for PC.
[10] Good control of ERM may be achieved by 3 applications of Ultra-Fine Oil at 2-week intervals beginning at petal fall.
[11] See note on CM and OFM on p. 1-2 for timing recommendations based on DD.
[12] Although postbloom applications of pyrethroids are not recommended, they are the most effective materials for control of periodical cicada.
[13] Sevin may cause mite outbreaks.
[14] Movento must be applied with a horticultural oil or a non-ionic spreading and penetrating adjuvant (not a sticker).
[15] 4-6 fl oz/A for aphids, leafhoppers; 6 fl oz/A for AM, STLM, and PC; 6-12 fl oz/A for CM, OFM, scale and stink bugs.
[16] For PC, apply 21-27 fl oz; for aphids, 17-21 fl oz; 14-21 fl oz for aphids; 14-21 fl oz for leafhoppers.

SECOND COVER SPRAY[1] : Diseases

Disease	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Scab	E = 3, 5, 6, 7, 8, 10, 11, 12, 14, 15, 16, 17, 19, 20, 30, 31, 32, 33, 37, G = 2, 13, 34, 35, 35, 36, 38 F = 22	2. Captan 50W	1.5 lb	6.0 lb
		3. Fontelis 1.67SC + Mancozeb 75DF	-	16 to 20 fl oz + 3 lb
		5. Luna Sensation 500SC + Mancozeb 75DF	-	4.0 to 5.8 fl oz + 3 lb
		6. Luna Tranquility 4.16SC + Mancozeb 75DF	-	11.2 to 16 fl oz + 3 lb
Powdery mildew	E = 5, 6, 7, 8, 10, 11, 12, 19, 20, 34, 35 G = 3, 14, 15, 16, 17, 22, 30, 31, 32, 33, 36, 37, 38	7. Merivon 4.18SC + Mancozeb 75DF	-	4 to 6.7 fl oz + 3 lb
		8. Rally 40WSP + Captan 50W	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3.25 lb
Rusts	E = 8, 10, 11, 12, 15, 16, 17, 30, 31, 32, 33, 34, 35, 36, 37 G = 3, 5, 6, 7, 13, 14, 38	10. Rally 40WSP + Ziram 76DF	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3.25 lb
		11. Rally 40WSP + mancozeb 75DF	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3 lb
Rots and frogeye leaf spot	G = 2, 3, 5, 6, 7, 13, 19, 20, 30, 31, 32, 33, 37, 38 F = 8, 10, 11, 12, 34, 35	12. Rally 40WSP + Polyram 80DF	1.25-2.0 oz + 1 lb	5.0-7.5 oz + 3 lb
		13. Ziram 76DF	1.5 lb	6 lb
Brooks spot	E = 3, 5, 7, 19, 20, 37, 38 G = 2, 11, 13, 15, 30, 31, 32, 33, 35, 36 F = 8, 10, 12, 14, 16, 17, 34	14. Procure 50WS + Captan 50W	3 oz + 1 lb	12 oz + 3.25 lb
		15. Procure 50WS + mancozeb 75DF	3 oz + 1 lb	12 oz + 3 lb
		16. Procure 50WS + Polyram 80DF	3 oz + 1 lb	12 oz + 3 lb
		17. Procure 50WS + Ziram 76DF	3 oz + 1 lb	12 oz + 3.25 lb
		19. Sovran 50WGm + mancozeb	1.0-1.6 oz -	4.0 oz 3 lb
		20. Flint 50WG + mancozeb	- -	2.0-2.5 oz 3 lb
		22. Sulfur	2-3 lb	7-10 lb
		30. Indar 2F + Captan 50W	-	8 fl oz + 3.25 lb
		31. Indar 2F + mancozeb 75DF	-	8 fl oz + 3 lb
		32. Indar 2F + Polyram 80DF	-	8 fl oz + 3 lb
		33. Indar 2F + Ziram 76DF	-	8 fl oz + 3 lb
		34. [2]Topguard 1.04SC + Captan 50W	3.2 fl oz + 1 lb	13 fl oz + 3.75 lb
		35. [2]Topguard 1.04SC + mancozeb	3.2 fl oz + 1 lb	13 fl oz + 3 lb
		36. Inspire Super 2.82EW	-	12 fl oz
		37. Inspire Super + mancozeb 75DF	-	8.5-12 fl oz 3 lb
		38. Aprovia + mancozeb	- -	5.5-7 fl oz 3 lb

[1] CAUTION: In some years, primary scab and rust inoculum may be depleted by the time for the second cover spray. If this is the case and primary scab has been well controlled, the spray program should be aimed more at control of "summer diseases" including Brooks spot, sooty blotch, fly speck, and rots. If mildew is a problem, maintain mildew protection until shoot growth hardens off.

[2] Topguard use is restricted to one application every 14 days.

Note: Pound for pound, the EBDC fungicides are the most active fungicides available for bitter rot control. Where bitter rot has been difficult to control EBDCs should be used to their fullest advantage, approaching the allowable 77 day pre-harvest interval. Different spray schedules should be considered based on groupings of cultivars by expected harvest dates: Early cultivars - Gala and Ginger Gold; Mid-season - Red Delicious and Golden Delicious; Late season cultivars (later EBDC use permitted by calendar date - Rome, York, Fuji and Granny Smith. Note that EBDC use must not exceed 21 lb/A/yr when used later than petal fall.

SECOND COVER SPRAY : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Tentiform leafminer (TLM)	E = 8, 9, 10, 17, 24, 26, 32, 34, 35, 37, 38, 41 G = 2, 6, 16, 19	1. Esteem 35W	-	4-5 oz
		2. Lannate 90SP or Lannate LV	4 oz -	0.5-1 lb 1.5-3 pt
Mites (ERM/TSM)[1]	E = 3, 13, 21, 22, 23, 25 G = 8, 14, 18, 20, 40	3. Nealta	-	13.7 fl oz
		4. Imidan 70WSB	16-21 oz	3-4 lb
Codling moth (CM)[7]	E = 4, 26, 31, 34, 37, 38, 41 G = 1, 2, 6, 9, 12, 16, 24, 28	5. *Bacillus thuringiensis*	See label	See label
		6. Aza-Direct or Neemix	-	1-2 pt
		7. Sivanto 200SL or Sivanto Prime	-	7-14 fl oz
San Jose scale (SJS)[2]	E = 1, 29 G = 2, 7, 17, 33, 36	8. Vydate L	1 pt	2-4 pt
		9. [4]Assail 30SG	-	2.5-8.0 oz
Variegated leafroller and tufted apple budmoth (VLR + TBM)[3, 7]	E = 19, 26, 32, 34, 37, 38, 41 G = 4, 5, 16, 30	10. Actara 25WG	-	2.0- 5.5 oz
		11. Versys	-	1.5 fl oz
		12. Avaunt eVo 30DG	-	5-6 oz
Green aphid (SA/AA)	E = 7, 9, 10, 11, 15, 17, 24, 36 G = 2, 8, 30, 39	13. [8]Nexter SC	-	11-17 oz
		14. Vendex 50W	6 oz	18 oz
		15. Beleaf 50SG	-	2-2.8 oz
Oriental fruit moth (OFM)[7]	E = 4, 27, 30, 31, 32, 34, 37, 38, 41 G = 9, 12, 19, 24, 28 (Madex, Virosoft)	16. [5]Sevin XLR PLUS	2 pt	6 pt
		17. Admire Pro or Alias 4F	- 1-2 fl oz	1.4-2.8 fl oz or 3.2 fl oz
		18. [6]Ultra-Fine oil	2 gal	
Woolly apple aphid (WAA)	E = 33 G = 15, 39	19. Intrepid 2F	-	12-16 fl oz
		20. Acramite 50WS or Banter SC	-	12-16 oz
Brown marmorated stink bug (BMSB)	See footnote 9	21. Zeal 72WDG	-	2-3 oz
		22. Portal 5EC	10 fl oz	2 pt
		23. Kanemite 15SC	-	21-31 fl oz
		24. Belay 2.13SC	-	6-12 fl oz
		25. Envidor 2SC	-	16-18 fl oz
		26. Rimon 0.83EC	-	20-40 fl oz
		27. CheckMate OFM-F	-	1.3-2.9 fl oz
		28. CM Virus	-	1-6 fl oz (Cyd-X) 0.5-3.0 fl oz (Cydex HP, Madex; CM and OFM) 1.6-3.2 fl oz (Virosoft)
		29. Centaur 70WDG	-	21-34.5 oz
		30. No. 2 + No. 4	2 oz + 10 oz	6 oz + 32 oz
		31. Voliam Flexi 40WG	-	4-7 oz
		32. Entrust 2SC	-	6-10 fl oz
		33. Diazinon 50W	1 lb	3 lb
		34. Delegate 25WG	-	4.5-7 oz
		35. Proclaim 5SG	0.8-1.2 oz	3.2-4.8 oz
		36. [10]Movento 2SC	-	6.0-9.0 fl oz
		37. Altacor eVo 70WDG	-	1.3-2.2 oz
		38. Exirel	-	8.5-17 fl oz
		39. Closer 2SC	-	1.5-2.75 fl oz
		40. Magister SC	-	32-36 fl oz
		41. Verdepryn	-	5.5-11 fl oz

SECOND COVER SPRAY : Insects

[1] Mites are laying eggs at this time; two consecutive sprays are needed where mites are a problem and predators are not numerous enough to provide control. Continue monitoring for *Stethorus punctum*. Start monitoring *Amblyseius fallacis*, predaceous thrips, mirids, and *Orius* species.

[2] SJS crawlers appear now. Yellow crawlers may be detected by capturing them on a ring of black electrical tape tightly encircling a scale infested branch, sticky side out. Tape should be observed and replaced every other day. Expect SJS crawlers 300-350 DD above base of 50°F.

[3] Members of the leafroller complex will begin laying eggs. Start looking for egg masses while monitoring orchard. Determine species present using pheromone traps.

[4] 2.5-4.0 oz for TLM and SA/AA; 5.5-8.0 oz for CM and OFM.

[5] Use of Sevin may cause mite outbreaks.

[6] Good control of ERM may be achieved by 3 applications of Ultra-Fine Oil at 2-week intervals beginning at petal fall.

[7] See notes on CM, OFM, and TBM on p.1-2 for timing recommendation based on DD.

[8] Use 8.8-10.7 oz/A for TSM.

[9] **Brown marmorated stink bug (BMSB) and samurai wasp:** Captures of BMSB in pheromone traps in 2023 varied among locations in Virginia, but appeared to show a general decline, relative to previous years. The samurai wasp, Trissolcus japonicus, was again monitored in Frederick County, VA and at 7 other locations across Clarke, Loudoun, Fauquier, Shenandoah, and Rockingham counties in Virginia. It was also monitored for the fifth season at the nine sites between northern and southwest Virginia where it was released in 2018 and 2020. In Frederick county, samurai wasps again showed evidence of being widely distributed and abundant. Monitoring at the four counties where it had not been released yielded samurai wasp detections at all sites, suggesting that it has spread naturally from Frederick county. Across the nine release sites in Virginia, samurai wasp was detected for the first time at two new sites in Rappahannock and Nelson counties and in Hillsville, in Carroll county. The project that sought to promote the establishment of samurai wasp was completed in 2022, and ultimately resulted in its detection at 8 of 9 release sites. Although the number of detections was generally low, we can conclude that it is now established throughout much of the tree fruit production area in Virginia, although more time will be needed for populations to increase and impact BMSB noticeably. A long-standing recommendation of tree fruit Extension Specialists is to avoid or minimize the use pyrethroids during post-bloom, due to their disruptive effects on natural enemies of secondary pests. Consequently, we have not included them or pre-mixes containing them in most post-bloom cover sprays for pome fruit. However, the most effective products for BMSB continue to include Belay (neonicotinoid), some of the pyrethroids (Brigade, Perm-UP, Pounce, Baythroid, Danitol, Warrior II), Lannate (carbamate), and pre-mixes that contain a pyrethroid (Endigo ZCX and Leverage 360). Brigade was recently labelled for use in all pome and stone fruit against BMSB, but Bifenture continues to be labelled only for use in pears (see writeup on page 38). Because the residual effectiveness of products for BMSB control varies considerably and may not extend beyond several days, particularly following rain, we continue to recommend alternate-row-middle applications at about 7-day intervals for managing BMSB injury when its populations require. Peaches and nectarines are vulnerable to injury from BMSB from fruit set onward, while injury to apples can be detected from about mid-June onward. For additional information about BMSB and its management in tree fruit orchards, see www.stopbmsb.org.

[10] Movento must be applied with a horticultural oil or a non-ionic spreading and penetrating adjuvant (not a sticker).

THIRD COVER SPRAY[1] : Diseases

Disease	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Scab and Mildew	See tight cluster-2nd cover sprays	13. Ziram 76DF	1.5 lb	6 lb
		19 [2]Sovran 50WG	1.0-1.6 oz	4.0-6.4 oz
Brooks spot	E = 19, 20, 25, 26, 28, 29 G = 13, 27	20. [2]Flint 50WG	-	2.0-2.5 oz
		25. Topsin-M 70W + Captan 50W	2-3 oz + 1 lb	8-10 oz + 3-4 lb
Sooty blotch and fly speck	E = 19, 20, 25, 26, 28, 29 G = 13, 27	26. Topsin-M 70W + Ziram 76DF	2-3 oz + 1 lb	8-10 oz + 3-4 lb
Black rot and white rot	E = 28, 29 G = 19, 20, 25, 26, 27 F = 13	27. Captan 50W	2 lb	6.5-8 lb
		28. Captan 50W + Ziram 76DF + Topsin M 70W	1 lb + 1 lb + 2-3 oz	3-4 lb + 3-4 lb + 8-10 oz
Bitter rot	E = 29 G = 13, 19, 20, 27, 28 F = 25, 26	29. [3]Pristine 38WG	-	14.5 oz

[1] CAUTION: Do not apply mancozeb or Polyram within 77 days of harvest. Without the broad spectrum rot control of the EBDC fungicides (mancozeb and Polyram), potential rot problems should be anticipated. Monitor orchard blocks frequently for rots, sooty blotch and fly speck. Topsin-M does not effectively control bitter rot. Do not apply more than 64 lb of Captan 50W per acre per year. Do not use more than 42.4 lb of Ziram 76DF per acre per year.

[2] Use higher rates and shorter intervals if bitter rot pressure is high. While benefits for summer disease control are recognized, ratings for rot disease are still under evaluation. Caution is advised on the use of these materials where bitter rot pressure is heavy.

[3] Limit the number of applications of Pristine and similar modes of action to four/yr; do not make more than two sequential applications of Pristine before alternating to a fungicide with another mode of action.

IMPROVED CULTURAL PRACTICES FOR BETTER SUMMER DISEASE MANAGEMENT

Summer disease control without EBDC fungicides may involve more expensive but less effective spray programs. Here are some general disease management practices which do not directly involve fungicides but can improve disease control under any fungicide program:

1. Prune trees to improve spray coverage and shorten drying time. This includes removing and keeping vines out of the tree.
2. Disease inoculum reduction:
   a. Remove prunings, cankers, dead wood from the trees.
   b. Remove fruit mummies from the trees when feasible.
   c. Control fireblight to reduce fruit rot fungus build-up on cankers. Fireblight-killed wood often becomes colonized by fruit rot fungi later that season. Where blighted shoots are not removed, they should be recognized as a source of increased rot pressure and the spray interval should be tightened accordingly.
   d. Consider removing alternate hosts such as brambles, honeysuckle, etc. from rock outcroppings and ditches inside large orchard areas. (Also, where feasible, remove cedar trees from the vicinity of the orchard as a deterrent to heavy cedar apple rust and quince rust infection).
3. Be aware of and avoid thinning with NAA under cool conditions which aggravates pygmy fruit retention on cultivars such as Rome Beauty, Golden Delicious, spur Red Delicious, Fuji and Granny Smith.
4. Optimize tree nutrition to improve wound and canker healing, thereby reducing rot inoculum sources.
5. Use calcium sprays to control cork spot to reduce bitter rot build-up on affected fruit and subsequent spread to healthy fruit (especially Red Delicious and York). (See pages 164-165).
6. Prevent insect damage to reduce fruit susceptibility to rots.
7. Monitor disease-prone areas regularly and frequently. Some areas of the orchard tend to have chronic problems. Some areas may have a likely inoculum source as indicated above. Sooty blotch and fly speck usually appear first as light symptoms in lower, foggy areas.
8. Try to stay ahead of problems. Some cultivars are more prone to summer disease problems. Sooty blotch is easiest to detect on Golden Delicious. Romes have the habit of weighing down under a heavy crop load late in the season, making thorough spray coverage almost impossible. Concentrating on maintaining better control throughout the early summer months will help to compensate for this problem later in the season.

THIRD COVER SPRAY : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Tentiform leafminer (TLM)	E = 7, 8, 9, 14, 21, 23, 27, 29, 30, 31, 32, 33, 38 G = 2, 5, 13, 15	1. Esteem 35W	-	4-5 oz
		2. Lannate 90SP or Lannate LV	4 oz -	0.5-1 lb 1.3-3 pt
		3. Imidan 70WSB	16-21 oz	2.1-5.75 lb
Mites (ERM/TSM)[1]	E = 11, 18, 19, 20, 22, 34 G = 7, 12, 17, 37	4. *Bacillus thuringiensis*	See label	See label
		5. Aza-Direct or Neemix	-	1-2 pt
		6. Sivanto 200SL or Sivanto Prime	-	7-14 fl oz
Codling moth (CM)[4]	E = 3, 23, 26, 27, 29, 31, 32, 33, 38 G = 1, 2, 5, 8, 10, 13, 21, 35	7. Vydate 2L	1 pt	3 pt
		8. [5]Assail 30SG	-	2.5-8.0 oz
		9. Actara 25WG	-	2.0- 5.5 oz
San Jose scale (SJS)	E = 1, 25 G = 2, 6, 14, 28	10. Avaunt eVo 30DG	-	5-6 oz
		11. Nexter SC	-	11-17 fl oz
Variegated leafroller and tufted apple budmoth (VLR + TBM)[6]	E = 15, 23, 27, 29, 30, 31, 32, 33, 38 G = 3, 4, 5, 26	12. Vendex 50W	6 oz	18 oz
		13. [3]Sevin XLR PLUS	2 pt	6 pt
		14. Admire Pro or Alias 4F	- 1-2 fl oz	1.4-2.8 fl oz or 3.2 fl oz
Rose leafhopper (RLH)	E = 2, 6, 8, 9, 14, 21, 32 G = 7, 10, 13, 16, 26, 36	15. Intrepid 2F	-	12-16 fl oz
		16. [6]Surround WP	-	25 lb
		17. Acramite 50WS or Banter SC	-	12-16 oz
Apple maggot (AM)[2]	E = 3 G = 2, 8, 26, 27, 28	18. Zeal 72WDG	-	2-3 oz
Oriental fruit moth (OFM)[4]	E = 3, 24, 26, 27, 28, 29, 31, 32, 33, 38 G = 2, 5, 8, 10, 13, 15, 21, 23, 35 (Madex, Virosoft)	19. Portal 5EC	10 fl oz	2 pt
		20. Kanemite 15SC	-	21-31 fl oz
		21. Belay 2.13SC	-	6-12 fl oz
		22. Envidor 2SC	-	16-18 fl oz
		23. Rimon 0.83EC	-	20-40 fl oz
Woolly apple aphid (WAA)	E = 28 G = 36	24. CheckMate OFM-F	-	1.3-2.9 fl oz
		25. Centaur 70WDG	-	34.5 oz
Brown marmorated stink bug (BMSB)	See footnote 9, Second cover	26. No. 2 + No. 3	2 oz + 10 oz	6 oz + 32 oz
		27. Entrust 2SC	-	6-10 fl oz
		28. Diazinon 50WP	1 lb	3 lb
		29. Delegate 25WG	-	4.5-7 oz
		30. Proclaim 5SG	0.8-1.2 oz	3.2-4.8 oz
		31. Altacor eVo 70WDG	-	1.3-2.2 oz
		32. Voliam Flexi 40WG	-	4-7 oz
		33. Exirel	-	8.5-17 fl oz
		34. Nealta	-	13.7 fl oz
		35. CM Virus	-	1-6 fl oz (Cyd-X) 0.5-3 fl oz (Cyd-X HP, Madex; CM and OFM) 1.6-3.2 fl oz (Virosoft)
		36. Closer 2SC	-	1.5-2.75 fl oz
		37. Magister SC	-	32-36 fl oz
		38. Verdepryn	-	5.5-11 fl oz

[1] Predatory mites can be valuable predators of spider mites. The most common species is Amblyseius fallacis. When present, they may be protected by avoiding pesticides that are toxic to Amblyseius (see Table 9). A predator-to-prey ratio of at least 1:10 presents a good probability of biological control. Higher ratios increase the probability of success. Lower predator-to-prey ratios (e.g., 1:20) may result in successful control on some apple varieties less conducive to spider mite reproduction than `Delicious'.

[2] AM is seldom a problem in our region, except when an abandoned orchard is nearby. Growers interested in exporting to certain countries should be prepared to control AM starting at 900 degree days above 50˚ F after Jan. 1.

[3] See note 11, p. 71.

[4] See notes on CM, OFM, and TBM on p.1- 2 for timing recommendations based on DD.

[5] 2.5-4.0 oz/A for TLM and RLH; 5.5-8.0 oz/A for CM, OFM and AM.

[6] Apples treated with Surround after second cover may not be acceptable for sale to processors due to residue.

FOURTH COVER SPRAY : Diseases

Disease	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Scab and mildew	See tight cluster-2nd cover sprays	13. Ziram 76DF	1.5 lb	6 lb
		19. [2]Sovran 50WG	1.0-1.6 oz	4.0-6.4 oz
Brooks spot	E = 19, 20, 25, 26, 28, 29 G =13, 27	20. [2]Flint 50WG	-	2.0-2.5 oz
		25. Topsin-M 70W + Captan 50W	2-3 oz + 1 lb	8-10 oz + 3-4 lb
Sooty blotch and fly speck	E = 19, 20, 25, 26, 28, 29 G = 13, 27	26. Topsin-M 70W + Ziram 76DF	2-3 oz + 1 lb	8-10 oz + 3-4 lb
Black rot and white rot	E = 28, 29 G = 19, 20, 25, 26, 27 F = 13	27. Captan 50W	2 lb	6.5-8 lb
		28. Captan 50W + Ziram 76DF+ Topsin M 70W	1 lb + 1 lb + 2-3 oz	3-4 lb + 3-4 lb + 8-10 oz
Bitter rot	E = 29 G = 13, 19, 20, 27, 28 F = 25, 26	29. [3]Pristine 38WG	-	14.5 oz

[1] See cautions and summer disease management comments under third cover spray p. 77. Observe days-to-harvest limitations on all pesticides (Table 28). Do not apply mancozeb or Polyram within 77 days of harvest. Do not apply more than 30 lb active ingredient of captan per acre per year. If mildew is a problem, maintaining mildew protection until terminal shoot growth hardens off will reduce the amount of mildew that overwinters in the buds. This will reduce the severity of mildew next year. Regrowth late in the season may require additional protection to prevent heavy overwintering.

[2] Use higher rates and shorter intervals if bitter rot pressure is high. While benefits for summer disease control are recognized, ratings for rot diseases are still under evaluation. Caution is advised on the use of these materials where bitter rot pressure is heavy.

[3] Limit the number of applications of Pristine and similar modes of action to four/yr; do not make more than two sequential applications of Pristine before alternating to a fungicide with another mode of action.

FOURTH COVER SPRAY : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Redbanded leafroller (RBLR)	E = 14, 22, 24, 25, 27, 28, 33, 31, 32, 36 G = 2, 3, 12	1. Lannate 90SP or Lannate LV	4 oz -	0.5-1 lb 1.5-3 pt
		2. Imidan 70WSB	16-21 oz	2.1-5.75 lb
		3. *Bacillus thuringiensis*	See label	See label
Mites (ERM)[1]	E = 10, 17, 18, 19, 21, 33 G = 6, 11, 16, 35	4. Aza-Direct or Neemix	-	1-2 pt
		5. Sivanto 200SL or Sivanto Prime	-	14 fl oz
Codling moth (CM)[4]	E = 2, 22, 24, 25, 27, 30, 32, 36 G = 1, 4, 7, 9, 12, 20, 29 (Madex, Virosoft)	6. Vydate 2L	1 pt	2-4 pt
		7. [6]Assail 30SG	-	2.5-8.0 oz
		8. Actara 25 WG	-	2.0-5.5 oz
		9. Avaunt eVo 30DG	-	5-6 oz
Variegated leafroller and tufted apple budmoth (VLR + TBM)[4]	E = 15, 22, 25, 27, 28, 30, 31, 32, 36 G = 2, 3, 12, 24	10. Nexter SC	-	11-17 fl oz
		11. Vendex 50W	6 oz	18 oz
Japanese beetle (JB)	E = 12, 15 G = 1, 7	12. [2]Sevin XLR	2 pt	6 pt
		13. Admire Pro or Alias 4F	- 1-2 fl oz	1.4-2.8 fl oz or 3.2 fl oz
Rose leafhopper (RLH)	E = 1, 5, 7, 8, 13, 20, 31 G = 6, 9, 12, 15, 24, 34	14. Intrepid 2F	-	12-16 fl oz
		15. [5]Surround WP	-	25 lb
		16. Acramite 50WS or Banter SC	-	12-16 oz
Apple maggot (AM)[3]	E = 2 G = 1, 7, 9, 15, 24, 36	17. Zeal 72WDG	-	2-3 oz
Oriental fruit moth (OFM)[4]	E = 2, 23, 24, 25, 27, 30, 31, 32, 36 G = 1, 4, 7, 9, 12, 14, 20, 22, 29 (Madex)	18. Portal 5EC	10 fl oz	2 pt
		19. Kanemite 15SC	-	21-31 fl oz
		20. Belay 2.13SC	-	6-12 fl oz
Woolly apple aphid (WAA)	E = 26	21. Envidor 2SC	-	16-18 fl oz
		22. Rimon 0.83EC	-	20-40 fl oz
		23. CheckMate OFM-F	-	1.3-2.9 fl oz
Brown marmorated stink bug (BMSB)	Footnote 9, Second cover	24. No. 1 + No. 2	2 oz + 10 oz	6 oz + 32 oz
		25. Entrust 2SC	-	6-10 fl oz
		26. Diazinon 50WP	1 lb	3 lb
		27. Delegate 25WG	-	4.5-7 oz
		28. Proclaim 5SG	0.8-1.2 oz	3.2-4.8 oz
		29. CM Virus	-	1-6 fl oz (Cyd-X) 0.5-3 fl oz (Cyd-X HP, Madex; CM and OFM) 1.6-3.2 fl oz (Virosoft)
		30. Altacor eVo 70WDG	-	1.3-2.2 oz
		31. Voliam Flexi 40WG	-	4-7 oz
		32. Exirel	-	8.5-17 fl oz
		33. Nealta	-	13.7 fl oz
		34. Closer 2SC	-	1.5-2.75 fl oz
		35. Magister SC	-	11-17 fl oz
		36. Verdepryn	-	5.5-11 fl oz

FOURTH COVER SPRAY : Insects

[1] See note 1, p. 78.
[2] Sevin XLR Plus poses less risk to honey bees than other Sevin formulations, especially when used in concentrate sprays of 30 gallons per acre (1:39 dilution ratio). However, some additional bee safety is obtained at more dilute rates. Frequent applications may be necessary to control new immigrating Japanese beetles. Mite build up can be expected. Also see note 11, p. 70.
[3] See note 3, p. 78.
[4] See note on CM, OFM, and TBM on p.1- 2 for timing recommendations based on DD.
[5] For effective control of JB, apply **BEFORE** adult activity on trees begins. Apples treated with Surround after second cover may not be acceptable for sale to processors due to residue.
[6] 2.5-4.0 oz/A for RLH; 5.5-8.0 oz/A for CM, JB, AM and OFM.

FIFTH COVER SPRAY[1] : Diseases

Disease	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Scab and mildew	See tight cluster to 2nd cover sprays	1. Ziram 76DF	1.5 lb	6 lb
		2. [2]Sovran 50WG	1.0-1.6 oz	4.0-6.4 oz
Brooks spot	E = 2, 3, 4, 5, 7, 8 G = 1, 6	3. [2]Flint 50WG	-	2.0-2.5 oz
Sooty blotch and fly speck	E = 2, 3, 4, 5, 7, 8 G = 1, 6	4. Topsin-M 70W + Captan 50W	2-3 oz + 1 lb	8-10 oz + 3-4 lb
		5. Topsin-M 70W + Ziram 76DF	2-3 oz + 1 lb	8-10 oz + 3-4 lb
Black rot and white rot	E = 7, 8 G = 2, 3, 4, 5, 6 F = 1	6. Captan 50W	2 lb	6.5-8 lb
Bitter rot	E = 8 G = 1, 2, 3, 6, 7 F = 4, 5	7. Captan 50W + Ziram 76DF + Topsin M 70W	1 lb + 1 lb + 2-3 oz	3-4 lb + 3-4 lb + 8-10 oz
		8. [3]Pristine 38WG	-	14.5 oz

[1] See cautions and summer disease management comments under third cover spray p. 77. Observe days-to-harvest limitations on all pesticides (Table 28). Do not apply more than 30 lb active ingredient of captan per acre per year. If mildew is a problem, maintaining mildew protection until terminal shoot growth hardens off will reduce the amount of mildew that overwinters in the buds. This will reduce the severity of mildew next year. Regrowth late in the season may require additional protection to prevent heavy overwintering.
[2] Use higher rates and shorter intervals if bitter rot pressure is high. While benefits for summer disease control are recognized, ratings for rot diseases are still under evaluation. Caution is advised on the use of these materials where bitter rot pressure is heavy.
[3] Limit the number of applications of Pristine and similar modes of action to four/yr; do not make more than two sequential applications of Pristine before alternating to a fungicide with another mode of action.

FIFTH COVER SPRAY : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Japanese beetle (JB)	E = 11, 14 G = 1	1. Lannate 90SP or Lannate LV	4 oz -	0.5-1 lb 1.5-3 pt
Mites (ERM/TSM)	E = 9, 16, 17, 18, 20, 29 G = 10, 15, 31	2. Imidan 70WSB	16-21 oz	2.1-5.75 lb
		3. Aza-Direct or Neemix	-	1-2 pt
		4. Exirel	-	8.5-17 fl oz
Codling moth (CM)[5]	E = 2, 4, 26, 27, 28, 32 G = 1, 3, 6, 8, 11, 19, 23	5. Vydate L	1 pt	2-4 pt
		6. [6]Assail 30SG	-	2.5-8.0 oz
San Jose scale (SJS)	E = 24 G = 1, 12, 25	7. Actara 25WG	-	2.0- 5.5 oz
		8. Avaunt eVo 30DG	-	5-6 oz
White apple leafhopper (WALH)	E = 1, 6, 12, 19, 28 G = 5, 8, 11, 30, 32	9. [4]Nexter SC	-	11-17 oz
		10. Vendex 50W	6 oz	18 oz
Woolly apple aphid (WAA)	E = 24	11. [1]Sevin PLUS	2 pt	6 pt
Apple maggot (AM)[2]	E = 2 G = 1, 6, 8, 14, 25, 32	12. Admire or Alias 4F	- 1-2 fl oz	1.4-2.8 fl oz or 3.2 fl oz
Oriental fruit moth (OFM)[5]	G =1, 3, 6, 8, 11, 13, 19, 21, 23 (Madex, Virosoft)	13. Intrepid 2F	-	12-16 fl oz
		14. [3]Surround WP	-	25 lb
		15. Acramite 50WS or Banter SC	-	12-16 oz
Brown marmorated stink bug (BMSB)	Footnote 9, Second cover	16. Zeal 72WDG	-	2-3 oz
		17. Portal 5EC	10 fl oz	2 pt
		18. Kanemite 15SC	-	21-31 fl oz
		19. Belay 2.13SC	-	6-12 fl oz
		20. Envidor 2SC	-	16-18 fl oz
		21. [5]Rimon 0.83EC	-	20-40 fl oz
		22. CheckMate OFM-F	-	1.3-2.9 fl oz
		23. CM Virus	-	1-6 fl oz (Cyd-X) 0.5-3 fl oz (Cyd-X HP, Madex; CM and OFM) 1.6-3.2 fl oz (Virosoft)
		24. Centaur 70WDG	-	34.5 oz
		25. Diazinon 50WP	1 lb	3 lb
		26. Delegate 25WG	-	4.5-7 oz
		27. Altacor eVo 70WDG	-	1.3-2.2 oz
		28. Voliam Flexi 40WG	-	4-7 oz
		29. Nealta	-	13.7 fl oz
		30. Closer 2SC	-	1.5-2.75 fl oz
		31. Magister SC	-	11-17 fl oz
		32. No. 1 + No. 2	2 oz+6 oz	6 oz+32 oz
		33. Verdepryn	-	5.5-11 fl oz

[1] See note 11, p. 71.
[2] See note 3, p. 78 .
[3] For effective control of JB, apply **BEFORE** adult activity on trees begins. Apples treated with Surround after second cover may not be acceptable for sale to processors due to residue.
[4] Use 8.8-10.7 oz/A for TSM.
[5] See note on CM and OFM on p.1- 2 for timing recommendations based on DD.
[6] Use 2.5-4.0 oz/A for WALH; 5.5-8.0 oz/A for JB, CM, AM and (insert text?).

SIXTH COVER SPRAY[1] : Diseases

Disease	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Scab and mildew	See tight cluster to 2nd cover sprays	1. Ziram 76DF	1.5 lb	6 lb
		2. [2]Sovran 50WG	1.0-1.6 oz	4.0-6.4 oz
Brooks spot	E = 2, 3, 4, 5, 7, 8 G = 1, 6	3. [2]Flint 50WG	-	2.0-2.5 oz
Sooty blotch and fly speck	E = 2, 3, 4, 5, 7, 8 G = 1, 6	4. Topsin-M 70W + Captan 50W	2-3 oz + 1 lb	8-10 oz + 3-4 lb
Black rot and white rot	E = 7, 8 G = 2, 3, 4, 5, 6 F = 1	5. Topsin-M 70W + Ziram 76DF	2-3 oz + 1 lb	8-10 oz + 3-4 lb
		6. Captan 50W	2 lb	6.5-8.0 lb
Bitter rot	E = 8 G = 1, 2, 3, 6, 7 F = 4, 5	7. Captan 50W + Ziram 76 DF or WDG+ Topsin M 70W	1 lb + 1 lb + 2-3 oz	3-4 lb + 3-4 lb + 8-10 oz
		8. [3]Pristine 38WG	-	14.5 oz

[1] See cautions and summer disease management comments under third cover spray p. 77. Observe days-to-harvest limitations on all pesticides (Table 28). Do not apply more than 30 lb active ingredient of captan per acre per year. If mildew is a problem, maintaining mildew protection until terminal shoot growth hardens off will reduce the amount of mildew that overwinters in the buds. This will reduce the severity of mildew next year. Regrowth late in the season may require additional protection to prevent heavy overwintering.

[2] Use higher rates and shorter intervals if bitter rot pressure is high. While benefits for summer disease control are recognized, ratings for rot diseases are still under evaluation. Caution is advised on the use of these materials where bitter rot pressure is heavy.

[3] Limit the number of applications of Pristine and similar modes of action to four/yr; do not make more than two sequential applications of Pristine before alternating to a fungicide with another mode of action.

SIXTH COVER SPRAY: Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Mites (ERM/TSM)	E = 9, 16, 17, 18, 29 G = 6, 10, 15, 30	1. Lannate 90S or Lannate LV	4 oz -	0.5-1 lb 1.5-3 pt
Codling moth (CM)[1, 6]	E = 2, 5, 21, 27, 28, 31, 32 G = 1, 4, 7, 8, 11, 19, 23	2. Imidan 70WSB	16-21 oz	2.1-5.75 lb
		3. *Bacillus thuringiensis*	See label	See label
		4. Aza-Direct or Neemix	-	1-2 pt
		5. Exirel	-	8.5-17 fl oz
White apple leafhopper (WALH), Rose leafhopper (RLH)	E = 1, 7, 12, 19, 31 G = 8, 11, 14	6. Vydate L	1 pt	2-4 pt
		7. [2]Assail 30SG	-	2.5-8.0 oz
San Jose scale (SJS)	E = 24 G = 1, 12, 26	8. Avaunt eVo 30DG	-	5-6 oz
		9. [5]Nexter SC	-	11-17 fl oz
		10. Vendex 50W	6 oz	18 oz
Tentiform leafminers (TLM)	E = 5, 6, 7, 12, 19, 21, 25, 27, 28, 31, 32 G = 1, 4, 11, 13	11. [3]Sevin XLR PLUS	2 pt	6 pt
		12. Admire Pro or Alias 4F	- 1-2 fl oz	1.4-3.8 fl oz or 3.2 fl oz
		13. Intrepid 2F	-	12-16 fl oz
Woolly apple aphid (WAA)	E = 26	14. [7]Surround WP	-	25 lb
		15. Acramite 50WS or Banter SC	-	12-16 oz
Apple maggot (AM)[4]	E = 2 G = 1, 7, 8, 14, 25, 26, 31	16. Zeal 72WDG	-	2-3 oz
		17. Portal 5EC	10 fl oz	2 pt
Oriental fruit moth (OFM)[6]	E = 2, 5, 22, 27, 28, 31, 32 G = 1, 4, 7, 8, 11, 13, 19, 21, 23 (Madex, Virosoft)	18. Kanemite 15SC	-	21-31 fl oz
		19. Belay 2.13SC	-	6-12 fl oz
		20. Envidor 2SC	-	16-18 fl oz
Brown marmorated stink bug (BMSB)	See footnote 9, Second cover	21. Rimon 0.83EC	-	20-40 fl oz
		22. Checkmate OFM-F	-	1.3-2.9 fl oz
		23. CM Virus	-	1-6 fl oz (Cyd-X) 0.5-3 fl oz (Cyd-X HP, Madex; CM and OFM) 1.6-3.2 fl oz (Virosoft)
		24. Centaur 70WDG	-	34.5 oz
		25. Entrust 2SC	-	6-10 fl oz
		26. Diazinon 50WP	1 lb	3 lb
		27. Delegate 25WG	-	4.5-7 oz
		28. Altacor eVo 70WDG	-	1.3-2.2 oz
		29. Nealta	-	13.7 fl oz
		30. Magister SC	-	11-17 fl oz
		31. No. 1 + No. 2	2 oz+6 oz	6 oz+32 oz
		32. Verdepryn	-	5.5-11 fl oz

[1] Examine fruit for injury by second generation larvae, and monitor with pheromone traps to determine need for third generation control.
[2] 2.5-4.0 oz/A for WALH, RLH; 5.5-8.0 oz/A for CM, AM and OFM.
[3] See note 11, p. 71.
[4] See note 3, p. 78.
[5] Use 8.8- 10.7 oz/A for TSM.
[6] See note on CM and OFM on p.1- 2 for timing recommendations based on DD.
[7] Apples treated with Surround after second cover may not be acceptable.

SEVENTH AND EIGHTH COVER SPRAYS : Diseases

Disease	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Scab and mildew	See tight cluster to 2nd cover sprays	1. Ziram 76DF	1.5 lb	6 lb
		2. [2]Sovran 50WG	1.0-1.6 oz	4.0-6.4 oz
Brooks spot	E = 2, 3, 4, 5, 7, 8 G = 1, 6	3. [2]Flint 50WG	-	2.0-3.0 oz
		4. Topsin-M 70W + Captan 50W	2-3 oz + 1 lb	8-10 oz + 3-4 lb
Sooty blotch and fly speck	E = 2, 3, 4, 5, 7, 8 G = 1, 6	5. Topsin-M 70W + Ziram 76DF	2-3 oz + 1 lb	8-10 oz + 3-4 lb
Black rot and white rot	E = 7, 8 G = 2, 3, 4, 5, 6 F = 1	6. Captan 50W	2 lb	6.5-8 lb
		7. Captan 50W + Ziram 76 DF + Topsin M 70W	1 lb + 1 lb + 2-3 oz	3-4 lb + 3-4 lb + 8-10 oz
Bitter rot	E = 8 G = 1, 2, 3, 6, 7 F = 4, 5	8. [3]Pristine 38WG	-	14.5 oz

[1] See cautions and summer disease management comments under third cover spray p. 77. Observe days-to-harvest limitations on all pesticides (Table 28). Do not apply more than 30 lb active ingredient of captan per acre per year. If mildew is a problem, maintaining mildew protection until terminal shoot growth hardens off will reduce the amount of mildew that overwinters in the buds. This will reduce the severity of mildew next year. Regrowth late in the season may require additional protection to prevent heavy overwintering.

[2] Use higher rates and shorter intervals if bitter rot pressure is high. While benefits for summer disease control are recognized, ratings for rot diseases are still under evaluation. Caution is advised on the use of these materials where bitter rot pressure is heavy.

[3] Limit the number of applications of Pristine and similar modes of action to four/yr; do not make more than two sequential applications of Pristine before alternating to a fungicide with another mode of action. Use of Pristine at this time may reduce the amount of post-harvest rot.

SEVENTH AND EIGHTH COVER SPRAYS : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Mites (ERM/TSM)[1]	E = 8, 10, 16, 17, 18, 20 G = 5, 9, 15, 31	1. Lannate 90SP or Lannate LV	4 oz -	0.5-1 lb 1.5-3 pt
		2. Imidan 70WSB	16-21 oz	2.1-5.75 lb
		3. Aza-Direct or Neemix	-	1-2 pt
Codling moth (CM)[5]	E = 2, 4, 21, 24, 25, 27, 29, 32 G = 3, 6, 7, 11, 19	4. Exirel	-	8.5-17 fl oz
		5. Vydate L	1 pt	2-4 pt
		6. [6]Assail 30SG	-	2.5-8.0 oz
San Jose scale (SJS)	E = 23 G = 1, 12, 26	7. Avaunt eVo 30DG	-	5-6 oz
		8. [8]Nexter SC	-	11-17 fl oz
Leafrollers (VLR, TBM, RBLR)[2, 5]	E = 4, 13, 25, 27, 28, 29, 32 G = 3, 11, 24	9. Vendex 50W	6 oz	18 oz
		10. Nealta	-	13.7 fl oz
		11. [3]Sevin XLR PLUS	2 pt	6 pt
White apple leafhopper (WALH) Rose leafhopper (RLH)	E = 1, 6, 12, 19 G = 5, 7, 11, 14, 24, 30	12. Admire Pro or Alias 4F	- 1-2 fl oz	1.4-2.8 fl oz or 3.2 fl oz
		13. Intrepid 2F	-	12-16 fl oz
		14. [8]Surround WP	-	25 lb
Tentiform leafminers (TLM)	E = 4, 5, 6, 19, 21, 25, 27, 29, 32 G = 1, 3, 11, 13	15. Acramite 50WS or Banter SC	-	12-16 oz
		16. Zeal 72WG	-	2-3 oz
		17. Portal 5EC	10 fl oz	2 pt
Apple maggot (AM)[4]	E = 2 G = 1, 6, 7, 14, 26	18. Kanemite 15SC	-	31 fl oz
		19. Belay 2.13SC	-	6-12 fl oz
		20. Envidor 2SC	-	16-18 fl oz
Oriental fruit moth (OFM)[5]	E = 2, 4, 22, 25, 27, 29, 32 G = 1, 3, 6, 7, 11, 13, 19, 21	21. Rimon 0.83EC	-	20-40 fl oz
		22. CheckMate OFM-F	-	1.3-2.9 fl oz
		23. Centaur 70WDG	-	34.5 oz
		24. No. 1 + No. 2	2 oz + 10 oz	6 oz + 32 oz
		25. Entrust 2SC	-	6-10 fl oz
Woolly apple aphid (WAA)	E = 26	26. Diazinon 50WP	1 lb	3 lb
		27. Delegate 25WG	-	4.5-7 oz
		28. Proclaim 5SG	0.8-1.2 oz	3.2-4.8 oz
Brown marmorated stink bug (BMSB)	See footnote 9, Second cover	29. Altacor eVo 70WDG	-	1.3-2.2 oz
		30. Closer	-	1.5-2.75 fl oz
		31. Magister SC	-	11-17 fl oz
		32. Verdepryn	-	5.5-11 fl oz

[1] If mite predators are present, carefully consider the need to control mites this late in the season. Unless they are abundant enough to prevent fruit sizing, or to cause discomfort to pickers, it may be advisable to protect the predators for the next year.
[2] Monitor VLR + TBM male moths with pheromone traps. Monitor eggs and larvae by visual examination. Concentrate search on south side of tree below 5 feet. Time sprays with degree days to coincide with egg hatch. Follow restrictions on minimum days between last spray and harvest (Table 28).
[3] See note 11, p. 71.
[4] See note 3, p. 78.
[5] See notes on CM, OFM, and TBM on p.1-2 for timing recommendations based on DD.
[6] 2.5-4.0 oz/A for WALH, RLH and TLM; 5.5-8.0 oz/A for CM, AM and OFM.
[7] Use 8.8-10.7 oz/A for TSM.
[8] Apples treated with Surround after second cover may not be acceptable due to residues.
[9] Thirty-five day PHI.

POSTHARVEST DISEASE AND FRUIT SCALD CONTROL[1]

SUGGESTED CHEMICALS[2] Fungicides	100 GAL DILUTE
Mertect 340F + Captan 50W (thiabendazole)	1 pt + 1 lb
Scholar 50W	5 oz[3]
Scholar 1.92SC Scholar EZ (see label for thermal fogging instructions).	10-16 fl oz
Penbotec 400SC	1-2 pt

[2] It is recommended that one of these fungicide treatments be included if fruit must be dipped in a scald inhibitor. If fruit do not need to be treated for scald inhibition, prompt movement into storage with rapid cooling and no fungicide treatment is another option.

[3] A rate of 5 oz in 25-100 gal may be used as a dilute application or dip for control of blue mold and gray mold.

Scald inhibitors

Variety	Early Maturity	Middle Maturity	Late Maturity
Red Delicious	2000 ppm DPA	2000 ppm DPA	2000 ppm DPA
Stayman, Rome, York, Granny Smith	2000 ppm DPA	1000 ppm DPA	

[1] Based on minimum days after full bloom considered safe for picking apples for storage: Red Delicious, 135-145 (depending on strain); Stayman and York, 160; Rome, 165. DPA = Diphenylamine.

Fungicide and scald inhibitor should be applied by flooding or dipping apples after harvest. Additional water with appropriate amounts of chemical must occasionally be added to the holding tank to replace that used in treating the fruit.

Fungicides: The chemical suspension should be recharged with additional material after 600 bushels have been treated. As a general guideline, approximately 15 percent of the initial amount of each material should be added again plus the additional amount needed to replace the volume of suspension lost during treatment. Such recharging of the mixture may be done two times before being discarded. The chemical suspension should be discarded after approximately 1000-1500 bushels have been treated with 100 gallons of mixture or if the mixture becomes dirty.

CAUTION: To prevent infection of fruit in the dip tank by strains of rot fungi resistant to thiabendazole, captan should always be mixed with this material. Do not treat with thiabendazole for more than 3 minutes.

DO NOT USE CAPTAN AS A POSTHARVEST TREATMENT ON FRUIT THAT IS TO BE SHIPPED TO CANADA.

Scald inhibitors: It is important that adequate levels of DPA be maintained in drencher or dip tanks by recharging with inhibitors and water. Tanks should be drained and cleaned at the end of each week. This will provide an opportunity to change mixtures to accommodate changing varieties and maturities. DPA has been known to cause peel injury on Golden Delicious, however, scald is usually not severe on Golden Delicious.

Thorough fruit coverage is necessary for proper scald control, but do not treat for longer than 3 minutes. Treat after harvest and before storage for maximum scald control. Coverage is less effective with cold fruit or cold solutions. Fruit should be treated only once with the same scald inhibitor to avoid exceeding residue tolerance. After treatment, it is a good practice to tilt bins to remove liquid collected in the ends of fruit and in bin bottoms. Read and follow label instructions carefully for use of scald inhibitors.

Check regularly for possible scald development during storage whether or not a scald inhibitor is used. Apple samples from the earliest picked fruit should be taken out of storage each month starting in December. Hold samples one week at room temperature. If scald is a problem in early picked lots of fruit, samples from later pickings should also be taken and checked for scald development. When samples from a given lot of apples begin to show scald, that lot of fruit should be marketed without delay if intended for fresh market.

Nonbearing Apple Orchards

Effectiveness rating: E = excellent, G = good, F = Fair

FIRST SPRAY (Green tip - 1/2 inch green)

Disease	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Scab	G	Ziram 76DF	1.5 lb	5 lb
	G	Mancozeb 75DF	2 lb	5 lb
	G	Sulfur	5.lb	13 lb

Insects/Mites	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
San Jose Scale (SJS)	E = 1	1. Superior oil	2 gal	See note.[1]
Rosy apple aphid (RAA)	G = 1			
Green aphids (SA/AA)[1]	G = 1			
Mites (ERM)	G = 1			

[1] Control of aphids with superior oil is best when application is made close to bud break. If mites are the problem, this oil spray should be applied close to the pink stage (of bearing trees) for best control. In calculating pesticide rate per acre on small trees, use tree row volume method (p. 156). See insect note 1, p. 62.
CAUTION: Do not use sulfur within 14 days of an oil spray or in combination with oil.

SECOND SPRAY (Pink stage of bearing trees)[1]

Disease	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Scab	E = 1	1. Syllit 3.4F +	6 fl oz +	1.3 pt +
Rusts[3]	G = 1	Mancozeb 75DF +	10 oz +	2.0 lb +
Mildew[2]	F = 1	Sulfur	2 lb active ingredient	7 lb active ingredient

[1] The primary objective in disease control on young trees is to maintain the foliage and shoots in good condition so that normal growth and bud development will not be impaired. As trees approach the bearing age, a stronger control program may be required to ensure that disease inoculum levels do not build up so high that the first fruit crops cannot be adequately protected.
[2] If mildew is a serious problem, raise the sulfur rate to 3 lb per 100 gal.
[3] Where cedar-apple rust is a serious problem, consider one of the combinations involving an SI fungicide listed for bearing trees during the pink to second cover spray.

SECOND SPRAY (Pink stage of bearing trees) (cont.)

Insects/Mites	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Rosy apple aphid (RAA)	E = 3	1. Superior Oil	2 gal	See page 68, and Insect note 1, page 71. See tree-row recommendations, p. 156.
Green aphids (SA/AA)	E = 3	2. Vendex 50W	6 oz	
Mites (ERM)[1]	E = 1, 2	3. Assail 30SG	2.5 oz	

[1] See note 2, p. 73.
[2] Use pheromone traps to determine species and period of moth activity.

THIRD SPRAY (During blossoming of bearing trees)[1]

Disease	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Scab, Rusts, and mildew	See recommendations under second spray.			
Fireblight	**On susceptible cultivars, and cultivars on Mark, M.9 and M.26 rootstocks, it is important to prevent fireblight from becoming established on bloom of young trees.** In the year the trees are planted, blossoms can be removed by hand or protected by copper sprays registered for application during bloom. In subsequent non-bearing years, dormant copper sprays and copper formulations registered for application during bloom are recommended. If compatibility of copper with other spray materials is questionable, or if fruit russetting is a concern, substitute streptomycin.			

FOURTH SPRAY (when most of the petals have fallen on bearing trees)[1]

Disease	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Scab, mildew, rusts, fireblight	See second spray, p. 88.			

[1] CAUTION: In blocks having a few blossoms, use streptomycin for fireblight control if conditions are favorable for infection. This spray timing is important to reduce spread of shoot blight, scab, and mildew epidemics. Monitor young orchards to avoid serious outbreaks of these diseases.

FOURTH SPRAY (when most of the petals have fallen on bearing trees)[1] (cont.)

Insects/Mites	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Rosy apple aphid (RAA)	E = 1, 2, 4	1. Movento 2SC	2-3 fl oz	See page 68, and Insect note 1, page 71. See tree-row recommendations, p. 156.
Green aphids (SA/AA)	E = 1, 2, 4	2. Beleaf 50SG	0.5 oz	
Leafrollers[2]	G = 3	3. Imidan 70WSB	12-16 oz	
		4. Assail 30SG	2.5 oz	
White apple leafhopper (WALH)	E = 1, 4 G = 5	5. Surround WP	25 lb	

[1] Spraying any open bloom on trees or ground covers with insecticides.
[2] Use pheromone traps to determine species present and period of moth.

COVER SPRAYS[1]

(14-21 day intervals after petal fall, until terminal growth ceases)

Diseases and Insects/Mites	Effectiveness	Suggested Chemicals	100 gal Dilute	Acre Concentrate
Scab, rusts, mildew	See second spray, p. 88.	1. Vendex 50W	6 oz	See page 61, and Insect note 1, page 71. See tree-row recommendations, p. 156.
Mites (ERM/TSM)	E = 2, 10, 11, 12, 13, 14, 15 G = 1	2. Nealta	13.7 fl oz	
		3. Imidan 70WSB	12-16 oz	
		4. Assail 30SG	2.5 oz	
Leafhoppers (WALH/RLH/PLH)	E = 4, 6, 7, 18 G = 3, 5, 8, 9	5. Surround WP	25 lb	
		6. Lannate 90SP or Lannate LV	0.5-1 lb 1.5-3 pt	
Defoliating caterpillars	E = 16, 17, 18 G = 3, 7, 9	7. No. 5 + No. 9	32 oz + 6 oz	
		8. [2]Sevin 50W	2 lb	
Periodical cicada (C)[3]	G = 4, 5, 6, 8, 9	9. [2]Sevin XLR PLUS	2 pt	
Japanese beetle (JB)	E = 5, 8, 9 G = 4, 6	10. Nexter 75WP	2.2 oz	
		11. Omite 30WS	2 lb	
Dogwood borers (DB)	G = 4	12. Envidor 2SC	6 fl oz	
		13. Acramite 50WS or Banter SC	12-16 oz	
		14. Zeal 72WDG	1 oz	
		15. Portal 5EC	10 fl oz	
		16. Delegate 25 WG	4.5 oz	
		17. Altacor eVo 70WDG	1 oz	
		18. Voliam Flexi 40WG	4-7 oz	

[1] Orchards should be examined frequently from bloom until the trees harden off. Early detection of pests and prompt control measures during the period when trees are becoming established is very important. Frequent sprays may be necessary to control migrating Japanese beetles, cicadas or gypsy moths in outbreak years.

[2] Sevin XLR PLUS poses less risk to honey bees than other Sevin formulations. Caution should be exercised in the use of Sevin because of the potential to cause mite outbreaks. Preliminary research indicates that the XLR PLUS formulation may be less disruptive to mite management programs than other formulations.

[3] Control required only during outbreak years; see map, p. 94.

Figure 1A. Apple Insect Life Cycles

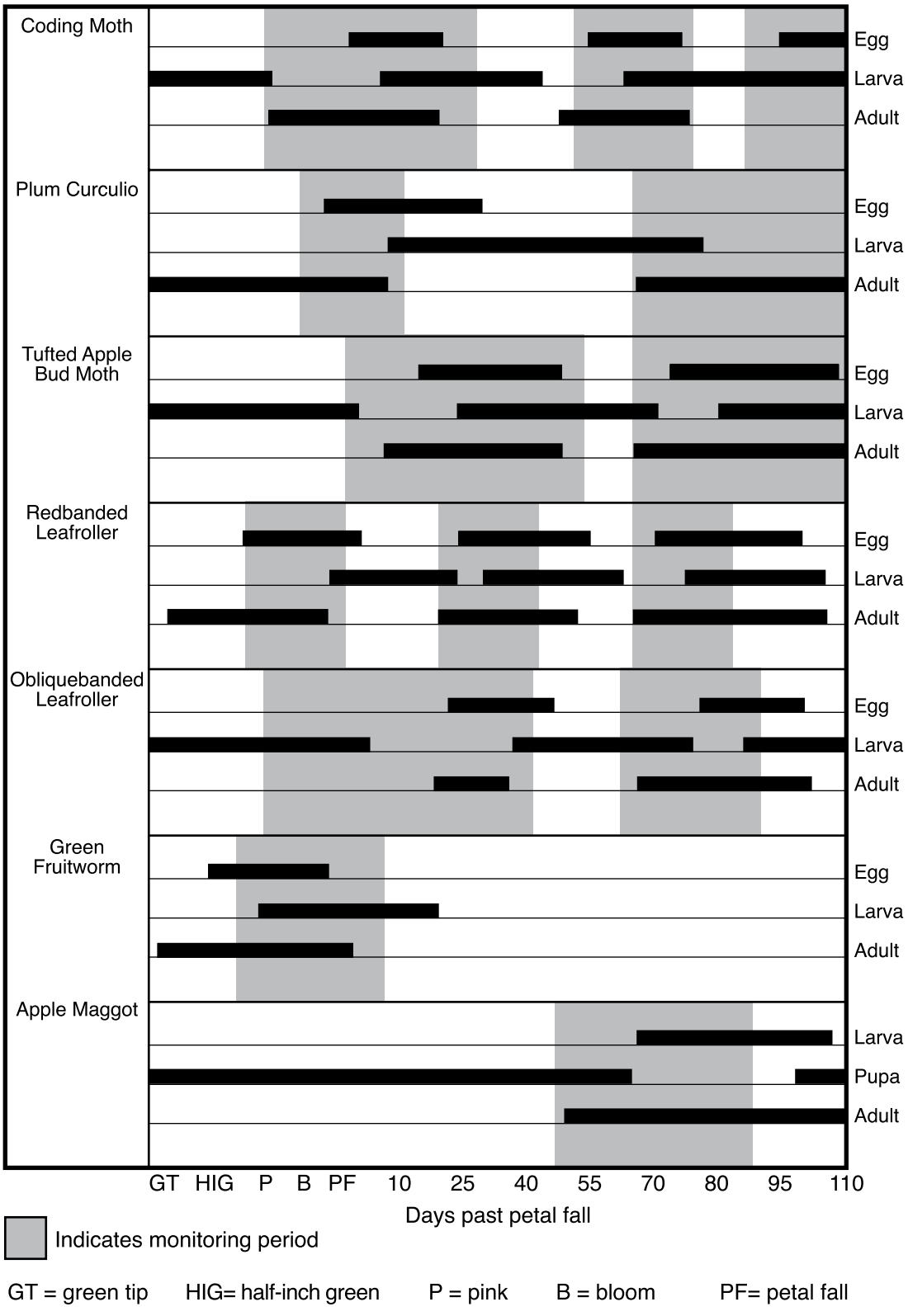


Figure 1B. Apple Insect Life Cycles

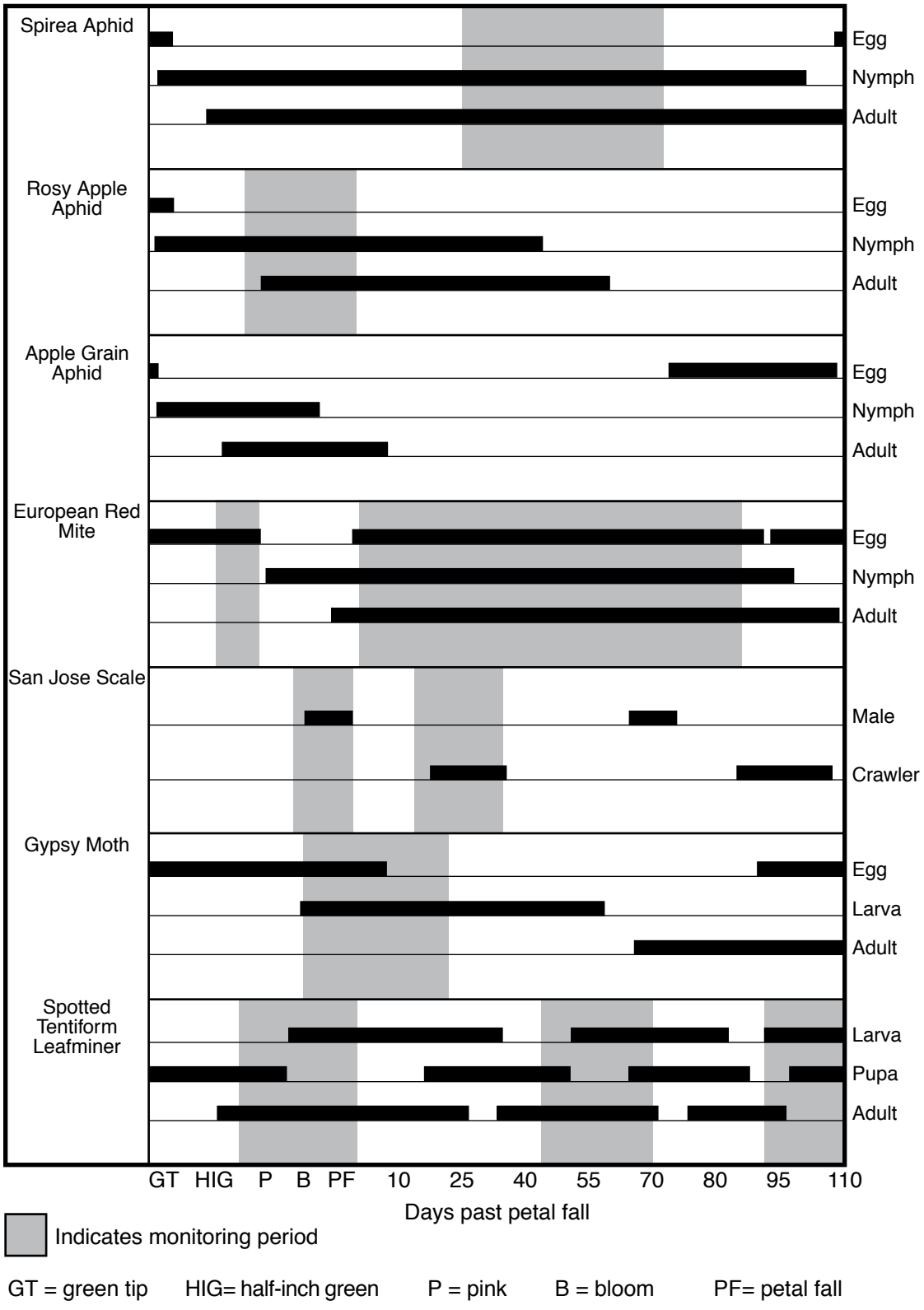


Figure 1C. Apple Insect Life Cycles

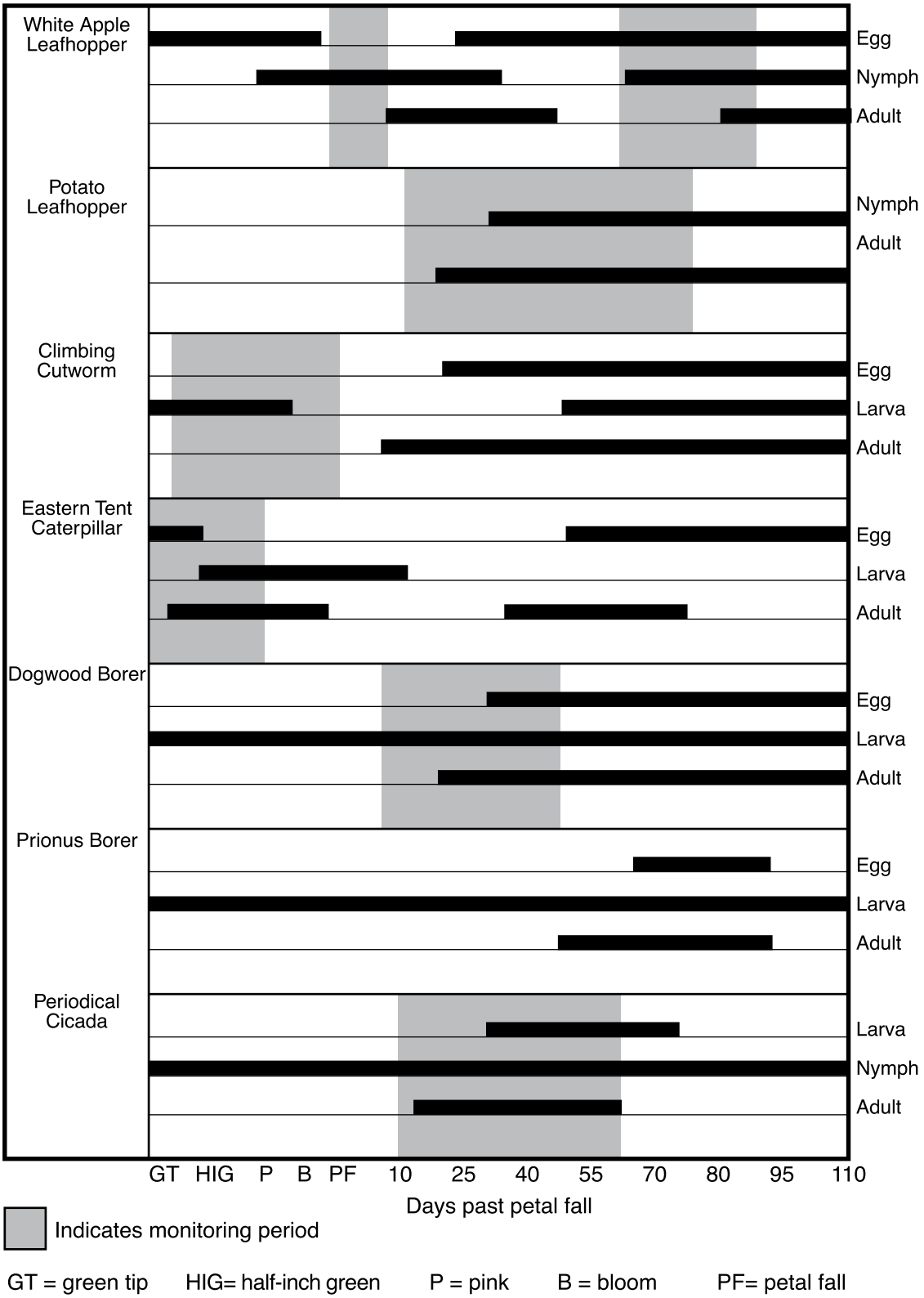


FIGURE 2. Cicada Emergence

LOCATIONS AND OCCURRENCE OF PERIODICAL CICADA. NUMBERS INDICATE YEAR OF OCCURRENCE. CICADA EMERGE AT SEVENTEEN-YEAR INTERVALS THEREAFTER, EXCEPT CIRCLED NUMBERS WHICH OCCUR AT THIRTEEN-YEAR INTERVALS.

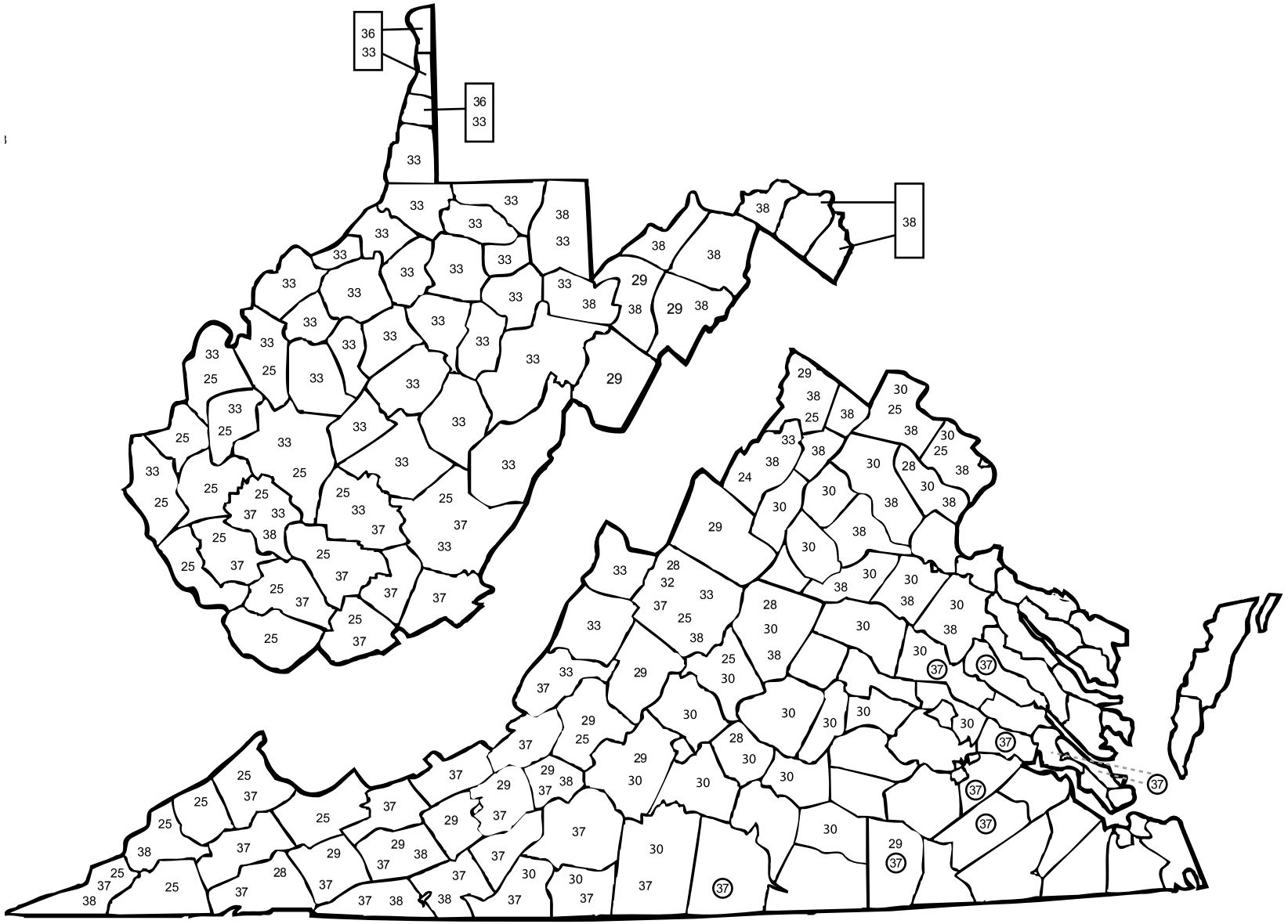


Table 10. Seasonal Activity of Apple Diseases

Initial infection possible (+); observable symptoms (S); secondary infection (*)

	scab	powdery mildew	cedar apple rust	quince rust	fireblight	moldy core	frogeye/ black rot	Brooks spot	sooty blotch and fly speck	bitter and white rots
green tip	+									
tight cluster	+	+ S	+							
pink	+	+ S	+	+			+			
bloom	+ S *	+ S *	+	+	+	+	+ S			
petal fall	S*	+ S *	+ S	+	+ S	+	+ S			
1st cover	S *	S *	+ S	+ S	+ S *	+	+ S			
2nd cover	S *	S *	+ S	S	S *		+ S	+	+	+
3rd cover	S *	S *	S	S	S *	S	S	+	+	+
4th cover	S *	S *	S	S	S	S	S *	+ S	+	+S
5th cover	S *	S *	S	S	S	S	S *	S	+ S	+ S *
6th cover	S *	S *	S	S	S	S	S *	S	+ S	+ S *
7th cover	S *	S *	S	S	S	S	S *	S	S *	+ S *
8th cover	S *	S *	S	S	S	S	S *	S	S *	S *

Note: Date for development of diseases may vary more than a month from year to year and by location in Virginia, West Virginia, and Maryland.

Table 11. Approximate wetting periods required for primary apple scab infection at different air temperatures and time required for development of conidia[a]

Average Temperature	Wetting period (hr)[b]			Incubation period[c] (days)
	Light Infection	Moderate Infection	Heavy Infection	
78	13	17	26	...
77	11	14	21	...
76	9.5	12	19	...
63-75	9	12	18	9
62	9	12	19	10
61	9	13	20	10
60	9.5	13	20	11
59	10	13	21	12
58	10	14	21	12
57	10	14	22	13
56	11	15	22	13
55	11	16	24	14
54	11.5	16	24	14
53	12	17	25	15
52	12	18	26	15
51	13	18	27	16
50	14	19	29	16
49	14	20	30	17
48	15	20	30	17
47	15	23	35	...
46	16	24	37	...
45	17	26	40	...
44	19	28	43	...
43	21	30	47	...
42	23	33	50	...
41	26	37	53	...
40	29	41	56	...
39	33	45	60	...
38	37	50	64	...
37	41	55	68	...
33-36	48	72	96	...

[a] Adapted from Mills, 1944, as modified by A. L. Jones.
[b] The wetting period is determined from the beginning of the rainfall.
[c] Approximate number of days required for development of conidia after the start of an infection period.

Supplementary Apple Disease Discussions

APPLE SCAB

The apple scab fungus overwinters in the previous year's infected leaves on the orchard floor. In the spring, usually around the time of bud break, ascospores are formed and released during periods of rain. The occurrence of infection depends upon the length of the wetting period and the average temperature during the wetting period. This relationship is outlined in Table 10.

Infections of new tissue by ascospores produced from last year's leaves are termed primary infections. Olive-green lesions appear on new leaves or flower parts 10-28 days after a primary infection has occurred. These lesions produce a second type of spore, termed conidia or summer spores, which are spread by splashing rain and wind, and which reinfect the leaves and developing fruit. This type of infection is termed secondary infection. The occurrence of secondary infection also depends upon the length of the wetting period and the average temperature.

To determine whether or not an infection period has occurred, you must note the time from the start of a rain until the time the foliage dries. This interval is the wetting period. Calculate the average temperature during the wetting period and check Table 10 to determine if leaves were wet long enough for an infection to occur. Environmental monitoring devices that record temperature, leaf wetness, and relative humidity are very reliable and relatively inexpensive.

Periods of dew or high humidity (over 90%) will also lengthen a wetting period if preceded by rain. Calculate the average temperature for the wetting period starting at the beginning of a rain. For example, if it rains at 4:00 p.m. and stops at 9:00 p.m., and the leaves remain wet all night with dew, the total wetting period is calculated from the 4:00 p.m. rain until the dew dries the next morning. If dew occurs at 11:00 p.m. and it rains at 6:00 a.m. the next morning, the wetting period is calculated from 6:00 a.m. until the leaves are dry.

Wet periods during intermittent rains should be added together to determine the total length of the wetting period unless these shorter wet periods are separated by 10 hours or more of dry, sunny weather.

As the length of the wetting period exceeds the minimum amount of time required for infection, the severity of the infection period becomes greater. For example, if leaves are wet for 8 hours and the average temperature is 50° F, no infection period has occurred. However, if the leaves are wet for 14 hours at this temperature, a light primary infection period has occurred. At the same temperature, wet periods of 19 and 29 hours are needed to initiate moderate and heavy primary infection periods, respectively.

Apple scab is controlled with fungicides such as the protectants (Captan, EBDCs, Ziram), strobilurins (Flint, Sovran), APs (Vangard, Scala), sterol inhibitors (Rally, Inspire Super, Procure), SDHIs (benzovindiflupyr, boscalid, fluopyram, fluxapyroxad, penthiopyrad), and dodine. Sterol inhibitors, SDHIs, dodine, and especially the strobilurins and benzimidazoles (Topsin-M) must be used in fungicide programs that consider the presence or the potential occurrence of strains of the fungus that are resistant to these materials. Fungicide control programs for apple scab are integrated early in the season with control measures for powdery mildew and rusts, and later in the season with control measures for summer diseases such as sooty blotch, fly speck, Brooks spot and fruit rots. For control of primary infections, sprays are usually timed according to tree phenology (growth stages), with the first spray at 1/2 inch green and additional sprays at tight cluster, full pink, bloom, and petal fall. The number of sprays needed before petal fall varies with weather conditions, cultivar, rate of tissue development, fungicide used, and density of ascospore inoculum present in the orchard. Cover sprays are applied beginning 1 week after petal fall and are repeated every 10-14 days until 2-3 weeks prior to harvest. Primary scab inoculum is usually depleted by the time of the second cover spray.

Weather forecasts can be used to modify the timing of spray applications in calender-based schedules. For example, protective fungicides are applied only when extended wetting periods are in the forecast, thus extending the intervals of application during dry weather and decreasing them during wet weather. To achieve the greatest efficiency from weather-based programs, growers must be aware of the rate of tree development and how quickly fungicide residues are being lost by weathering. Control programs based on a post-infection schedule are an alternative to calender-based and weather forecast-based schedules. To use a postinfection schedule, a grower must know when an infection period has occurred and what fungicides control scab within 24-96 hours after the initiation of an infection period. The grower must be able to cover the entire acreage within this time interval or risk control failure. Therefore, this type of program may only be suitable for well-equipped operations, although extended weather conditions unfavorable for spraying could pose a risk to even the well-equipped grower. Postinfection applications are used in modified calendar-based schedules when critical sprays are missed because of incorrect weather forecasts or unfavorable conditions for spraying.

The efficient use of fungicides is a concept that is still evolving within the industry. For example, spraying alternate row-middles on a 5-day schedule rather than spraying every row middle on a 7-day schedule increases efficiency and improves disease control. Growers also may adjust for differences in tree size from orchard to orchard by determining the amount of fungicide from the volume of foliage per acre (tree-row-volume method). The former standard of 400 gallons of water per acre for large trees on standard rootstocks may eventually be replaced completely by more efficient practices for smaller, higher-density trees.

Several sanitation and cultural practices help to reduce the risks of severe scab infection. Orchard spacing should be such that trees are far enough apart to facilitate air movement and rapid drying of trees when they are mature. Trees should be pruned regularly so that their interiors are relatively open, to enhance the drying of foliage and improve spray coverage.

A fall application of urea is suggested as a means of reducing the overwintering inoculum of the apple scab fungus and offsetting the potential for development of resistance to fungicides. Apply urea to the tree and orchard floor near leaf drop at the rate of 40 lb per acre.

FIRE BLIGHT IN APPLES AND PEARS – P. W. STEINER (DECEASED)

Fire blight is one of the most destructive and difficult to control diseases of apples and pears in the mid-Atlantic region. It also appears to becoming more common and causing more significant tree losses in young apple orchards planted at high densities using clonal rootstocks in combination with susceptible cultivars. The disease develops in several phases, not all of which occur every year in every orchard or with equal intensity. Managing fire blight well requires an aggressive approach aimed at limiting the number and distribution of inoculum sources before and during the growing season and in preventing primary infections.

The fire blight bacterium, *Erwinia amylovora*, overwinters in the healthy bark tissue surrounding limb and twig cankers established the previous season. In the spring, as the daily average temperature increases and early bud development begins mobilizing stored carbohydrates, the overwintering bacteria multiply and initiate new infections in bark tissues at about 90-96 cumulative degree days above 55˚F after green tip (approx. tight cluster to open cluster stage of spur bud development). Symptoms of these first infections won't be apparent until several weeks after bloom, but this early activity produces many bacteria which are then extruded onto bark surfaces as ooze in the weeks before flowering begins. These exposed bacteria continue to multiply and are dispersed again and again throughout the orchard by rain and insects. Thus, unlike apple scab where inoculum dispersal occurs immediately prior to infection, the fire blight pathogen can be dispersed widely to bark ad bud tissues for several weeks to a month before flowering begins and the first blossom infections occur.

Once flowering begins, honey bees serve as very effective vectors in carrying the bacteria to nearly all open flowers in and around the orchard site. The rate at which flowers are colonized by the pathogen and, hence, at risk for infection if rain or dew occurs increases exponentially at temperatures above 64˚F. If no rain or dew occurs during bloom, few if any blossom infections occur. If rain or dew does occur when the average daily temperature is 60ºF or higher, infections can occur within minutes in flowers already colonized by the bacteria. Thus, the early dispersal of bacteria, their colonization of flowers in advance of any wetting that triggers an infection event and the very short time required to establish infections all help explain why blossom blight epidemics develop so explosively in some years. The minimum requirements for blossom infection and the order in which they must occur are: 1) flowers must be open with petals intact (flowers in petal fall are resistant); 2) an accumulation of at least 198 degree hours above 65˚F; 3) a wetting event as dew or rain; and, 4) an average daily temperature of 60˚F. The more any one or more of these minimum requirements is exceeded (e.g., many open flowers, more than 200 cumulative degree hours, extended rains and average temperatures above 65˚F) the more severe the epidemic will be.

In addition to the direct loss of infected spurs resulting from blossom blight, the sudden availability of thousands of new sources of inoculum greatly increases the chances for many shoot infections, which can lead to additional limb and tree losses. Regardless of whether blossom blight occurs or whether large numbers of shoot blight symptoms develop, the presence of active cankers within or near an orchard can provide enough bacteria to support colonization of apple and pear foliage in an orchard by early to midsummer. Under normal conditions this epiphytic colonization poses no problem. However, should hail or wind storms damage the foliage, widespread and often severe trauma blight symptoms affecting all tissues can occur.

High density apple orchards where either the M-26 or M-9 clonal rootstock is used with any of the highly susceptible cultivars (Gala, Fuji, Braeburn, Rome, Jonathan, Ida Red, Ginger Gold, Jonagold, etc.) are at high risk for significant tree losses from fire blight when cankers develop on the rootstock. Even a few blossom or shoot blight strikes on the scion variety provide sufficient bacteria that then move rapidly through the heathy tree stem (i.e., without causing visible damage or symptoms) into the root where they initiate cankers that expand quickly, killing the entire trees within one to several months. Rootstock infections can also occur where Red Delicious, a normal blight resistant scion, develops trauma blight symptoms following hail or wind damage. Some rootstock infections also occur with the M-7A rootstock, but these are never as aggressive as those on M-26 and M-9 and seldom completely girdle and kill trees.

While it is impossible to totally eradicate fire blight to the extent that it no longer occurs, there are a number of tactics that, if followed rigorously, can reduce the frequency of serious outbreaks and provide more consistent and cost-effective control. Because fire blight develops in different phases, the strategies and tactics needed for control also are different (see Table 12).

Table 12. Aggressive Fire Blight Management

Timing	Tactics and basis for treatment
Dormant season	Thorough pruning to remove all blighted limbs and shoots every year reduces the number and distribution of canker sites available the following spring. Complete removal of severely damaged trees and replanting may be more cost-effective than retraining and allowing potential inoculum sources to remain.
Pre-bloom period	Include a copper formulation with the oil at green tip; later copper applications may damage foliage and fruit. Treat entire orchard blocks, not just susceptible varieties. The purpose of this treatment is to prevent or reduce the colonization of tree surfaces by the bacteria before bloom. Full block treatments are necessary since the bacteria also colonize resistant varieties from which the bacteria then can be dispersed to susceptible varieties during bloom.
Bloom period	Apply streptomycin (plus surfactant) just before an anticipated infection event when infection risk is moderate to high. Treat again in 4 days of high risk conditions persist. Do not exceed four antibiotics sprays per year. Make blossom treatments strictly on whether an infection event is expected or has occurred, not on how severe that event might be. The fire blight forecasting program, MARYBLYT™ can aid in these decisions. A Windows-compatible version, MARYBLYT v.7.1, is now available for free download at *http://grapepathology.org/maryblyt.*Consider applying Apogee to reduce the threat of shoot blight on vigorous trees of susceptible varieties that have nearly filled their tree space. The ideal timing of application for this purpose is at late bloom when active shoot growth is 1-3 inches long.
Postbloom through bud set	Control sucking insect pests to reduce the incidence of shoot blight. Monitor orchards closely for early blight symptoms and remove these promptly before extensive necrosis develops. Use the "ugly stub" method for blight removal. Several cutting tours may be needed to limit the number and distribution of inoculum sources for shoot blight and subsequent canker formation. Do not use streptomycin after symptoms develop or to control shoot blight since it is not effective and increases the risk for developing resistance. Avoid extensive cutting that may stimulate vegetative replacement growth and lengthen the period of shoot blight susceptibility. Shoot blight susceptibility of vigorous trees may be reduced by additional Apogee applications if shoot growth resumes in mid-season.
Late season	Although the risk for infection during the late season is relatively low, severe weather storms can still trigger a trauma blight incident, especially if blight has occurred earlier in the season. Late-season shoot blight seldom causes severe damage and is often ignored. These strikes, however, should be cut out promptly.

Streptomycin treatments and resistance. The antibiotic, streptomycin, works best in limiting the multiplication of bacteria, not in killing large populations. Also, only those blossoms open at the time of the application are protected against infection. Thus, it is most effective when it is applied as a thorough coverage spray (either low volume or high volume when coverage is adequate throughout the tree) just before an anticipated infection event. The addition of an activator-type surfactant (Regulaid, Ortho X-77, Widespread, LI-700, etc.) will improve coverage and penetration of the flower structure, especially the nectaries where most infections occur. Once treated, an open blossom is protected until petal fall when it becomes naturally resistant. Sprays applied too late are not effective in stopping infections already in progress, and those applied too early afford no protection for new flowers opening after treatment. Because thorough coverage is required, these treatments should not be made on an alternate row middle basis as is commonly done for other diseases and insect pests. Streptomycin is not effective in preventing shoot blight and should not be used for that purpose.

Resistance to streptomycin has been reported from many locations in the U.S.. In nearly all cases, however, such resistance has developed only where six or more sprays are used per year. Where growers have routinely limited the number of sprays to four or less, the product appears to remain effective even after 20-30 years use. Because of the manor in which streptomycin resistance develops in a population is should not be used repeatedly after symptoms first appear since this is more likely to encourage the selection of resistant strains.

Using Apogee to manage shoot blight. The plant growth regulator, Apogee (prohexadione-calcium), is a new tool for management of shoot blight that may reduce the threat of development of resistance to streptomycin. Apogee causes shoots to start hardening off beginning about 10 days after application, resulting in reduced susceptibility to shoot tip infection. For shoot blight suppression, Apogee should be applied at late bloom when active shoot growth is 1-3 inches long. Recent studies at Winchester indicate that Apogee may be safely tank-mixed with Agri-Mycin and Regulaid, allowing Apogee to take effect while there is residual protection from streptomycin. Registered rates for Apogee are 6-12 oz/ 100 gal dilute or 24-48 oz/acre. To reduce interference from naturally occurring calcium in the water used for spraying, ammonium sulfate should be added to the tank **before** Apogee, at the same rate per 100 gal of spray mix as for Apogee. Based on research at Winchester, the combination of 6 oz of Apogee plus 6 oz of ammonium sulfate per 100 gal is suggested for moderately vigorous trees. An adjuvant such as Regulaid should be included to increase systemic uptake of Apogee. (Further testing may indicate the suitability of other water conditioners). Vigorous trees might be more responsive to the 12 oz Apogee rate than to the 6 oz rate.

Because shoot blight suppression is related to early hardening off and continued suppression of shoot tip growth, vigorous trees might benefit from additional Apogee applications if shoot growth is resumed in mid-season. Studies in WV showed that Apogee reduced shoot blight infections that occurred with hail injury in June. Apogee should not be expected to provide a satisfactory growth response in time to be beneficial when applied after hail injury has occurred. However, it might be possible to predict its usefulness for shoot blight suppression if the year is marked by frequent Maryblyt™ infection periods during bloom and the potential threat of severe shoot tip infection under high secondary inoculum conditions. Apogee is not to be considered a replacement for streptomycin sprays for blossom blight control. Other situations in which Apogee should be most beneficial include vigorous trees and susceptible varieties. Apogee treatment for shoot blight suppression would be most strongly suggested for vigorous young trees that have nearly filled their tree space. Apogee must be further tested to determine whether its application will reduce the progression of fire blight bacteria into the rootstock.

Cutting out active fire blight strikes. Cutting out fire blight strikes while an epidemic is in progress is often controversial. Where symptoms of fire blight are severe and widespread, extensive cutting should not be done except as a salvage effort to limit the invasion of the central tree structure. Where outbreaks of fire blight are light to moderate or are limited to isolated areas within a larger orchard, however, the prompt removal of all blighted tissues can be beneficial. Recent research on both apples and pears indicates that sterilizing pruning tools prior to each cut is not useful because the bacteria often are present internally in mature bark well in advance of symptom margins. Cutting shoots or limbs to remove symptoms appears to breach the natural defense mechanisms active in mature tissues so that a small canker then develops around the cut stub. For this reason, if cuts are make back to the next healthy branch union, as is usually recommended, the small canker that forms will remain in place and provide inoculum for the following season. By making the cut into at least 2-year-old wood and leaving a 3- to 4-inch, naked, "ugly stub", however, the stub and its small tip canker can then be removed safely and completely during the dormant pruning operation so that cankers are not left in the trees.

PHYTOPHTHORA COLLAR ROT

In Virginia and West Virginia, Phytophthora collar rot is the major root/crown disease of apple. The fungus causes a canker with dead bark in the root or crown area. Typically, the canker begins on the roots and advances up the trunk, usually stopping near the graft union unless the scion is highly susceptible. In some cases laboratory isolation of the *Phytophthora* fungus can provide a positive diagnosis but this is not always possible. Wherever girdling-type symptoms are observed, several other potential causes should also be considered. These include voles, borers in burr knots, mechanical injury, graft union necrosis on Red Delicious on MM.106 roots, and fireblight on M.26 or M.9 roots.

Phytophthora growth and infection are facilitated by water. The fungus produces a zoospore that can swim in a film of water to sites of infection on the crown and roots, and is thus favored by heavy, poorly drained soils.

The likelihood of collar rot occurrence can be reduced by several cultural practices:

1. Although most rootstocks can be infected in poor situations, MM.106 and M.26 are considered very susceptible.
2. Avoid wet sites and heavy clay soils. Improve subsurface drainage.
3. Some drainage problems can be associated with planting method. Do not plant a tree more than 2-3 inches deeper than it grew in the nursery. With auger planting, avoid drilling the hole too deep, resulting in a waterlogged hole and deep planting. Cross-drainage may help to drain low spots in the furrow left by a tree planter.
4. Check nursery stock for root lesions.
5. Provide tree support as needed early in the life of the tree to reduce root and crown injury from wind rocking.

Cultural practices may be supplemented with chemical control. Materials registered for bearing trees include cupric hydroxide (Kocide), mefenoxam (Ridomil Gold EC), and Aliette WDG. Options for non-bearing orchard trees are Kocide, Ridomil 2E or Ridomil 5G, Ridomil Gold EC, and fosetyl-Al (Aliette 80WDG). Aliette 80WDG is also registered as a pre-plant root dip treatment. Check the labels for up-to-date registration and application instructions.

Pears

Chemical effectiveness rating: E = excellent, G = good

DORMANT SPRAY : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Fireblight	G	Copper:		
		C-O-C-S 50WDG	2-4 lb	-
		Kocide DF	2-4 lb	-
		Bordeaux mixture (copper sulfate + agricultural spray lime) 325 mesh[1]	8 lb + 8 lb	- -
		Various formulations	See label	

[1] See page 28 for mixing instructions for Bordeaux. Caution: Suggested where fireblight was difficult to control during previous year. DO NOT APPLY AFTER GREEN IS SHOWING.

DORMANT-GREEN TIP SPRAY : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Pear psylla (PP)[1]	E = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	1. Superior oil	2 gal	6 gal
		2. Asana XL or Adjourn 0.66EC	3 fl oz	9 fl oz
		3. Perm-UP 3.2EC or Pounce 3.2EC	-	12-16 fl oz
		4. Perm-UP 25DF	-	12.8-17.6 oz
		5. Surround WP	-	25 lb
		6. Danitol 2.4EC	-	16-21 fl oz
		7. Warrior 1CS, Lambda-Cy 1EC, Silencer 1EC, or Warrior 2CS	-	2.6-5.1 fl oz or 1.3-2.5 fl oz
		8. Declare 1.25CS or Proaxis 0.5CS	-	1.02-2.05 fl oz or 2.6-5.1 fl oz
		9. Esteem 35WP	-	5 oz
		10. Dimilin 2L	-	40-48 fl oz
		11. Mustang Maxx 0.8EC	-	4 fl oz
		12. Sivanto Prime	-	10.5-13 fl oz

[1] Examine buds with hand lens. Apply first spray when tiny yellow oval eggs are found - usually at bud swell. The addition of Superior oil to any of the insecticides above will increase their effectiveness.

GREEN CLUSTER BUD SPRAY : Insects

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Scab Leaf spot	E = 1, 2, E = 1, 2, 3	1. Topsin-M 70W Mancozeb 75DF	4 oz + 1 lb	1 lb + 3 lb
		2. Topsin-M 70W Ziram 76DF	4 oz + 1 lb	1 lb + 3 lb
		3. Ziram 76DF	1.5 lb	6 lb

GREEN CLUSTER BUD SPRAY : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Pear psylla (PP)	E = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 16, 17, 18 G = 14	1. Superior oil	2 gal	6 gal
		2. Asana XL or Adjourn 0.66 EC	3 fl oz	9 fl oz
		3. Perm-UP 3.2EC or Pounce 3.2EC	-	12-16 fl oz
San Jose Scale (SJS)	E = 10, 11	4. Perm-UP 25DF	-	12.8-17.6 oz
Tarnished plant bug (TPB)[1]	E = 2, 3, 4, 6, 7, 8, 12, 13, 14, 16 G = 5, 15	5. Surround WP	-	25 lb
		6. Danitol 2.4EC	-	16-21 fl oz
Climbing cutworms (CC)[2]	E = 2, 3, 4, 6, 7, 8, 12, 14, 16, 18	7. Warrior 1CS, Lambda 1EC, Silencer 1EC, or Warrior 2CS	-	2.6-5.1 fl oz or 1.3-2.5 fl oz
		8. Declare 1.25CS or Proaxis 0.5CS	-	1.02-2.05 fl oz or 2.6-5.1 fl oz
		9. Assail 30SG	-	8 oz
		10. Esteem 35WP	-	5 oz
		11. Centaur 70WDG		34.5-46.0 oz
		12. Baythroid XL 1EC or Tombstone 2EC	-	2.0-2.8 fl oz
		13. Dimilin 2L	-	40-48 fl oz
		14. Mustang Maxx 0.8EC	-	4 fl oz
		15. Beleaf 50SG	-	2-2.8 oz
		16. Bifenture 2EC or Brigade 2EC	-	2.6-12.8 fl oz
		17. Sivanto Prime	-	10.5-13 fl oz
		18. [3]Verdepryn	-	5.5-11 fl oz

[1] Monitor appearance of TPB by jarring tree limbs over a sheet placed on the ground; TPB will fall from limbs to sheet.
[2] CC feed in trees at night and hide in ground cover during the day.
[3] Use 11 fl oz for pear psylla.

WHITE BUD (POPCORN) SPRAY : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Scab	E = 1, 2, 3, 5	1. Topsin-M 70W Mancozeb 75DF	4 oz + 1 lb	1 lb + 3 lb
Leaf spot	E = 1, 2, 3	2. Topsin-M 70W Ziram 76DF	4 oz + 1 lb	1 lb + 3 lb
Fireblight[1]	G = 4	3. Ziram 76DF	1.5 lb	6 lb
		4. Streptomycin	6.5 oz (80 ppm)	1.5 lb
		5. [2]Inspire Super 2.82 EW	-	12 fl oz

[1] CAUTION: FIREBLIGHT. The conditions favorable for fireblight include all of the following: (1) open blossoms and succulent young growth; (2) a temperature of 65°F or higher; and (3) rainfall, or a relative humidity of 60% or higher. Apply the first streptomycin spray just before the earliest blossoms open and repeat at 5-day intervals until petals on latest blossoms have fallen. If streptomycin is applied alone, the rate may be reduced to 60 ppm (5 oz/100 gal dilute; 15 oz/A concentrate). The effectiveness of streptomycin can be increased by including the adjuvant Regulaid at the rate of 1 pint per 100 gal of tank mix. Apply streptomycin in at least 50 gallons of water per acre.
[2] Do not apply more than 60 fl oz per acre per year. Do not apply more than two sequential applications before rotating to a different mode of action and no more than four applications per season. Do not apply within 14 days of harvest

WHITE BUD (POPCORN) SPRAY : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Pear psylla (PP)	E = 1, 2, 3, 4, 5, 6, 7, 8, 13, 14, 15, 16, 18, 20, 21 G = 9	1. [1]Asana XL or Adjourn 0.66 EC	3 fl oz	9 fl oz
		2. [1]Perm-UP 3.2EC or Pounce 3.2EC	-	12-16 fl oz
Tarnished plant bug (TPB)	E = 1, 2, 3, 5, 6, 7, 14, 16, 18, 20 G = 4, 17	3. Perm-UP 25DF	-	12.8-17.6 oz
		4. Surround WP	-	25 lb
		5. [1]Danitol 2.4EC	-	16-21 fl oz
Green fruitworms (GFW)	E = 1, 2, 3, 5, 6, 7, 14, 16, 18, 20, 21	6. [1]Warrior 1CS, Lambda-Cy 1EC, Silencer 1EC, or Warrior 2CS	-	2.6-5.1 fl oz or 1.3-2.5 fl oz
Mites (ERM)	E = 11, 12, 19, 20 G = 5, 10	7. Declare 1.25CS or Proaxis 0.5CS	-	1.02-2.05 fl oz or 2.6-5.1 fl oz
		8. Assail 30SG	-	8.0 oz
		9. Imidan 70WSB	1 lb	3.5 lb
		10. Vendex 50W	6 oz	18 oz
		11. [2]Apollo 42SC	-	4-8 fl oz
		12. [2]Savey 50DF or Onager Optek	-	3-6 oz or 12-24 fl oz
		13. Esteem 35WP	-	5 oz
		14. Baythroid XL 1EC or Tombstone 2EC	-	2.0-2.8 fl oz
		15. Dimilin 2L	-	40.0-48.0 fl oz
		16. Mustang Maxx 0.8EC	-	4 fl oz
		17. Beleaf 50SG	-	2-2.8 oz
		18. Bifenture 2EC or Brigade 2EC	-	2.6-12.8 fl oz
		19. Nealta	-	13.7 fl oz
		20. Gladiator	-	19 fl oz
		21. [3]Verdepryn	-	5.5-11 fl oz

[1] Pyrethroids may be applied no more than twice during the prebloom period. Monitor ERM closely postbloom because these products are highly toxic to predators of ERM.
[2] Apply only once per season, when eggs or young mites are present.
[3] Use 11 fl oz for pear psylla.

BLOOM SPRAY

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Scab	E = 1, 2, 3, 5	1. Topsin-M 70W Mancozeb 75DF	4 oz + 1 lb	1 lb + 3 lb
Leaf spot	E = 1, 2, 3	2. Topsin-M 70W Ziram 76DF	4 oz + 1 lb	1 lb + 3 lb
Fireblight[1]	G = 4	3. Ziram 76DF	1.5 lb	6 lb
		4. Streptomycin	6.5 oz (80 ppm)	1.5 lb
		5. [2]Inspire Super 2.82 EW	-	12 fl oz

[1] CAUTION: See cautions about fireblight control under white bud spray.
[2] Do not apply more than 60 fl oz per acre per year. Do not apply more than two sequential applications before rotating to a different mode of action and no more than four applications per season. Do not apply within 14 days of harvest.

WARNING - DO NOT APPLY INSECTICIDES DURING BLOOM.

PETAL FALL, FIRST THROUGH FIFTH COVER SPRAYS : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Scab	E = 2, 6, 7, 9	2. Topsin-M 70W [2]Ziram 76DF	4 oz + 1 lb	1 lb + 3 lb
Leaf spot	E = 8 G = 2, 4	4. [2]Ziram 76DF	1.5 lb	6 lb
		5. Streptomycin	6.5 oz (80 ppm)	1.5 lb
Fireblight[1]	G = 5	6. [3]Flint 50WG	-	2.-2.5 oz
		7. [3]Sovran 50WG	1.0-1.6 oz	4.0-6.4 oz
Sooty blotch and fly speck	E = 6, 7, 8	8. [3]Pristine 38WG	-	14.5 oz
		9. [4]Inspire Super 2.82EW	-	12 fl oz

[1] CAUTION: See cautions about fireblight control under white bud spray. Do not apply streptomycin closer than 30 days to harvest. Use of more than four streptomycin sprays per year may lead to streptomycin-resistant fireblight bacteria.
[2] Do not apply more than 42.4 lb per acre per year of Ziram 76DF.
[3] Limit the number of applications of Pristine, Flint and Sovran and similar modes of action to four per year. Do not make more than two sequential applications of Pristine before alternating to a fungicide with another mode of action.
[4] Do not apply more than 60 fl oz per acre per year. Do not apply more than two sequential applications before rotating to a different mode of action and no more than four applications per season. Do not apply within 14 days of harvest

PETAL FALL, FIRST THROUGH FIFTH COVER SPRAYS : Insects

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Pear psylla (PP)[1]	E = 1, 2, 9, 10, 11, 18, 23, 25, 27, 31 G = 4, 12, 21, 26, 30	1. Surround WP	-	25 lb
		2. Assail 30SG	-	5.5-8.0 oz
		3. Nealta	-	13.7 fl oz
Tarnished plant bug (TPB)	E = 14, 28 G = 1, 21, 22	4. Imidan 70WSB	1 lb	3.5 lb
		5. Exirel	-	8.5-17 fl oz
		6. Vendex 50W	6 oz	18 oz
Stink bugs (SB)[5]	E = 14, 28 G = 1, 21, 22	7. [2]Apollo 42SC	-	4-8 fl oz
		8. [2]Savey 50DF or Onager Optek	-	3-6 oz or 12-24 fl oz
Mites (ERM/TSM)	E = 3, 7, 8, 10, 11, 17, 18, 19, 20, 25 G = 6, 16, 29	9. Esteem 35WP	-	5 oz
		10. [3]Agri-Mek or Abba 0.15EC, or Agri-Mek 0.8SC	2.5-5 fl oz or 0.5-1.0 fl oz	10-20 fl oz or 2.25-4.25 fl oz
Plum curculio (PC)	E = 4, 13 G = 1, 2, 14, 21, 25, 27, 30	11. [4]Nexter 75WP	-	4.4-10.7 oz
		12. [7]Admire Pro or Alias 4F	2.8-7.0 fl oz or 5 fl oz	20 fl oz or 8 fl oz
Codling moth (CM)	E = 4, 5, 23, 24, 27, 28, 31 G = 2, 9, 13, 15, 32	13. Avaunt eVo 30DG	-	5-6 oz
		14. Bifenture 2EC or Brigade 2EC	-	2.6-12.8 fl oz
Oriental fruit moth (OFM)	E = 4, 5, 15, 23, 24, 27, 28, 31 G = 2, 13, 21, 32 (Madex, Virosoft)	15. [6]Mating disruption	See labels	See labels
		16. Acramite 50WS or Banter SC	-	12-16 oz
		17. Zeal 72WDG	-	2-3 oz
		18. Portal 5EC	10 fl oz	2 pt
		19. Kanemite 15SC	-	31 fl oz
		20. Envidor 2SC	-	16-18 fl oz
		21. [7]Belay 2.13SC	-	6-12 fl oz
		22. Beleaf 50SG	-	2-2.8 oz
		23. Delegate 25WG	-	4.5-7 oz
		24. Altacor eVo 70WDG	-	1.3-2.2 oz
		25. [7]Agri-Flex	1.5-2 fl oz	5.5-8.5 fl oz
		26. [8]Movento 2SC	-	6-9 fl oz
		27. [9]Voliam Flexi 40WG	-	4-7 oz
		28. Besiege	-	6-12 fl oz
		29. Magister SC	-	32-36 fl oz
		30. [9]Apta	-	21-27 fl oz
		31. [1]Verdepryn	-	5.5-11 fl oz
		32. CM virus	-	1-6 fl oz (Cyd-X) 0.5-3 fl oz (Cyd-X HP, Madex; CM and OFM 1.6-3.2 fl oz (Virosoft)

PETAL FALL, FIRST THROUGH FIFTH COVER SPRAYS : Insects

[1] For Verdepryn, use 11 fl oz. If PP is a problem, alternating insecticides with differing modes of action will slow development of resistance. If PP is not a problem, reduce insecticide rates for PP by 25%.
[2] Apply only once per season, when eggs or young mites are present.
[3] See comments on p. 38.
[4] Use higher rates for PP and TSM.
[5] The rates relate to native stink bugs. For recommendations regarding BMSB, see footnote 9, Apple Second Cover.
[6] Mating disruption for CM and OFM should be initiated at petal fall. See mating disruption note on page 44.
[7] Consider withholding until after first cover, in order to protect pollinators.
[8] Movento should not be applied after second cover. Movento must be applied with a horticultural oil or a non-ionic spreading an penetrating adjuvant (not a sticker).
[9] Apta is highly toxic to bees. Do not use until after petal fall.

Peaches and Nectarines

DORMANT SPRAY : Diseases

Chemical effectiveness rating: E = excellent, G = good, F = fair

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Leaf curl[1]	E = 1, 2, 4, 5, 6 G = 3	1. Ferbam 76WDG	2-3 lb	-
		2. Liquid lime sulfur	4 gal	-
		3. [3]Copper sulfate (25%Cu) + hydrated lime	2 lb + 4 lb	-
		4. [2]Bravo 720 (or equivalent a.i. of other formulation)	16-22 fl oz	3.1-4.1 pt
		5. [3]Basic Copper (50% Cu)	4.0 lb	-
		6. Ziram 76DF	2 lb	-

[1] CAUTION: Thorough coverage is essential for leaf curl control. Apply when there is little or no wind and use dilute sprays only. May be applied in the fall after 90% of the leaves have fallen or in the spring before the buds swell. If leaf curl has been severe or difficult to control, use the higher rate per 100 gal of dilute spray. In those peach and nectarine orchards where leaf curl was severe during the previous year, a fall and spring application of either of the above fungicides would be advisable until the leaf curl problem has been corrected. According to the label, both spring and fall applications of Bravo may be made for control of leaf curl. Thorough coverage of each bud is necessary for leaf curl control.
Do not combine liquid lime sulfur with oil.
[2] The above dilute rate for Bravo 720 is for 300 gal/A.
[3] NOTE: Treatments with copper compounds are suggested where bacterial spot has been a problem.

DORMANT SPRAY[1] : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
San Jose Scale (SJS)	E = 1, 2, 3 G = 4	1. Superior oil	2 gal	-
		2. Esteem 35W	-	4-5 oz
Mite eggs (ERM)	E = 1	3. Centaur 70WDG	-	34.5 oz
		4. Sivanto Prime	-	10.5-14 fl oz

[1] A dilute application is recommended for effective control.

PINK SPRAY : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Brown rot blossom blight	E = 7, 8, 11, 12, 13, 14, 15 G = 4, 9, 10	4. [1]Bravo 720 (or equivalent a.i. of other formulation)	16-22 fl oz	3.1-4.1 pt
		7. [2]Topsin-M 70W + Captan 50W	4-6 oz + 1-2 lb	12-18 oz + 3-4 lb
		8. [2]Topsin-M 70W + Sulfur 95W	4-6 oz + 4-6 lb	12-18 oz + 12-15 lb
		9. Captan 50W	2 lb	5 lb
		10. Sulfur 95W	6 lb	15 lb
		11. Rovral 50W	-	2 lb
		12. Rally 40WSP	1.25-2.0 oz	2.5-6.0 oz
		13. Tilt 3.6E	-	4 fl oz
		14. Indar 2F	-	6 fl oz
		15. Elite 45WP	2 oz	5 oz

[1] NOTE: The above concentrate rate for Bravo 720 is for trees 20 ft. or shorter. For taller trees, use 4.1-5.5 pt/A.
[2] CAUTION: A strain of brown rot resistant to the benzimidazole fungicide Topsin-M is present in some areas of Virginia. To reduce the threat of resistance to Topsin-M, it should be used only in combination with other (non-benzimidazole) fungicides. If resistance is suspected, submit a brown rot sample to Virginia Tech AREC, Winchester, Virginia and switch to a different fungicide program until the fungus has been tested for sensitivity.

PINK SPRAY : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Tarnished plant bug (TPB)	E = 3, 4, 5, 6, 7, 9, 10, G = 2, 11, 12, 15	1. Sivanto Prime	-	7.0-14.0 fl oz
		2. [2]Lannate 90SP or Lannate LV	4 oz -	1 lb 3 pt
Green peach aphid (GPA)[1]	E = 1, 11, 12, 14 G = 2	3. Asana XL or Adjourn 0.66EC	3 fl oz	8 fl oz
Oriental fruit moth (OFM)	E = 8	4. Perm-UP 25DF	-	6.4-17.6 oz
		5. Pounce 3.2EC or Perm-UP 3.2EC	-	4-10 fl oz
		6. Warrior 1CS, Lambda-Cy 1EC, Silencer 1EC, or Warrior 2CS	-	2.6-5.1 fl oz or 1.3-2.5 fl oz
		7. Declare 1.25CS or Proaxis 0.5CS	-	1.02-2.05 fl oz or 2.6-5.1 fl oz
		8. [3]Mating disruption	See label	
		9. Baythroid XL 1EC or Tombstone 2EC	-	2.0-2.8 fl oz
		10. Mustang Maxx 0.8EC	-	1.3-4 fl oz
		11. Beleaf 50SG	-	2-2.8 oz
		12. [4]Assail 30SG	-	2.5-8 oz
		13. Danitol 2.4EC	-	10.7-21.3 fl oz
		14. Versys	-	1.5 fl oz
		15. Bifenture 2EC or Brigade 2EC	-	2.6-12.8 fl oz

[1] In most years, control of GPA is not required before petal fall; however, lower small (half inch) leaves should be checked carefully for the presence of immigrating adults or newly deposited nymphs. If GPA are found commence the aphid treatment.
[2] Use only on peaches at this time.
[3] See notes on mating disruption products, page 44.
[4] Use lower rate for GPA.

BLOOM PERIOD SPRAY

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Brown rot blossom blight	E = 2, 3, 6, 7, 8, 9, 10, 11 G = 1, 4, 5	1. [1]Bravo 720	16-22 fl oz	3.1-4.1 pt
		(or equivalent a.i. of other formulations)		
		2. [2]Topsin-M 70W + Captan 50W	4-6 oz + 1-2 lb	12-16 oz + 3-4 lb
		3. [2]Topsin-M 70W + Sulfur 95W	4-10 oz + 4-6 lb	12-32 oz + 12-15 lb
		4. Captan 50W	2 lb	5 lb
		5. Sulfur 95W	6 lb	15 lb
		6. Rovral 50W	-	2 lb
		7. Rally 40WSP	1.25-2.0 oz	2.5-6.0 oz
		8. Tilt 3.6E	-	4 fl oz
		9. Indar 2F	-	6 fl oz
		10. Elite 45WP	2 oz	5 oz
		11. Vangard 75WG	-	5 oz

[1] NOTE: The above concentrate rate for Bravo 720 is for trees 20 ft or shorter. For taller trees, use 4.1-5.5 pt/A.
[2] See caution about Topsin-M under pink spray.

INSECTS: Do not apply insecticides during bloom.

PETAL FALL SPRAY : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Brown rot	E = 2, 3, 6, 7, 8, 9, 10 G = 1, 4, 5	1. [1]Bravo 720	16-22 fl oz	3.1-4.1 pt
		(or equivalent a.i. of other formulation)		
Scab	E = 1, 10 G = 2, 3, 4, 5, 8	2. [2]Topsin-M 70W + Captan 50W	4-6 oz + 1-2 lb	12-18 oz + 3-4 lb
Rusty Spot	E = 6, 8, 10	3. [2]Topsin-M 70W + Sulfur 95W	4-6 oz + 4-6 lb	12-18 oz + 12-15 lb
		4. Captan 50W	2 lb	5 lb
		5. Sulfur 95W	6 lb	15 lb
		6. Rally 40WSP	1.25-2.0 oz	2.5-6.0 oz
		7. Tilt 3.6E	-	4 fl oz
		8. Indar 2F	-	6 fl oz
		9. Elite 45WP	2.0 oz	5 oz
		10. Inspire Super	-	1 pt

[1] NOTE: The above concentrate rate for Bravo 720 is for trees 20 ft or shorter. For taller trees use 4.1-5.5 pt/A.
[2] CAUTION: See caution about Topsin-M under pink spray. Do not apply Bravo 720 after shuck split stage. In nectarine plantings where scab has been destructive, apply four sprays at weekly intervals.

PETAL FALL SPRAY : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Tarnished plant bug (TPB)	E = 2, 3, 4, 5, 7, 8,10, 12 G = 1, 9, 13, 17, 20	1. [1]Lannate 90SP or Lannate LV	4 oz -	1 lb 3 pt
		2. Asana XL or Adjourn 0.66EC	3 fl oz	8 fl oz
Stink bugs (SB)[5]	E = 2, 3, 4, 5, 7, 8, 10, 12, 20 G = 1, 9, 13, 17	3. Perm-UP 25DF	-	6.4-17.6 oz
		4. Pounce 3.2EC or Perm-UP 3.2EC	-	4-10 fl oz
Green peach aphid (GPA)	E = 13, 16, 17, 18, 19 G = 1, 6	5. Warrior 1CS, Lambda-Cy 1EC, Silencer 1EC, or Warrior 2CS	-	2.6- 5.1 fl oz or 1.3-2.5 fl oz
Plum curculio (PC)	E = 9, 14 G = 2, 3, 4, 5, 6, 7, 8, 10, 12, 20	6. Apta	-	21.0-27.0 fl oz
		7. Declare 1.25CS or Proaxis 0.5EC	-	1.02-2.05 fl oz or 2.6-5.1 fl oz
Western flower thrips (WFT)[2]	E = 11, 15 G = 1	8. Baythroid XL 1EC or Tombstone 2EC	-	2.4-2.8 fl oz
		9. Imidan 70WSB	12-16 oz	2.12-4.25 lb
		10. Danitol 2.4EC	-	10.7-21.3 fl oz
		11. Entrust 2SC	-	4-8 fl oz
		12. Mustang Maxx 0.8C	-	1.3-4 fl oz
		13. Beleaf 50SG	-	2-2.8 oz
		14. Avaunt eVo 30DG	-	5-6 oz
		15. Delegate 25WG	-	4.5-7 oz
		16. [3]Movento 2SC	-	6-9 fl oz
		17. [4]Assail 30SG	-	2.5-8 oz
		18. Sivanto Prime	-	7-14 fl oz
		19. Versys	-	1.5 fl oz
		20. Bifenture 2EC or Brigade 2EC	-	2.6-12.8 fl oz

[1] 24(c) label for thrips in nectarines in Virginia.
[2] Control WFT now if scarring has been a problem.
[3] Movento must be applied with a horticultural oil or a non-ionic spreading and penetrating adjuvant (not a sticker).
[4] Use 2.5-5.3 oz/A for GPA; 5.3-8.0 oz/A for TPB, SB, and PC.
[5] These ratings relate to native stink bugs. For recommendations regarding BMSB, see footnote 9, Apple Second Cover.

SHUCK SPLIT, SHUCK FALL SPRAYS[1] : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Scab	E = 18, 19 G = 7, 8, 9, 10, 14	4. Bravo 720	16-22 fl oz	3.1- 4.1 pt
		7. Topsin-M 70W + Captan 50W	4-6 oz + 1-2 lb	12-18 oz + 3-4 lb
Brown rot	E = 7, 8, 14, 19 G = 9, 10	8. Topsin-M 70W + Sulfur 95W	4-6 oz + 4-6 lb	12-18 oz + 12-15 lb
Rusty Spot	E = 12, 14, 19 G = 8, 18 F = 7, 10	9. Captan 50W	2 lb	5 lb
		10. Sulfur 95W	6 lb	15 lb
		12. Rally 40WSP	1.25-2.0 oz	2.5-6.0 oz
		14. Indar 2F	-	6 fl oz
		18. Gem 25WG	-	4-8 oz
		19. Inspire Super	-	1 pt

[1] CAUTION: Do not apply Bravo after shuck-split stage. Do not extend intervals between cover sprays more than 14 days. Where scab has been a serious problem, see petal fall spray for more effective combinations.

SHUCK SPLIT, SHUCK FALL SPRAYS[1] : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Tarnished plant bug (TPB)	G = 1, 4, 7, 12, 14, 18, 21	1. [2]Lannate 90SP or Lannate LV	4 oz -	1 lb 3 pt
Stink bugs (SB)[6]	E = 21 G = 1, 4, 7, 12, 14	2. Apta	-	21.0-27.0 fl oz
		3. Exirel	-	8.5-17.0 fl oz
Green peach aphid (GPA)	E = 7, 11, 12, 13, 17, 18, 21 G = 1, 2	4. Imidan 70WSB	12-16 oz	2.12-4.25 lb
		5. [3]Isomate PTB-Dual	not a spray	See label for dispenser rate
Plum curculio (PC)	E = 4, 8 G = 2, 21	6. Intrepid 2F	-	12-16 fl oz
		7. Beleaf 50SG	-	2-2.8 oz
Oriental fruit moth (OFM)	E = 1, 3, 4, 9, 10, 14, 19 G = 6, 12, 20, 21	8. Avaunt eVo 30DG	-	5-6 oz
		9. Delegate 25WG	-	4.5-7 oz
Lesser peachtree borer	E = 5	10. Altacor eVo 70WDG	-	1.5-2.2 oz
White peach scale	E = 15, 16 G = 11, 17	11. [4]Movento 2SC	-	6-9 fl oz
		12. [5]Assail 30SG	-	2.5-8 oz
		13. Versys	-	1.5 fl oz
		14. Besiege	-	6-12 fl oz
		15. Esteem 35W	-	4-5 fl oz
		16. Centaur 70WDG	-	34.5 oz
		17. Sivanto Prime	-	7-14 fl oz
		18. Closer 2SC	-	1.5-2.75 fl oz
		19. Verdepryn	-	5.5-11 fl oz
		20. CM Virus (Madex HP, Virosoft)	-	0.5-3 fl oz
		21. Bifenture 2EC or Brigade 2EC	-	2.6-12.8 fl oz

[1] CAUTION: Applications at both shuck split and shuck fall are important to prevent catfacing injury.
[2] Residual life of this material is short; extend effectiveness by combining with 1/2 rate of 4. 24(c) label for nectarines in Virginia.
[3] Isomate PTB-Dual pheromone dispensers targeting LPTB should be placed before first flight at 150-250/A. Be sure to read note on p. 44. This formulation of Isomate is also effective against PTB.
[4] Movento must be applied with a horticultural oil or a non-ionic spreading and penetrating adjuvant (not a sticker).
[5] Use 2.5-5.3 oz/A for GPA; 5.3-8.0 oz/A for TPB, SB, PC and OFM.
[6] These ratings relate to native stink bugs. For recommendations regarding BMSB, see footnote 9, Apple Second Cover.

FIRST COVER SPRAY[1] : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Scab	E = 7, 8 G = 1, 2, 3, 4, 6	1. Topsin-M 70W + Captan 50W	4-6 oz + 1-2 lb	12-18 oz + 3-4 lb
Brown rot	E = 1, 2, 6, 8 G = 3, 4	2. Topsin-M 70W + Sulfur 95W	4-6 oz + 4-6 lb	12-18 oz + 12-15 lb
Rusty spot	E = 5, 6, 8 G = 2, 7 F = 1, 4	3. Captan 50W	2 lb	5 lb
		4. Sulfur 95W	6 lb	15 lb
		5. Rally 40WSP	1.25-2.0 oz	2.5-6.0 oz
		6. Indar 2F	-	6 oz
		7. Gem 25WG	-	4-8 oz
		8. Inspire Super	-	1pt

[1] CAUTION: Do not extend intervals between cover sprays more than 14 days. Where scab has been a serious problem, see petal fall spray for more effective combinations. Do not apply Bravo after shuck-split stage.

FIRST COVER SPRAY : Insects

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Tarnished plant bug (TPB)	E = 2, 3, 4, 5, 6, 7, 13, 19, 20, 22, 23, 27 G = 1, 8, 15, 17, 21	1. [1]Lannate 90SP or Lannate LV	4 oz -	1 lb 3 pt
		2. Asana XL or Adjourn 066EC	3 fl oz	8 fl oz
Stink bugs (SB)[7]	E = 2, 3, 4, 5, 6, 7, 13, 19, 20, 22, 27 G = 1, 8, 15, 17, 23	3. Perm-UP 25DF	-	6.4-17.6 oz
		4. Pounce 3.2EC or Perm-UP 3.2EC	-	4-10 fl oz
Oriental fruit moth (OFM)	E = 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 13, 14, 16, 18, 19, 20, 24, 25, 27 G = 9, 12, 17, 22, 23, 36	5. Warrior 1CS, Lambda-Cy 1EC, Silencer 1EC, or Warrior 2CS	-	2.6-5.1 fl oz or 1.3-2.5 fl oz
Periodical cicada (C)[2]	E = 2, 3, 4, 5, 6, 7, 13, 19, 20, 22, 23 G = 1, 11, 12, 17	6. Declare 1.25CS or Proaxis 0.5CS	-	1.02-2.05 fl oz or 2.6-5.1 fl oz
		7. Baythroid XL 1EC Tombstone 2EC	-	2.4-2.8 fl oz
Lesser peachtree borer adults (LPTB)[3]	G = 2, 3, 4, 5, 6, 7, 13, 19, 20, 22, 23	8. Imidan 70WSB	12-16 oz	2.12-4.25 lb
		9. Intrepid 2F	-	12-16 fl oz
		10. [5]Mating disruption	-	See labels
		11. [4]Sevin XLR PLUS	2 pt	5 pt
		12. Sevin 50W	2 lb	5 lb
		13. Mustang Maxx 0.8EC	-	1.3-4 fl oz
		14. Delegate 25WG	-	4.5-7 oz
		15. Beleaf 50SG	-	2-2.8 oz
		16. Altacor eVo 70WDG	-	1.5-2.2 oz
		17. Assail 30SG	-	5.3-8 oz
		18. Voliam Flexi 40WG	-	4-7 oz
		19. Besiege	-	6-12 fl oz
		20. Danitol 2.4EC	-	10.7 fl oz
		21. [6]Belay 2.13SC	-	6 fl oz
		22. Endigo ZC	-	5-6 fl oz
		23. [8]Leverage 360	-	2.8 fl oz
		24. Exirel	-	8.5-17.0 fl oz
		25. Verdepryn	-	5.5-11 fl oz
		26. CM Virus (Madex, Virosoft)	-	3 fl oz
		27. Bifenture 2EC or Brigade 2EC	-	2.6-12.8 fl oz

[1] Residual life of this material is short; extend effectiveness by combining with 1/2 rate of 8. For nectarines by 24(c) label in Virginia.
[2] Cicada immigration from unsprayed areas necessitates frequent applications for effective control. See maps, Fig. 2, for location and year of cicada occurrence.
[3] Pyrethroids give good control of adults. Monitor with pheromone trap for proper timing. Mites can be expected to increase if pyrethroids are used at this time. Monitor them closely. If adults are not controlled now, other recommendations for larval control are given under second cover spray.
[4] Sevin XLR PLUS is safer for honey bees, mainly when used in concentrate sprays of 25 gallons per acre (1:39 dilution ratio). However some additional bee safety over Sevin 50W is obtained when applied in more dilute sprays.
[5] Mating disruption for OFM should be applied before first flight of second generation (Figure 3). Be sure to read note regarding mating disruption products on p. 44.
[6] Registered only for use in peach.
[7] These ratings relate to native stink bugs. For recommendations regarding BMSB, see footnote 9, Apple Second Cover.
[8] Use only once per season.

SECOND COVER SPRAY[1] : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Scab	E = 7, 8 G = 1, 2, 3, 4, 6	1. Topsin-M 70W + Captan 50W	4-6 oz + 1-2 lb	12-18 oz + 3-4 lb
Brown rot	E = 1, 2, 6, 8 G = 3, 4	2. Topsin-M 70W + Sulfur 95W	4-6 oz + 4-6 lb	12-18 oz + 12-15 lb
Rusty spot	E = 5, 6, 8 G = 2, 7 F = 1, 4	3. Captan 50W	2 lb	5 lb
		4. Sulfur 95W	6 lb	15 lb
		5. Rally 40WSP	1.25-2.0 oz	2.5-6.0 oz
		6. Indar 2F	-	6 fl oz
		7. Gem 25WG	-	4-8 oz
		8. Inspire Super	-	1 pt

[1] CAUTION: Do not extend intervals between cover sprays more than 14 days. Where scab has been a serious problem, see petal fall spray for more effective combinations.

SECOND COVER SPRAY : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Stink bugs (SB)[2]	E = 16 G = 1, 2, 7, 8, 9, 10, 11, 12	1. [1]Lannate 90SP or Lannate LV	4 oz -	1 lb 3 pt
Oriental fruit moth (OFM)	E = 1, 2, 4, 5, 6, 13, 14 G = 3, 7, 15, 16	2. Imidan 70WSB	12-16 oz	2.12-4.25 lb
		3. Intrepid 2F	-	12-16 fl oz
		4. CheckMate OFM-F	-	1.3-2.9 fl oz
		5. Delegate 25WG	-	4.5-7 oz
		6. Altacor eVo 70WDG	-	1.5-2.2 oz
		7. Assail 30SG	-	5.3-8 oz
		8. Danitol 2.4EC	-	10.66-21.3 fl oz
		9. Perm-UP 3.2EC	-	4-10 fl oz
		10. Endigo ZC	-	5-6 fl oz
		11. [3]Belay 2.13 SC	-	6 fl oz
		12. [4]Leverage 360	-	2.8 fl oz
		13. Exirel	-	8.5-17 fl oz
		14. Verdepryn	-	5.5-11 fl oz
		15. CM Virus (Madex, Virosoft)	-	0.5-3 fl oz
		16. Bifenture 2EC or Brigade 2EC	-	2.6-12.8 fl oz

[1] Available for nectarines by 24(c) label in Virginia.
[2] These ratings relate to native stink bugs. For recommendations regarding BMSB, see footnote 9, Apple Second Cover.
[3] Registered only for use on peach.
[4] Use only once per season.

THIRD COVER SPRAY[1] : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Brown rot[2]	E = 1, 2, 6, 7 G = 3, 4	1. Topsin-M 70W + Captan 50W	4-6 oz + 1-2 lb	12-18 oz + 3-4 lb
Rusty spot	E = 5, 6, 7 G = 2 F = 1, 4	2. Topsin-M 70W + Sulfur 95W	4-6 oz + 4-6 lb	12-18 oz + 12-15 lb
		3. Captan 50W	2 lb	5 lb
		4. Sulfur 95W	6 lb	15 lb
		5. Rally 40WSP	1.25-2.0 oz	2.5-6.0 oz
		6. Indar 2F	-	6 fl oz
		7. Inspire Super	-	1 pt

[1] Do not extend intervals between cover sprays more than 14 days.
[2] Fungicide applications for brown rot control are not required for green fruit after the pit-hardening stage. Resume fungicide applications as fruit begin to color or as weather favorable for brown rot development occurs.

THIRD COVER SPRAY : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Stink bugs (SB)[4]	E = 25 G = 1, 2, 13, 15, 16, 18, 19, 20, 21	1. [1]Lannate 90SP or Lannate LV	4 oz -	1 lb 3 pt
		2. Imidan 70WSB	12-16 oz	2.12-4.25 lb
Oriental fruit moth (OFM)	E = 1, 2, 3, 4, 6, 9, 11, 12, 16, 19, 23 G = 5, 13, 20, 24, 25	3. Voliam Flexi 40WG	-	4-7 oz
		4. Entrust 2SC	-	4-8 fl oz
Leafrollers (RBLR,VLR,TBM)	E = 1, 3, 4, 5, 9, 11, 12, 23 G = 2	5. Intrepid 2F	-	12-16 fl oz
		6. [3]CheckMate OFM-F	-	1.3-2.9 fl oz
Mites (ERM)	E = 7, 8, 14, 17 G = 10, 22	7. [2]Apollo 42SC	-	4-8 fl oz
		8. [2]Savey 50DF or Onager 1EC	-	3-6 oz or 12-24 fl oz
		9. Exirel	-	8.5-17 fl oz
		10. Vendex 50W	6 oz	1 lb
		11. Delegate 25WG	-	4.5-7 oz
		12. Altacor eVo 70WDG	-	1.5-2.2 oz
		13. Assail 30SG	-	5.3-8 oz
		14. Zeal 72WDG	-	2-3 oz
		15. Danitol 2.4EC	-	10.66-21.3 fl oz
		16. Perm-UP 3.2EC	-	4-10 fl oz
		17. Portal 5EC	-	2 pt
		18. Endigo ZC	-	5-6 fl oz
		19. Besiege	-	6-12 fl oz
		20. [5]Belay 2.13 SC	-	6 fl oz
		21. [6]Leverage 360	-	2.8 fl oz
		22. Magister SC	-	32-36 fl oz
		23. Verdepryn	-	5.5-11 fl oz
		24. CM Virus (Madex, Virosoft)	-	0.5-3 fl oz
		25. Bifenture 2EC or Brigade 2EC		2.6-12.8 fl oz

THIRD COVER SPRAY : Insects

[1] For nectarines by 24(c) label in Virginia.
[2] Mites are less important on peach than apple. Apply at a time before mites are most damaging. These materials should best be considered in blocks where other acaricides have failed to give adequate control.
[3] See note on mating disruption products, page 44.
[4] These ratings relate to native stink bugs. For recommendations regarding BMSB, see footnote 9, Apple Second Cover.
[5] Registered for use only on peach.
[6] Use only once per season.

FOURTH AND FIFTH COVER SPRAYS[1] : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Brown rot	E = 1, 2 G = 3, 4	1. Topsin-M 70W + Captan 50W	4-6 oz + 1-2 lb	12-18 oz + 3-4 lb
		2. Topsin-M 70W + Sulfur 95W	4-6 oz + 4-6 lb	12-18 oz + 12-15 lb
		3. Captan 50W	2 lb	5 lb
		4. Sulfur 95W	6 lb	15 lb

[1] Do not exceed 14-day intervals between cover sprays. Consult pre-harvest spray intervals (Table 25) for early-maturing cultivars.

FOURTH AND FIFTH COVER SPRAYS: Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Stink bugs (SB)[4]	E = 30 G = 1, 2, 3, 16, 18, 19, 22, 23, 24	1. [1]Lannate 90SP or Lannate LV	4 oz -	1 lb 3 pt
		2. Imidan 70WSB	12-16 oz	2.12-4.25 lb
Plum curculio (PC)	E = 2, 13 G = 20, 25, 30	3. Voliam Flexi 1.25SC	-	6-12 fl oz
		4. Entrust 2SC	-	4-8 fl oz
Western flower thrips (WFT)	E = 4, 14 G = 1, 16	5. Intrepid 2F	-	12-16 fl oz
		6. CheckMate OFM-F	-	1.3-2.9 fl oz
Oriental fruit moth (OFM)	E = 1, 2, 3, 4, 6, 14, 15, 20, 26, 28 G = 5, 7, 8, 16, 29	7. [2]Sevin XLR PLUS	2 pt	5 pt
		8. [2]Sevin 50W	2 lb	5 lb
Leafrollers (RBLR,VLR,TABM)	E = 1, 3, 4, 5, 14, 15, 26, 28 G = 2	9. Vendex 50W	6 oz	1 lb
		10. [3]Nexter SC	-	7.5-17 fl oz
		11. Acramite 50WS	-	12-16 oz
Japanese beetle (JB)	E = 7, 8, 19, 20, 28 G = 1, 16, 30	12. Envidor 2SC	-	16-18 fl oz
		13. Avaunt 30DG	-	5-6 oz
Cicada (C)	E = 18, 19, 26 G = 1, 7, 8, 16	14. Delegate 25WG	-	4.5-7 oz
		15. Altacor eVo 70WDG	-	1.5-2.2 oz
Mites (ERM,TSM)	E = 10, 12, 17, 23 G = 9, 11, 27	16. Assail 30SG	-	5.3-8 oz
		17. Zeal 72WDG	-	2-3 oz
		18. Danitol 2.4EC	-	10.66-21.3 fl oz
		19. Pounce 3.2EC or Perm-UP 3.2EC	-	4-10 fl oz
		20. Exirel	-	8.5-17.0 fl oz
		21. Portal 5EC	-	2 pt
		22. Endigo ZC	-	5-6 fl oz
		23. [5]Venom 70SG	-	4 oz
		24. [5]Scorpion 35SL	-	7 fl oz
		25. Apta	-	21.0-27.0 fl oz
		26. Besiege	-	6-12 fl oz
		27. Magister SC	-	32-36 fl oz

FOURTH AND FIFTH COVER SPRAYS: Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
		28. Verdepryn	-	5.5-11 fl oz
		29. CM Virus (Madex, Virosoft)	-	0.5-3 fl oz
		30. Bifenture 2EC or Brigade 2EC	-	2.6-12.8 fl oz

[1] Available for nectarines by 24(c) label in Virginia.
[2] Sevin application is likely to result in an increase in mites. Eliminate blooming weeds in order to protect bees. See note 11 on Sevin XLR PLUS on p. 71.
[3] Use the higher rate range for TSM.
[4] These ratings relate to native stink bugs. For recommendations regarding BMSB, see footnote 9, Apple Second Cover.
[5] Highest rate on Section 3 label may not provide adequate protection against BMSB.

PRE-HARVEST SPRAYS[1]

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Brown rot	E = 1, 8, 4, 5, 6, 8 G = 3, 7	1. Topsin-M 70W + Captan 50W	4-6 oz 1-2 lb	12-18 oz + 3-4 lb
Rhizopus rot		2. Topsin-M 70W + Sulfur 95W	4-6 oz + 4-6 lb	12-18 oz + 12-15 lb
		3. [2]Captan 50W	2 lb	5 lb
		4. [3]Tilt 3.6E	-	4 fl oz
		5. [4]Indar 2F	-	6 fl oz
		6. [5]Elite 45WP	2.0 oz	5 oz
		7. Elevate 50WDG	-	1.0-1.5 lb
		8. [6]Pristine 38 WDG	-	10.5- 14.5 oz

[1] Starting two to three weeks before harvest, shorten the spray interval to 7-10 days. Where a range of rates is presented, use the higher rates under heavier disease pressure (rot present or rainy, humid weather).
[2] IF FRUIT IS TO BE SHIPPED TO CANADA, DO NOT APPLY CAPTAN CLOSER TO HARVEST THAN 2 DAYS. The residue tolerance for Captan in Canada is 5 ppm.
[3] Do not exceed two applications of Tilt in the pre-harvest period.
[4] Do not apply more than 48 fl oz per acre per year of Indar 2F.
[5] Do not apply more than 3 lb of Elite per acre per year.
[6] Do not make more than two sequential applications of Pristine before alternating to a fungicide with another mode of action.

HARVESTED FRUIT TREATMENT[1]

Diseases	Fungicide	Rate per 100 Gal
Brown rot Rhizopus rot	Scholar 50W or 1.92SC, EZ	8-16 oz (see label for specific information on application methods, mixtures, etc.) or 16 fl oz of SC. See label for thermal fogging instructions for Scholar EZ.

[1] Do not make more than one post-harvest application to the fruit by any application method.
CAUTION: Flush and clean the hydrocooler daily. With the losses of postharvest uses of Benlate, Topsin-M and Botran, there is increased interest in the use of chlorine as a postharvest hydrocooler treatment for stone fruits. The main value of chlorine is to kill viable spores of brown rot and other fungi to reduce the likelihood of serious infection in the hydrocooler water. Although chlorine kills fungal spores in the hydrocooler, it provides no residual fungicidal activity. Several registered chlorine-generating materials are available as calcium hypochlorite or sodium hypochlorite. Use only products which are registered for the desired use and use according to the label. Carefully monitor the concentration and maintain a “dirt-free” hydrocooler because chlorine is quickly de-activated by particulate matter. Because chlorine is pH sensitive, water must be monitored frequently and adjusted to neutral pH. Even with these factors controlled, chlorine lacks residual activity for protecting bruised fruit.
As with any new practice or product, caution is advised. Some possible drawbacks to chlorine use are: 1) it is corrosive to metal, 2) it is sensitive to pH (monitor water pH and chlorine concentration regularly), 3) chlorine concentration must be recharged frequently, and 4) although it is effective for killing fungal spores in water, it does not protect wounded tissue against subsequent infection from spores lodged in the wound.

FALL PRE-DORMANT SPRAY

Treatments with copper compounds are suggested where bacterial spot and leaf curl have been problems Apply at early leaf drop to protect the leaf abscission scars from fall infection and subsequent overwintering twig infection. Use label rate of copper material. A copper material applied in the fall is usually also adequate for leaf-curl control.

Figure 3. Peach Insect Life Cycles

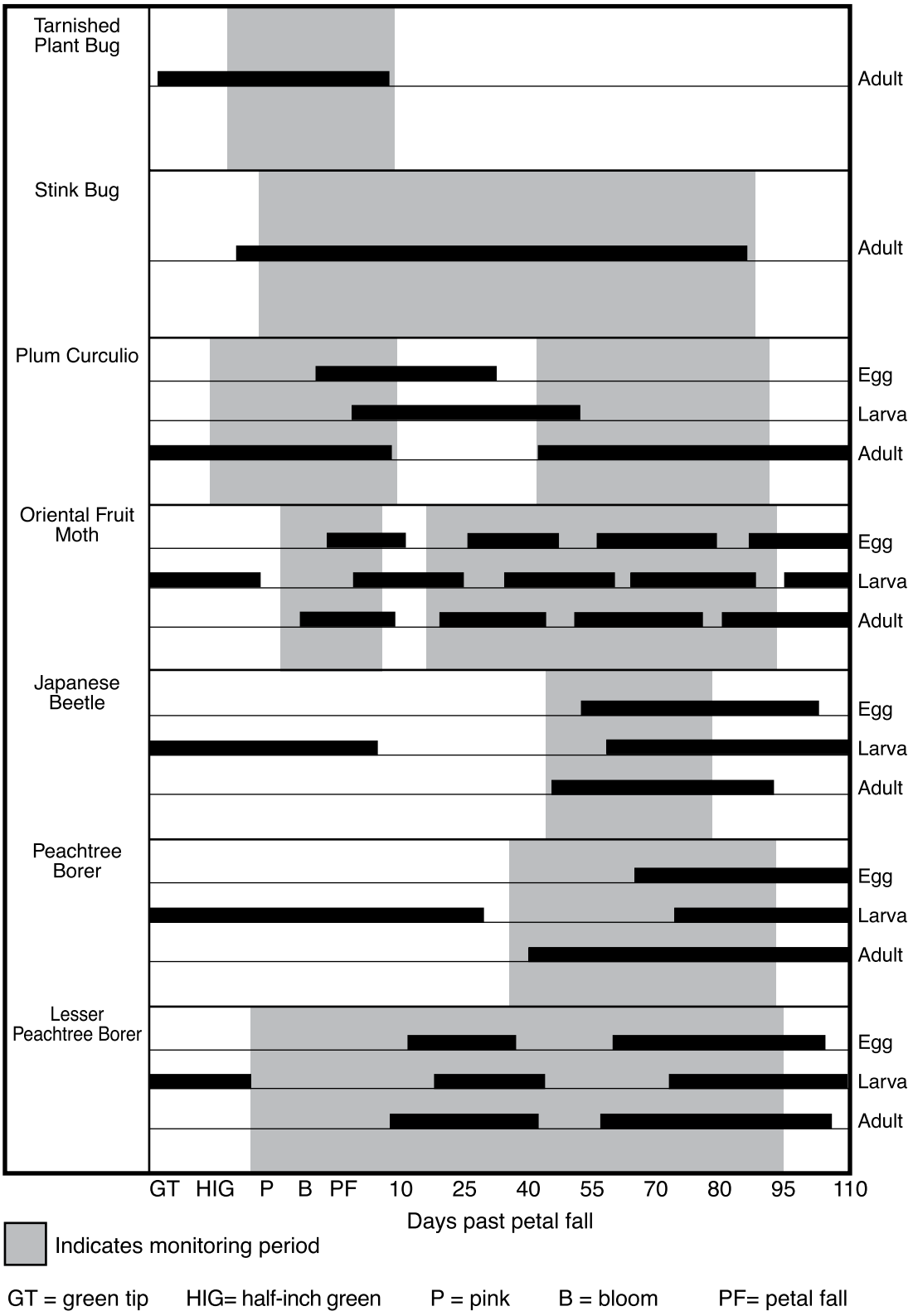


Table 13. Seasonal Activity of Peach Diseases

Infection periods (*); observable symptoms (S)

	Cytospora canker			brown rot		scab		rusty spot and powdery mildew	Rhizopus rot	bacterial spot
	new	old	leaf curl	blossoms & twigs	fruit	fruit	shoots			
dormant	*							S		
bud swell	* S		*					S		
pink	* S		*	*						
bloom	* S			* S						*
petal fall	* S		S	* S		*	*	*		*
shuck split	S		S	S		*	*	*		*
1st-3rd covers	S		S	S		*	*	* S		* S
4th-6th covers	S				* S	S		S		* S
preharvest					* S	S	* S	S	*	S
harvest					* S	S	* S	S	* S	S
after harvest	*									
fall	*						S			*

Note: Date for development of diseases may vary by several weeks from year to year. As it happened in 2017, the Mid-Atlantic region experienced an unusually warm February that influenced bud swelling and infection by Taphrina deformans (leaf curl) earlier than normal. Dormant fungicide application for peach leaf curl should be timed early with warm temperatures and always before bud swelling. Sometimes in an early spring, pruning brush is still in the orchard, and for this reason, fall application may be more suitable.

Supplementary Peach Disease Discussions

PEACH CANKER

Peach canker, also called Cytospora canker, perennial canker, or Valsa canker, is found primarily on peach and nectarine, although the causal fungus can also be found in cankers and twig dieback on plum, prune, sweet and sour cherry, wild black cherry and choke cherry, and apple. The fungus which causes peach canker enters the plant only through wounds or injuries. Practices which reduce the occurrence of injuries help reduce the frequency and severity of infection. All attempts to control peach canker must take place within the framework of an integrated crop management strategy. Managing the disease should be considered in all phases of orchard management from the establishment of new plantings to the care of bearing orchards. The present strategy of canker control is based on preventive measures designed to decrease winter injury and insect damage, to promote optimum plant health, and to facilitate rapid wound healing. As with other diseases, once canker becomes established within an orchard, it becomes increasingly difficult to control new infections. The following practices aid greatly in the prevention of peach canker:

1) Proper site selection. The site for the new orchard should have deep, well-drained soil and good air drainage to minimize the chances for winter injury. New plantings should be reasonably well-isolated from sources of disease inoculum. Young trees should not be planted adjacent to older, heavily infected blocks, and the downwind side of older blocks should be avoided. Interplanting young trees among older, diseased trees may appear economical, but the young trees planted in this way are at a much greater risk for developing cankers and having a shorter productive life than young trees planted in solid blocks.

2) Selection of cultivar and nursery stock. No commercial cultivar is resistant to peach canker. Only the hardier cultivars should be planted. Nursery stock should be disease free. Trees with small cankers on lateral branches may be planted if they are pruned so that at least 6 inches of healthy tissue below the canker is removed. Examine all trees closely and return the ones with obvious cankers to the nursery. Transplanting stress weakens trees and increases their susceptibility to disease. Trees should be carefully inspected after growth begins, and dead branches removed. Plant trees as soon as possible after receiving them from the nursery to avoid any additional stress. Avoid stock that is excessively large (greater than 11/16 inch) because the transplanting stress takes longer to overcome compared to smaller trees.

3) Orchard care. Many aspects of orchard care interact to form an integrated management system. For optimum control of peach canker, all the practices listed below should be followed:

   a) Nematode, insect, and disease control. Do not establish new trees in soils with high populations of plant pathogenic nematodes. Control oriental fruit moth and peach tree borers, even in the first few nonbearing years. Control brown rot to prevent twig infections which are often colonized by *Cytospora* spp.

   b) Train trees properly. Trees must be trained carefully during the first season so that branches develop wide crotch angles. Wide crotch angles are necessary for long orchard life. Narrow crotch angles are more susceptible to winter injury, borer attack, and breakage under heavy crop loads.

   c) Avoid rodent injury. Prevent rabbit and vole damage with plastic or wire guards. The guards should not be so high as to injure scaffold limbs when the tree sways in the wind. Plastic wrap-around guards should be removed each summer because they may delay hardening of the wood in late fall, they may harbor insects and interfere with trunk sprays for borer control. White latex paint mixed with Thiram also discourages rodent feeding and southwest injury.

   d) Prevent cold injury. Low-temperature injury is always a potential problem in our area. Certain cultural practices delay tissue maturation and thus promote increased susceptibility to early fall cold injury. Practices such as over-fertilization with nitrogen or late application of nitrogen fertilizer should be avoided. Trickle irrigation to maintain tree growth and fruit size also has the added benefit of making trees more resistant to *Cytospora* canker. Avoid postharvest water deficits but don't irrigate beyond September 1.

   e) Prune correctly and at the proper time. Infection at pruning cuts is less frequent when pruning is delayed until spring. Delay pruning until the first forecasts of warm, dry weather. Pruning should be well planned each year so that large cuts, which heal more slowly, will not be needed. When pruning side branches from larger limbs, the cut should be made just beyond the ridge of thickened bark where the smaller branch joins the larger limb. The branch bark ridge should not be removed or injured because it is the region where the most rapid and effective healing occurs. Avoid leaving stubs. Prune to open the center of the tree to light penetration because shaded branches are weakened and more susceptible to injury and infection. Remove all weakened and dead wood.

   f) Canker surgery. Cankers should be removed from the tree and burned, buried, or moved out of the orchard. Cankers on trunks and large limbs can be surgically removed in June or July when trees heal most rapidly. Surgery should be performed in dry weather with a forecast of dry conditions for at least three days. During surgery, remove all diseased bark around the canker and about 1-2 inches of healthy tissue from the sides and ends, respectively. The resulting wound when finished should have a smooth margin and be slightly rounded above and below to favor rapid wound closure.

   g) Tree wound paints or sealers. There is conflicting information regarding the use and effectiveness of these materials. They are mostly cosmetic and, unless mixed with fungicide, do not act directly to prevent infection by *Cytospora* spp. or decay-causing fungi. The drying of tissue is a normal part of wound healing. Some materials actually seal in moisture, thus providing an ideal environment for fungal infection. Sites of surgery in June or July heal best if left uncovered. If tree paints must be used, they should be free of acrylic resins because some of these compounds may injure plant tissue.

   h) Chemical control. Chemical control of the peach canker fungus is difficult. Fungicides applied for the control of leaf curl and brown rot blossom blight may provide some protection of fresh pruning cuts against infection by *Cytospora*.

   i) Tree fertilization. Nitrogen fertilizer, if needed, should be applied in late winter or early spring to avoid inducing late, cold-susceptible growth in the fall. Don't fertilize excessively. Foliage should show a healthy green color and terminal growth should be about 12 inches on bearing trees and 18 to 24 inches on nonbearing trees. Trees with pale, nitrogen-deficient leaves are also more susceptible to infection. Balance nitrogen with an adequate supply of potassium. Use leaf analysis to determine fertilizer requirements.

BROWN ROT

All stone fruit cultivars are susceptible to this fungal disease and, in some seasons, crop losses may be extensive. The brown rot fungus causes blossom blight, shoot dieback, twig cankers, and fruit rot. Infected blossoms wilt, shrivel, and die. As they turn brown, they often become affixed to the twig in a gummy mass and in wet weather, become covered with grayish-tan tufts of fungal spores.

Cankers form in either spring or fall depending upon whether the fungus entered the twig through an infected blossom or fruit. The canker appears as a brownish, sunken area, often covered with gum. In wet weather the canker supports tufts of spores similar to infected blossoms. Usually the tree is able to restrict twig cankers to small oval areas at the junction of the twig and the infected blossom or fruit. However, it is not uncommon for the fungus to girdle the twig and cause death to the shoot beyond the canker. Leaves on such twigs wilt, turn brown, and remain attached for 2 to 3 weeks or longer.

The first evidence of fruit rot is the appearance of a small, circular, brown spot on the ripening fruit. The spot increases rapidly in size and within a week, the entire fruit is infected. The infection produces a soft rot, though the skin occasionally remains firm. The surface of the fruit soon becomes covered with grayish-tan powdery spore masses. The infected fruit may hang in the tree or drop to the ground. Finally, the fruit shrivels and becomes a hard, grayish-black mummy that may drop or remain in the tree over winter.

The fungus survives over the winter in two ways: 1) in the mummified fruit hanging in the tree or on the ground beneath the tree; and 2) in the twig cankers resulting primarily from the previous season's rotted fruit. Two types of spores are produced in the spring. The more important of the two spore types (conidia) is produced on the surface of cankers, blighted twigs, and mummified fruit within the tree. The second spore type (ascospores), which is rare in our region, forms in small brownish cup-shaped structures about the size of a dime, called apothecia. Both spore types cause blossom infection and spores from infected blossoms may contribute to infections of ripening fruit later in the year.

Where blossom infection is carefully controlled, growers may find they still have a brown rot problem on their ripening fruit. Cultivar characteristics and orchard management practices influence the carryover of brown rot spores from spring to fruit maturity. Certain cultivars produce a proportion of stunted fruit which may shrivel and continue to hang within the tree. All the major cultivars examined to date produce some stunted or aborted fruit, and such fruit often become infected and produce spores throughout the summer. Winter injury to fruit buds also may result in the formation of nonabscised, aborted fruit.

Improper timing of fruit thinning can influence levels of carryover inoculum. For example, fruit thinned later than the pit hardening stage of development is susceptible to infection on the orchard floor; whereas fruit thinned earlier decomposes without becoming infected.

Sanitation is essential if your orchard is to be considered at low risk for a brown rot epidemic. Following the practices listed below should minimize spore populations of brown rot and limit the likelihood of an epidemic when conditions are favorable for rapid disease development.

1) Remove all remaining fruit from the tree after the final picking. This practice limits infection of fruit peduncles and twigs, thus reducing the number of brown rot cankers. In addition, this practice prevents overwintering mummies in the canopy, where they would be adjacent to susceptible blossoms in the spring.
2) Thin all cultivars prior to the pit-hardening stage of fruit development. Fruit thinned after pit hardening may serve as a source of brown rot later in the season. A fungicide cover spray, with one nozzle directed at the orchard floor, may help limit the production of spores from thinned fruits.
3) In spring, survey the orchard for blossom infection and prune out any cankers and infected shoots.
4) In spring, during the blossom period, examine the orchard floor for apothecia, the cup-shaped fungal structures that produce ascospores. Their presence should be considered a potential plant disease emergency. Blossoms should be thoroughly protected with fungicide sprays throughout the bloom period if apothecia are present.
5) Prune to avoid overcrowding of branches thereby increasing air circulation, promoting rapid drying, and increasing light and spray penetration.
6) Avoid dumping rotten fruit in one location, which could become the starting point for disease and insect outbreaks in the following season.

Fungicides are recommended generally in a protective program and are applied to blossoms and fruit prior to fungal infection. Infections of ripe peach fruit may take place within 6 hours during rainy periods at 77° F.

BACTERIAL SPOT

Bacterial spot causes severe defoliation and fruit spotting on susceptible peach, nectarine, prune, and plum varieties. The bacteria infect leaves, fruit, and young succulent shoots. The leaf lesions are small, angular, and often appear as brown to black spots. If the center of the lesion drops out, the margin of the lesion may have a reddish coloration. The disease is often worse at the tip of the leaf. Infected leaves usually turn yellow and drop prematurely, resulting in reduced fruit size in severe cases. Fruit infection early in the growing season may appear as deep pits or cracks. Late-season infections are more superficial and give the fruit a slightly checked or mottled appearance. Twig infections may result in small cankers.

The bacterial pathogen overwinters in cankers which are initiated in the fall at leaf scars. As cankers develop in the following spring, the bacteria ooze and are then spread by windblown rain to young leaves, fruit, or shoots. Periods of frequent rainfall with moderate temperatures and high winds favor infection. Extended periods of hot, dry weather reduce the threat of this disease.

Use of resistant varieties is the primary control method for bacterial spot. Where bacterial spot is a problem, copper materials should be applied at leaf drop to protect the leaf abscission scars from fall infection and subsequent overwintering twig cankers. Copper materials applied in the fall are usually adequate for leaf-curl control. Spray programs with oxytetracycline (Mycoshield, FireLine) may help suppress development of disease, although they do not eliminate it. Because of the cost and uncertainty of chemical control, resistant varieties are the best control option. Note that some recent introductions **(following, in bold)** are highly susceptible as reported in New Jersey. Relative susceptibility of some peach cultivars is as follows: **highly susceptible** — Blake, Jerseyland, Jersey Queen, **Klondike White, Snowfire, Snow Beauty, Snow Bride, Snow Giant, Snow King, Sugar Giant**, Suncrest, Suncling, Sunhigh, **Yukon King**; moderately susceptible — Babygold 5, J. H. Hale, Kalhaven, Raritan Rose, Rio-Oso-Gem, Spring Snow, White Lady; relatively resistant — Biscoe, Candor, Carolina Belle, Dixired, Jefferson, Loring, Madison, Manon, Redskin, Redhaven, Sunhaven.

Plums

Chemical effectiveness rating: E = excellent, G = good, F = fair

PREBLOOM SPRAYS : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Black knot	E = 1 F = 2	1. Topsin-M 70W + Captan 50W	4-6 oz + 1-2 lb	10-12 oz + 3-6 lb
Brown rot	E = 1 G = 2	2. Captan 50W	2 lb	4.5 lb

CAUTION: To reduce potential for development of thiophanate-methyl-resistant strains of brown rot and other fungi, these fungicides are recommended only in combination with captan or other fungicides with different modes of action. To achieve successful black knot control, all knots must be cut out of the tree and removed from the orchard or burned before the start of the growing season. Captan may cause injury on Japanese-type and Stanley plums in early season.

PREBLOOM SPRAYS[1] : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
San Jose scale (SJS)	E = 2, 3	1. Superior oil	2 gal	6 gal
Mite eggs (ERM)	E = 1	2. Esteem 35W	-	4-5 oz
		3. Centaur 70WDG	-	34.5 oz

[1] Control insects during the dormant or delayed-dormant period.

BLOOM SPRAY[1] : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Black knot	E = 1 F = 2	1. Topsin-M 70W + Captan 50W	4-6 oz + 1-2 lb	10-12 oz + 3-6 lb
Brown rot	E = 1 G = 2	2. Captan 50W	2 lb	4.5 lb

[1] CAUTION: Captan may cause injury on Japanese-type and Stanley plums in early season.

DO NOT APPLY INSECTICIDES DURING BLOOM

PETAL FALL SPRAY[1] : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Black knot	E = 1 F = 2	1. Topsin-M 70W + Captan 50W	4-6 oz + 1-2 lb	10-12 oz + 3-6 lb
Brown rot	E = 1 G = 2	2. Captan 50W	2 lb	4.5 lb

[1] CAUTION: Captan may cause injury on Japanese-type and Stanley plums in early season.

PETAL FALL SPRAY : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Plum curculio (PC)	E = 2, 7 G = 1	1. Apta	-	21.0-27.0 fl oz
		2. Imidan 70WSB	12-16 oz	2.12-4.25 lb
Mites (ERM/TSM)	E = 5, 6, 8, 9, 10 G = 3, 4	3. Vendex 50W	6 oz	1 lb
		4. Acramite 50WS or Banter SC	-	12-16 oz
		5. [1]Nexter SC	-	7.5-17 fl oz
		6. Envidor 2SC	-	16-18 fl oz
		7. Avaunt eVo 30DG	-	5-6 oz
		8. Zeal 72WDG	-	2-3 oz
		9. [2]Agri-Mek or Abba 0.15EC, or Agri-Mek 0.8SC	- -	10-20 fl oz or 2.25-4.25 fl oz
		10. Portal 5EC	-	2 pt

[1] Use higher rate for TSM.
[2] Use with a horticultural oil with a minimum of 1 gal/A.

SHUCK SPLIT, SHUCK FALL SPRAYS : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Black knot	E = 1 F = 2	1. Topsin-M 70W + Captan 50W	4-6 oz + 1-2 lb	10-12 oz + 3-6 lb
Brown rot	E = 1 G = 2	2. [1]Captan 50W	2 lb	4.5 lb

[1] CAUTION: Captan may cause injury on Japanese-type and Stanley plums in early season.

SHUCK SPLIT, SHUCK FALL SPRAYS : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Plum curculio (PC)	E = 2, 7 G = 1	1. Apta	-	21.0-27.0 fl oz
		2. Imidan 70WSB	12-16 oz	2.12-4.25 lb
Mites (ERM/TSM)	E = 5, 6, 8, 9, 10 G = 3, 4	3. Vendex 50W	6 oz	1 lb
		4. Acramite 50WS or Banter SC	-	12-16 oz
		5. [1]Nexter SC	-	7.5-17 fl oz
		6. Envidor 2SC	-	16-18 fl oz
		7. Avaunt eVo 30DG	-	5-6 oz
		8. Zeal 72WDG	-	2-3 oz
		9. Agri-Mek or Abba 0.15EC, or Agri-Mek 0.8SC	-	10-20 fl oz or 2.25-4.25 fl oz
		10. Portal 5EC	-	2 pt

[1] Use higher rate for TSM.

FIRST COVER SPRAY : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Black knot	E = 1 F = 2	1. Topsin-M 70W + Captan 50W	4-6 oz + 1-2 lb	10-12 oz + 3-6 lb
Brown rot	E = 1 G = 2	2. Captan 50W	2 lb	4.5 lb

FIRST COVER SPRAY : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Plum curculio (PC)	E = 2, 7 G = 1, 10	1. Actara 25WG	-	4.5-5.5 oz
		2. Imidan 70WSB	12-16 oz	2.12-4.25 lb
Mites (ERM/TSM)	E = 5, 6, 8, 9 G = 3, 4	3. Vendex 50W	6 oz	1 lb
		4. Acramite 50WS or Banter SC	-	12-16 oz
		5. [1]Nexter SC	-	7.5-17 fl oz
		6. Envidor 2SC	-	16-18 fl oz
		7. Avaunt eVo 30DG	-	5-6 oz
		8. Zeal 72WDG	-	2-3 oz
		9. Portal 5EC	-	2 pt
		10. Apta	-	21.0-27.0 fl oz

[1] Use higher rate for TSM.

SECOND AND THIRD COVER SPRAYS[1] : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Black knot	E = 1 F = 2	1. Topsin-M 70W + Captan 50W	4-6 oz + 1-2 lb	10-12 oz + 3-6 lb
Brown rot	E = 3, 4, 5 G = 2	2. Captan 50W	2 lb	4.5 lb
		3. [2]Tilt	-	4 fl oz
		4. [3]Pristine 38WDG	-	10.5- 14.5 oz
		5. Indar 2F	-	6 fl oz

[1] Additional sprays may be required during harvest if brown rot is prevalent or the harvest period is prolonged.
[2] Tilt is not to be used on plums to be dried and prepared as prunes.
[3] Do not make more than two sequential applications of Pristine before alternating to a fungicide with another mode of action.

SECOND AND THIRD COVER SPRAYS : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Japanese beetle (JB)	E = 4, 5 G = 6	1. Acramite 50WS or Banter SC	-	12-16 oz
Cicada (C)[1]	G = 5	2. [3]Nexter SC	-	7.5-17 fl oz
Mites (ERM/TSM)	E = 2, 7, 8 G = 1	3. Envidor 2SC	-	16-18 fl oz
		4. Sevin 50W	2 lb	5 lb
		5. [2]Sevin XLR PLUS	2 pt	5 pt
		6. Assail 30SG	-	5.3-8 oz
		7. Zeal 72WDG	-	2-3 oz
		8. Portal 5EC	-	2 pt

[1] See maps, Fig. 2, for location and year of cicada occurrence.
[2] See note 11 on Sevin XLR PLUS on p. 71.
[3] Use higher rate for TSM.

Cherries (Sweet and Sour)

Chemical effectiveness rating: E = excellent, G = good, F = fair

PREBLOOM SPRAY[1] : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Brown rot blossom blight	E = 1 G = 2, 3, 4	1. Topsin-M 70W + Captan 50W	6-8 oz + 1-2 lb	18-24 oz + 3-6 lb
Black knot	E = 1 F = 2	2. Captan 50W	2 lb	5 lb
		3. Bravo 720 (or equivalent a.i. of other formulation)	1-1.3 pt	3.1-5.5 pt
		4. Indar 2F	-	6 fl oz

[1] CAUTION: To reduce the potential for development of thiophanate-methyl resistant strains of brown rot and other fungi, these fungicides are recommended only in combination with captan or other fungicides with different modes of action.

INSECTS: No insects require control at this time.

PETAL FALL SPRAY : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Leaf spot	E = 1, 3, 4, 5 G = 2	1. Topsin-M 70W + Captan 50W	6-8 oz + 1-2 lb	18-24 oz + 3-6 lb
Mildew	E = 5 G = 1	2. Captan 50W	2 lb	5 lb
Black knot	E = 1	3. [1]Bravo 720 (or equivalent a.i. of other formulation)	1-1.3 pt	3.1-5.5 pt
Brown rot	E = 1, 4 G = 2, 3, 5	4. Indar 2F	-	6 fl oz
		5. Rally 40WSP	1.25-2.0 oz	2.5-6.0 oz

[1] Do not apply Bravo between shuck-split and harvest.

PETAL FALL SPRAY : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Plum curculio (PC)	E = 1, 5 G = 3, 9	1. [1]Imidan 70WSB	12 oz	2.12 lb
		2. Vendex 50W	6 oz	1 lb
Black cherry aphid (BCA)	E = 3, 6, 8, 9, 11	3. Apta	-	21-27 fl oz
		4. Envidor 2SC	-	16-18 fl oz
Mites (ERM/TSM)	E = 4, 10, 12, 13 G = 2, 7	5. Avaunt 30WDG	-	5-6 oz
		6. Beleaf 50SG	-	2-2.8 oz
		7. Acramite 50WS	-	12-16 oz
		8. Movento 2SC	-	6-9 fl oz
		9. Assail 30SG	-	2.5-5.3 oz
		10. Zeal 72WDG	-	2-3 oz
		11. Sivanto Prime	-	7-14 fl oz
		12. Portal 5EC	-	2 pt
		13. [2]Agri-Mek 0.15EC or 0.8SC	-	10-20 fl oz
		14. Versys	-	1.5 fl oz

[1] Do not apply Imidan on sweet cherries.

[2] Use with a horticultural oil at a minimum of 1 gal/acre.

SHUCK FALL SPRAY : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Leaf spot	E = 1, 4, 5 G = 2	1. Topsin-M 70W + Captan 50W	6-8 oz + 1-2 lb	18-24 oz + 3-6 lb
Mildew	E = 5 G = 1	2. Captan 50W	2 lb	5 lb
		4. Indar 2F	—	6 fl oz
Black knot	E = 1 F = 2	5. Rally 40WSP	1.25-2.0 oz	2.5-6.0 oz
Brown rot	E = 1, 4 G = 2, 5			

SHUCK FALL SPRAY : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Plum curculio (PC)	E = 2, 6 G = 4, 10	1. Portal 5EC	-	2 pt
		2. [1]Imidan 70WSB	12 oz	2.12 lb
Black cherry aphid (BCA)	E = 4, 7, 9, 10, 13, 14, 15	3. Vendex 50W	6 oz	1 lb
		4. Apta	-	21.0-27.0 fl oz
Mites (ERM/TSM)	E = 1, 5, 11, 12 G = 3, 8	5. Envidor 2SC	-	16-18 fl oz
		6. Avaunt eVo 30DG	-	5-6 oz
		7. Beleaf 50SG	-	2-2.8 oz
		8. Acramite 50WS or Banter SC	-	12-16 oz
		9. Movento 2SC	-	6-9 fl oz
		10. Assail 30SG	-	2.5-5.3 oz
		11. Zeal 72WDG	-	2-3 oz
		12. [2]Agri-Mek 0.15EC or 0.8SC	-	10-20 fl oz or 2.25-4.25 fl oz
		13. Sivanto Prime	-	7-14 fl oz
		14. Closer 2SC	-	1.5-2.75 fl oz
		15. Versys	-	1.5 fl oz

[1] Do not apply Imidan on sweet cherries.
[2] Use with a horticultural oil with a minimum of 1 gal/A.

FIRST COVER SPRAY : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Leaf spot	E = 1, 4, 5 G = 2	1. Topsin-M 70W + Captan 50W	6-8 oz + 1-2 lb	18-24 oz + 3-6 lb
Mildew	E = 5 G = 1	2. [1]Captan 50W	2 lb	5 lb
		4. Indar 2F	—	6 fl oz
Black knot	E = 1 F = 2	5. Rally 40WSP	1.25-2.0 oz	2.5-6.0 oz
Brown rot	E = 1, 4 G = 2, 5			

[1] CAUTION: Some sweet cherry cultivars such as Schmidt, Emperor Francis, and Giant may be sensitive to Captan.

FIRST COVER SPRAY : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Plum curculio (PC)	E = 2, 9 G = 1, 5, 13, 22	1. Exirel	-	13.5-20.5 fl oz
		2. [1]Imidan 70WSB	12 oz	2.1 lb
Black cherry aphid (BCA)	E = 4, 5, 10, 12, 13, 16, 20, 22, 23, 24	3. Vendex 50W	6 oz	1 lb
		4. Admire Pro or Alias 4F	- 2 fl oz	1.4-2.8 fl oz or 8-12 fl oz
Mites (ERM/TSM)	E = 6, 7, 8, 14, 21 G = 3, 11	5. [2]Actara 25WG	-	3.0-5.5 oz
Spotted wing drosophila (SWD)	E = 1, 2, 15, 16, 17, 18, 19	6. Envidor 2SC	-	16-18 fl oz
		7. Apollo 42SC	-	4-8 fl oz
		8. Savey 50DF or Onager 1EC	-	3-6 oz or 12-24 fl oz
		9. Avaunt eVo 30DG	-	5-6 oz
		10. Beleaf 50SG	-	2-2.8 oz
		11. Acramite 50WS or Banter SC	-	12-16 oz
		12. Movento 2SC	-	6-9 fl oz
		13. Assail 30SG	-	2.5-5.3 oz
		14. Zeal 72WDG	-	2-3 oz
		15. Delegate 25WG	-	4.5-7.0 oz
		16. Endigo ZC	-	5.0-5.5 fl oz
		17. Mustang Maxx	-	4 fl oz
		18. Danitol 2.4 EC	-	10.7-21.3 fl oz
		19. Asana XL	-	4.8-14.5 fl oz
		20. Sivanto Prime	-	7-14 fl oz
		21. Portal 5EC	-	2 pt
		22. Apta	-	21.0-27.0 fl oz
		23. Closer 2SC	-	1.5-2.75 fl oz
		24. Versys	-	1.5 fl oz

[1] Do not apply Imidan on sweet cherries.
[2] Use 3.0-4.0 oz/A for BCA; 4.5-5.5 oz/A for PC.

SECOND COVER SPRAY[1] : Diseases

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Leaf spot	E = 1, 4, 5 G = 2	1. Topsin-M 70W+ Captan 50W	6-8 oz + 1-2 lb	18-24 oz + 3-6 lb
Mildew	E = 5 G = 1	2. [1]Captan 50W	2 lb	5 lb
		4. Indar 2F	—	6 fl oz
Black knot	E = 1 F = 2	5. [2]Rally 40WSP	1.25-2.0 oz	2.5-6.0 oz
Brown rot	E = 1, 4, 5 G = 2			

[1] CAUTION: Some cultivars such as Schmidt, Emperor Francis and Giant may be sensitive to Captan.
[2] DO NOT APPLY RALLY WITHIN 7 DAYS OF HARVEST and NO MORE THAN 3.25 lb per acre per season. Do not apply more than 48 fl oz of Indar 2F per acre per year.

SECOND COVER SPRAY : Insects

Insects/Mites	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Cherry fruit flies (CFF)	E = 1 G = 3, 4, 6, 7, 9, 10, 12, 16	1. [2]Imidan 70WSB	12 oz	2.1 lb
		2. Vendex 50W	6 oz	1 lb
Japanese beetle (JB)	E = 6, 7 G = 10	3. Admire Pro or Alias 4F	- 2 fl oz	1.4-2.8 fl oz or 8-12 fl oz
		4. Actara 25WG	-	4.5-5.5 oz
Cicada (C)[1]	G = 6, 7, 10, 12	5. Envidor 2SC	-	16-18 fl oz
		6. Sevin 50W	2 lb	5 lb
Mites (ERM/TSM)	E = 5, 11, 15 G = 2, 8, 17	7. [3]Sevin XLR PLUS	2 pt	5 pt
		8. Acramite 50WS or Banter SC	-	12-16 oz
Spotted wing drosophila (SWD)	E = 1, 9, 12, 16 G = 13, 14	9. Delegate 25WG	-	4.5-7 oz
		10. Assail 30SG	-	5.3-8 oz
		11. Zeal 72WDG	-	2-3 oz
		12. Danitol 2.4EC	-	16-21.3 fl oz
		13. Malathion 57EC or Malathion 8F	-	1.5 pt 1.75 pt
		14. Entrust 2EC	-	4-8 fl oz
		15. Portal 5EC	-	2 pt
		16. Exirel	-	13.5-20.5 fl oz
		17. Magister SC	-	32-36 fl oz

[1] See maps (Fig. 2) for location and year of cicada occurrence.
[2] Do not apply Imidan on sweet cherries.
[3] See notes on Sevin XLR PLUS on pp. 71, 110.

PREHARVEST SPRAY[1]

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Leaf spot	E = 1, 8 G = 2	1. Topsin-M 70W+ Captan 50W	6-8 oz + 1-2 lb	18-24 oz + 3-6 lb
		2. Captan 50W	2 lb	5 lb
Brown rot	E = 1, 4, 8 G = 2, 7	4. Indar 2F	-	6 fl oz
		7. Elevate 50WDG	-	1.0-1.5 lb
Alternaria rot	E = 8 G = 2	8. [2]Pristine 38WDG	-	10.5-14.5 oz

[1] CAUTION: DO NOT APPLY TOPSIN-M WITHIN ONE DAY OF HARVEST. Apply additional sprays during harvest if necessary to provide protection against fruit rots where the harvest is prolonged or the trees are mixed cultivars. Some cultivars such as Schmidt, Emperor Francis, and Giant may be sensitive to Captan. Do not apply more than 48 fl oz of Indar 4F per acre per year.
[2] Do not make more than two sequential applications of Pristine before alternating to a fungicide with another mode of action.

POSTHARVEST SPRAY[1]

Disease	Effectiveness	Suggested Chemicals	100 Gal Dilute	Acre Concentrate
Leaf spot	E = 1, 2, 8 G = 4, 5, 9, 10	1. Syllit 3.4F	8 fl oz	1.5 pt
		2. Bravo 720 (or equivalent a.i. of other formulation	1-1.2 pt	3.1-5.5 pt
		4. Indar 2F	0.8-2 oz	6 fl oz
		5. Rally 40WSP	2-4 oz	2.5-6 oz
		8. Pristine 38 WDG	3.3-5.3 oz	10.5-14.5 oz
		9. Procure 50WS	2.6 oz	10-16 oz
		10. Elite 45WP		8 oz

[1] Apply postharvest sprays as needed to prevent defoliation from leaf spot. Heavy, early defoliation increases susceptibility to winter injury. In wet years, continue to control leaf spot up to 3 weeks after harvest with at least one or two sprays during the postharvest period. Seven-day intervals may be needed when conditions are wet. Ten-day intervals are satisfactory when the weather is less favorable. To manage leaf spot when lesions are visible and where defoliation may be severe, tank mix an SI material at the full rate + captan at the full rate and apply twice postharvest at 7-day intervals then make a third application of Pristine 7 to 10 days later.

CHEMICAL CONTROL OF WEEDS

Orchard Weed Control

Controlling weeds in the orchard is a cultural practice integrated with other practices in an overall management to obtain an optimum yield of quality fruit. An effective weed control program is the result of successfully integrating sound management strategies with the selection and application of the appropriate herbicide for specific weed problems throughout the life of the orchard.

The presence of weeds under young fruit trees decreases tree survival and growth and may result in reduced yields for several years. Grasses and broadleaf weeds effectively compete with young trees for moisture and nutrients, provide cover for rodents, harbor insects and disease organisms, and increase the risk of mechanical injury to trees from cultivation and mowing. Specific weeds may cause other management problems, such as the effect of dandelions on bee management in the spring and poison ivy and bramble interference with worker efficiency during harvesting.

Maximum benefits can be expected from maintaining a continuous weed-free zone beneath the tree canopy. Additional benefits may be realized by the establishment and maintenance of a permanent grass sod between the vegetation-free strips in the tree row. The grass sod will need an occasional postemergence herbicide treatment to control broadleaf weeds.

Application Equipment

Equipment for the application of herbicides in the orchard is relatively easy to calibrate and operate compared with other orchard sprayers. The objective in using this equipment is to obtain accurate placement of the correct herbicide dosage to obtain uniform control of the weeds without causing tree injury.

Although a sprayer unit may be built from individually purchased components, it is economically feasible and more convenient to purchase a system from a reputable equipment dealer. This will eliminate the uncertainty of component availability and possible incompatibility of the individual components. There are several tractor units available that can be mounted on a three-point hitch platform.

When looking for an appropriate sprayer, there are some basic qualifications to be considered in selecting suitable components.

PUMPS

Roller pumps and piston pumps are both suitable for herbicide application in the orchard. Roller pumps are more economical to purchase, but the abrasive nature of wettable powders may necessitate the replacement of the rollers on an annual basis. Positive displacement piston pumps are more expensive initially but require less maintenance and generally have a longer useful life. Regardless of the type selected, the pump capacity should be adequate to deliver a range of volumes of 30 to 60 gallons per acre (GPA) necessary for preemergence herbicide applications. These demands, plus an additional requirement for agitation, may be met by pumps with a capacity of approximately 8 to 10 gallons per minute. The higher capacity pump is necessary for the sprayer to be utilized for broadcast spraying of field crops.

AGITATION

Continuous agitation after the initial mixing of water-soluble herbicides, such as paraquat and glyphosate, is not necessary; but, all wettable powder and flowable formulations require continuous agitation to maintain the herbicides in suspension. Hydraulic (by-pass) agitation is generally adequate for relatively small (100 gal) vertically-mounted tanks; but, larger horizontally-mounted tanks should be equipped with mechanical agitation. If spraying operations are interrupted, suspended materials will settle in the bottom of the tank and will require vigorous agitation to re-establish the suspension before resumption of spraying.

PRESSURE, SPRAY VOLUME

Relatively low pressures (25 to 40 psi) are adequate and desirable for most herbicide applications in the orchard. Higher nozzle pressures increase the drift hazard and should be avoided. The potential for tree injury from drift is much greater when the spray mix includes glufosinate, glyphosate, fluroxypyr, paraquat, or 2,4-D.

Spray volumes within the range of 25 to 50 GPA are adequate for most preemergence herbicide applications. However, volumes of 40 to 60 GPA may be desirable to ensure thorough coverage when applying postemergence herbicides to rank weed growth. Glyphosate should be applied at lower spray volumes (less than 30 gallons per acre).

BOOMS

A rigid boom system is necessary for the application of herbicides to the orchard floor. Some means of adjusting the width of the treated band will be required when changing from younger trees to mature trees. This might be most easily accomplished by constructing a boom suitable for the maximum desired band width for mature trees. For younger plantings, use individual nozzle 'plugs' to reduce the width of the sprayed band. Remember that the sprayer should be re-calibrated whenever such changes are made. A 3-ft bandwidth is considered to be adequate for young tree-rows (1-3 yrs), whereas a 5-6 ft bandwidth is recommended for older tree-rows.

A handgun is often overlooked but necessary item of equipment in the applicator's inventory. Effective, postemergence spot treatments of weeds can be made most efficiently with a handgun. The handgun should have the capability of delivering a variable spray pattern to facilitate the treatment of either isolated clumps of weeds beneath the canopy of mature trees or larger areas with a more uniform weed cover.

TANKS

Although stainless steel tanks are acceptable, fiberglass tanks are considered to be most economically feasible. Galvanized or other unlined metal tanks are not desirable, since some herbicides are quite corrosive to certain metals. Sumps with removable plugs in the bottoms of tanks facilitate the complete removal of unused pesticide solutions and rinse water. Although various tank sizes are available, a volume of 100 to 150 gallons is considered adequate, since about 10 acres of orchard can be treated with 100 gallons of solution when spraying a 6-foot band at 35 GPA. A large removable strainer to remove foreign matter should be located between the tank outlet and the pump.

NOZZLES

A single off-center nozzle is useful in treating a narrow strip under young trees, but a series of flat-fan nozzles of the same output capacity would be more appropriate for treating wider strips under large trees. The large orifice flood-jet tips are not suitable for band applications of herbicides in the orchard. A line strainer and individual nozzle screens (50 mesh) should be used to minimize clogging problems.

APPLICATION PRECAUTIONS

After selecting the appropriate herbicide, there are several precautions that should be observed during the application process.

Apply preemergence herbicides in early spring to take advantage of frequent rainfall necessary to move the herbicide from the soil surface to the zone of weed seed germination (activation). When treating narrow strips under young trees using postemergence herbicides , make a pass on each side of the tree row rather than attempting to treat the entire band in one pass. Immature stem tissues may be severely injured when sprayed with foliar-active materials.

Choose preemergence herbicide rates according to the soil type of the orchard and soil organic matter content. High rates of application on coarse soils (sand, gravel, and sandy loam) are likely to cause injury to young trees. Use a good water source for mixing herbicides. Turbid water or water containing suspended particles such as clay or organic matter can affect the effectiveness of herbicides such as glyphosate and paraquat. Hard-water or water containing dissolved minerals such as calcium, magnesium, and sodium can also reduce herbicide efficacy.

ALWAYS read the ENTIRE PESTICIDE LABEL prior to use and follow the directions explicitly.

Sprayer Calibration

The importance of sprayer calibration cannot be over-emphasized, considering the cost of herbicides, the time invested in the purchase and application, and the importance of applying the correct rate of herbicide. The time invested in calibration is one of the most critical investments in the orchard. The fine line between effective weed control and tree injury is determined by the application of the correct herbicide at the correct rate.

There are many different methods or procedures that may be used to determine the output of a sprayer. Although the details of such procedures may vary, all methods will require at least some calculations, a container to measure spray volume, and a tape measure or yardstick.

The following method can be used for most types of field applicators:

1. Using the throttle and gear setting normally used when spraying, drop an object from the moving sprayer at the start of a minute. At the end of the minute drop another object on the ground. The distance between the objects will be the distance traveled in one minute. IMPORTANT - Perform this procedure under field conditions and NOT on a road.

2. Measure the distance traveled.
3. Measure the width of the spray swath.
4. Determine the area sprayed.

   Example: If the tractor traveled 353 feet in 1 minute, and the spray pattern was 30 inches wide, then the sprayed area would be calculated as follows:

$$\frac{30 \text{ inches}}{12 \text{ inches/ft}} \times 353 \text{ ft} = 882 \text{ sq. ft.}$$

   There are 43,560 sq ft in an acre, therefore,

$$\frac{882 \text{ sq ft}}{43{,}560 \text{ sq ft/A}} = 0.02 \text{ acre sprayed}$$

5. Determine the sprayer output. Using the throttle setting selected in Step 1 and adjusting the pressure to 25 to 40 psi, collect the spray from all nozzles used to apply the spray pattern in number 4 above, and calculate the total output from all nozzles in ounces per minute.

   Example: If the total output was 96 oz/minute, then

$$\frac{96 \text{ oz/minute}}{128 \text{ oz/gallon}} = 0.75 \text{ gallons per minute (GPM) rate of delivery}$$

6. Determine the output in GPA.

   Example: In 1 minute the sprayer covered 0.02 acres and delivered 0.75 gallons of water. Therefore, the output would be:

$$\frac{0.75 \text{ gal/minute}}{0.02 \text{ acre/minute}} = 37.5 \text{ GPA}$$

A second method for calibrating the herbicide sprayer:

1. Fill the sprayer with water.
2. Spray an area under orchard conditions.
3. Return to same location when filling the sprayer and measure the amount of water required to refill the sprayer to original amount.
4. Use the following example to determine the amount of spray per acre and the amount of material (5.0 lb of 80DF norflurazon) to place in the spray tank.
   a. Assume that a 5.0 foot band was sprayed for 1200 feet and 5.0 gallons of water was required to refill the sprayer tank.

$$\frac{\text{Gallons sprayed} \times \text{sq ft/acre}}{\text{Sq ft of area sprayed}} = \text{GPA} = \frac{5.0 \times 43560}{5.0 \times 1200} = 36 \text{ GPA}$$

$$\frac{\text{Size of tank (gallons)} \times \text{Rate of formulation/acre}}{\text{Gallons/sprayed acre}} = \frac{100 \times 5.0}{36} = 13.9 \text{ lb in tank}$$

   Examples of a sprayed acre: a. an 8 ft wide band 5,445 feet long or

   b. a 5 ft x 5 ft square area under 1,742 trees.

Herbicide Selection

The grower must know the major weeds present in each orchard block and select a herbicide that will control the major problem weeds. These efforts should be initiated before planting an orchard, but scouting to identify weeds or other problems and keeping block records should be maintained for newly planted and established orchards. No preemergence herbicide will control perennial weeds such as poison-ivy or brambles. These weeds must be controlled with postemergence herbicides.

There are some practical limitations to matching problem weeds with a specific herbicide. For example: if morningglories were a problem in a new planting, simazine (Princep) or diuron (Karmex) could not be recommended because the use of these herbicides is limited to established orchards (see Table 16). Therefore, the most economical herbicide for annual grass control should be applied under the new trees, and postemergence treatments should be applied as needed during the season for morningglory control. Simazine or diuron could be applied in the second year to control morningglories. Notes on weed control and weeds not killed should be maintained each year to assist in the herbicide selection process. The herbicide selection decision is not a one-time event, but must be made every year to accommodate shifts in the weed population or other management practices. In general use lower preemergence herbicides rates on sandy or gravelly soils low in organic matter (less than 2%), and higher rates in clay soils and in soils with higher organic matter levels.

Since no preemergence herbicide will control all weeds, herbicide combinations can be used to broaden the spectrum of weed control. The following discussion of individual herbicides can be used as a guide when choosing herbicide combinations. One example would be combining a compound which is effective on many annual broadleaf weeds [such as diuron, simazine or terbacil (Sinbar)] with one which provides long-lasting control of annual grasses [napropamide (Devrinol), norflurazon (Solicam) or oryzalin (Surflan), or pendimethalin (Prowl)]. Since most premergence herbicides will not control emerged weeds, a contact herbicide should be added to the spray mixture to kill existing vegetation. Check the labels for restrictions on use. In general, use lower preemergence herbicide rates on sandy or gravelly soils low in organic matter (less than 2%), and higher rates in clay soils and in soils with higher organic matter levels.

Check herbicide label restrictions to rotational crops if the area to be treated will be rotated to vegetables, ornamentals or other crops within one or two years. Repeat application of certain preemergence herbicides to tree fruit over several years may lead to a buildup of soil residues. Soil residues of certain herbicides, such as simazine, diuron and terbacil, can injure sensitive crops like vegetables.

Site preparation: Growers should attempt to eradicate perennial weeds, especially perennial broadleaf weeds, prior to establishing an orchard. Perennial broadleaves are harder to control after planting fruit trees. Check herbicide labels to determine registered treatments for the crop currently growing at the site.

If the site currently is in pasture, treatments such as 2,4-D or 2,4-D ester plus triclopyr ester (Crossbow) could be used to selectively control broadleaf weeds without injuring grasses such as tall fescue or orchardgrass. Allow at least one year between application of treatments such as Crossbow and planting of fruit trees. Glyphosate could be applied in strips in the fall to control perennial grasses and other weeds prior to planting fruit trees.

Listed below is one possible schedule for herbicide application in apples and peaches. This program is only listed as a general guideline - each grower should adapt this program to fit the weed problems and soil properties (% organic matter, texture) of the orchard.

Year of planting: pendimethalin (Prowl H20) plus paraquat plus surfactant in spring prior to budbreak
For fall treatment (if desired) – preemergence norflurazon (Solicam) plus paraquat* plus surfactant
Year 2: norflurazon (Solicam) plus paraquat* plus surfactant plus either simazine (Princep) or diuron (Karmex)
Year 3 and beyond: simazine (Princep) plus norflurazon (Solicam) plus paraquat * plus surfactant
or diuron (Karmex) plus terbacil (Sinbar) plus norflurazon (Solicam) plus surfactant
or indaziflam (Alion) plus paraquat* plus surfactant

*Paraquat is only needed when live vegetation is present. Paraquat can be reapplied in the summer to control weeds that escape the spring application. Paraquat is not needed if diuron (Karmex) plus terbacil (Sinbar) plus surfactant are combined and applied to small weed seedlings.

Perennial Weeds

Among the different types of weeds based on their life cycles, perennial weeds are most competitive and difficult to manage in an orchard. Creeping perennials, such as poison ivy and wild blackberry, spread both by seed and vegetatively through sprouts off rootstocks or rhizomes found beneath the soil surface. Unless the underground portion is completely killed, these spreading perennials will continue to grow into adjacent areas.

There are limited options for controlling perennial weeds, especially perennial broadleaf weeds, after planting. Controlling perennial weeds before planting trees can save the grower a lot of time and trouble. However, perennial weeds will tend to invade established orchards over time. If employing mechanical methods, the goal is to deplete the food reserves present in the underground plant parts, which can be accomplished by mowing or removal of top-growth as frequently as every two weeks during the growing season. Using specialized equipment such as rotary heads or blades improves efficiency. Mechanical weed control may be labor intensive, and it has the potential of spreading weed propagules and soil-borne disease pathogens around the orchard. Occasionally, mechanical removal may cause injury to trees, making them susceptible to diseases.

Planning ahead or using preventive methods before planting an orchard can go a long way toward managing perennial weeds. Leaving the orchard fallow for a couple of years before planting and applying a systemic herbicide such as glyphosate will control perennials. Alternatively, planting row crops such as soybean or corn for a few years before planting the orchard and employing different herbicides for perennial weed management could be effective in managing perennial weeds. If this strategy is used, one should carefully follow the rotational restrictions of the herbicides to avoid residual injury to trees. Conducting a bioassay before planting new trees may be prudent. Another option would be to grow a temporary cover crop such as sorghum-sudangrass or rape seed mustard for a season or two, and then control it prior to planting a permanent cover crop and the fruit trees.

To control perennial weeds within the tree row, perhaps the most effective method is application of systemic herbicides. In established orchards, systemic nonselective herbicides such as glyphosate and glufosinate control most perennial grass and broadleaf weeds. Broadleaf herbicides such as 2,4-D and clopyralid are effective on certain perennials. Herbicides that selectively control grasses such as sethoxydim, fluazifop, and clethodim can be used for control of perennial grasses such as quackgrass and johnsongrass. Systemic herbicides are most effective when applied to actively- growing weeds under good soil moisture conditions and warm temperatures. Postemergence herbicides are less effective when applied to drought-stressed weeds or to weeds under very low temperatures.

Weed control in row middles

There are limited options for controlling weeds in row middles after planting. Emphasis should be placed on controlling broadleaf weeds, especially perennial ones, in the cover crop prior to planting the orchard. After planting, 2,4-D amine (various formulations) can be used for control of dandelion, plantains, and certain other broadleaf weeds in apple and peach plantings. Stinger (clopyralid) can be used for control of legume and composite weeds such as white clover and Canada thistle in apples and stone fruit. Starane Ultra (fluroxypyr) can be used for control of vines, brambles, and hemp dogbane in well-established apple orchards. Combinations of these herbicides, such as 2,4-D plus fluroxypyr, can be used to broaden the spectrum of broadleaf weed control. These three herbicides do not injure grasses so they can be applied to row middles containing tall fescue, Kentucky bluegrass, perennial ryegrass, or other grass cover crops. Aim (carfentrazone) is a contact herbicide that will control small annual broadleaf weeds. Aim causes little to no damage to perennial grass cover crops but it will not by itself control perennial broadleaf weeds

SPLIT HERBICIDE APPLICATIONS

If herbicides are applied as a split fall and spring application (October/November and April/May) or a split spring and summer (March and July), improved length of control will be seen. A fall application of terbacil (Sinbar), diuron (Karmex), simazine (Princep), pronamide (Kerb), or norflurazon (Solicam) will provide improved control of certain perennial grasses. Since none of the residual herbicides control all of the perennial or woody weed species, the application of 2,4-D or glyphosate (various) or a combination of the two need to be applied before these weeds become a problem.

HERBICIDE-RESISTANT WEEDS

Herbicide-resistant weed biotypes may develop as a result of applying the same herbicide or herbicides with the same mode of action year after year. Smooth pigweed and common lambsquarters have developed resistance to the triazine herbicides in Virginia, for example. Glyphosate-resistant horseweed is present in Virginia. Where possible, the same herbicide should not be applied alone for more than 3 or 4 years in a row. Resistance to herbicides could be delayed or avoided by utilizing herbicide rotations and/or tank- mixes that employ chemicals differing in their mode of action. Rotating chemicals from different herbicide families that have the same mode of action may also delay development of herbicide resistance. However, some weed species can develop resistance to multiple herbicide families that have a similar mode of action. Consult the table below while determining a suitable herbicide rotation and/or tank-mixing program for orchard weed management.

Table 14. Herbicides used for weed management in tree fruit crops and their modes of action.

Herbicide (Common name)	Application Timing*	Herbicide Family	Primary Mode of Action
Dichlobenil	PRE	Benzonitrile	Cellulose biosynthesis inhibitor
Indaziflam	PRE	Alkylazine	Cellulose biosynthesis inhibitor
Diuron	PRE	Substituted urea	Photosystem II inhibitor
Simazine	PRE	Triazine	Photosystem II inhibitor
Terbacil	PRE	Uracil	Photosystem II inhibitor
Oryzalin	PRE	Dinitroaniline	Microtubule/spindle apparatus (Root growth) inhibitor
Pendimethalin	PRE	Dinitroaniline	Microtubule/spindle apparatus (root growth) inhibitor
Pronamide	PRE	Amide	Microtubule/spindle apparatus (Root growth) inhibitor
Norflurazon	PRE	Pyridazinone	Carotenoid synthesis inhibitor
Carfentrazone	POST	N-Phenyl-triazolinones	Protox inhibitor
Flumioxazin	PRE*	Phenylphthalimide	Protox inhibitor
Oxyfluorfen	PRE*	Diphenylether	Protox inhibitor
Sulfentrazone	POST	N-Phenyl-triazolinones	Protox inhibitor
Clopyralid	POST	Pyridine	Auxin-type growth regulator
2,4-D	POST	Phenoxy acid	Auxin-type growth regulator
Fluroxypyr	POST	Pyridine	Auxin- type growth regulator
Clethodim	POST	Cyclohexanedione	ACCase (lipid synthesis) inhibitor
Fluazifop	POST	Aryloxyphenoxy propionate	ACCase (lipid synthesis) inhibitor
Sethoxydim	POST	Cyclohexanedione	ACCase (lipid synthesis) inhibitor
Halosulfuron	POST*	Sulfonylurea	ALS inhibitor (amino acid synthesis)
Rimsulfuron	POST*	Sulfonylurea	ALS inhibitor (amino acid synthesis)
Glyphosate	POST	Amino acid derivative	EPSP synthase (amino acid synthesis) inhibitor
Glufosinate	POST	Amino acid derivative	Glutamate synthase inhibitor
Paraquat	POST	Bipyridilium	Photosystem I inhibitor (Cell membrane disrupter)

* Principal activity as either preemergence (PRE) or postemergence (POST) herbicide. Application timing followed by (*) indicates dual.

Herbicides

Preemergence (Residual)

DICHLOBENIL (CASORON 4G) is formulated as a 4% granular product and will control annual and certain perennial weeds. The use rate of this herbicide ranges from 4.0 to 6.0 lbs ai/A, which corresponds to 100 to 150 lbs of Casoron 4G per acre. Casoron should be applied between late fall and early spring for optimum weed control. Fruit trees must be established at least 4 weeks prior to application. The granules have to be distributed evenly to the soil surface, followed shortly by rain, irrigation or a shallow incorporation for optimum efficacy. Incorporation immediately after application is recommended if applied under warm conditions. The lower use rate is recommended for controlling annual weeds and the higher use rate is recommended for controlling certain perennial weeds. There is a liquid formulation of dchlobenil, Casoron CS, which can be applied at 1.4 to 2.8 gallons per acre.

DIURON (KARMEX) is formulated as an 80% dry flowable and can be applied at 4.0 lb Karmex per acre although it usually is applied at lower rates in combination with other herbicides. Diuron may be used around apple and pear trees established at least 1 year and around peach trees established at least 3 years. Apply once to the orchard floor in early spring (March-May) before fruit sets. Diuron (with added surfactant) may kill emerged weeds, but it should be used in combination with a contact herbicide for consistent results. Diuron controls several annual weed species, but does not control emerged perennials such as yellow rocket, dandelion, chicory, plantains, or purpletop. Diuron (1.0 to 2.0 lb of Karmex 80DF) may also be applied in a tank mixture with terbacil (1.0 to 2.0 lb of Sinbar 80W) around apple and peach trees established at least 2 years. This tank mixture will provide partial control of many non-woody perennials mentioned above. Do not replant the treated area to any crop within 2 years after last application. Do not use on soils with less than 1% organic matter content; use lower rates on soils with 1-2% organic matter content or light soils.

FLUMIOXAZIN (CHATEAU) is formulated as a 51% water dispersible granule (Chateau SW) and is applied at the rate of 6-12 oz formulation per acre and as a 4 pound per gallon liquid (Chateau EZ) at 6-12 fl ounces per acre. Use the 6 oz/A rate if the sand plus gravel content of the soil is over 80% and trees are less than 3 years old.

INDAZIFLAM (ALION) is formulated as a 1.67 lb per gal suspension concentrate (1.67 SC) and can be used in pome and stone fruits established for at least three years. This herbicide controls a range of annual grasses and broadleaf weeds. Applications carried out in late fall provide acceptable weed control till June of the following year and those carried out in spring provide weed control till mid to late summer. Since indaziflam does not control most emerged weeds, a postemergence nonselective herbicide should be added if weeds are present. Avoid spray contact with crop foliage, green bark, roots, or fruit to prevent localized injury. Do not apply to soils that have open channels, cracks, or depressions which may lead to herbicide contact with the roots. Excessive weed or crop debris at the time of application or dry soil conditions following application may lead to inconsistent weed control. Do not use in soils with 40% or more gravel content. The use rate is 5 oz formulation per acre for course and medium textured soils and 5-6 oz/A for fine textured soils. The use rate ranges from 3.5 fl oz per acre for soils less than 1% organic matter to 5.0-6.5 fl oz per acre for soils greater than 3% organic matter.

NORFLURAZON (SOLICAM DF) is formulated as an 80% dry flowable and recommended for preemergence control of annual grasses and certain broadleaf weeds in newly transplanted and established apple trees. Delay application until 6 months after planting peaches or nectarines and one year after planting pears and plums and 18 months after treating cherry. Do not treat cherry when growing in a sand or loamy-sand soil. Recommended rates are 2.5 to 5.0 lb of formulated Solicam per acre. Norflurazon does not have postemergence activity and will not control emerged grasses. However, early spring applications will suppress the growth and spread of certain perennial grasses such as quackgrass, fescues, redtop, and paspalums. Complete control would be possible when used in combination with 1.5 qt per acre of glyphosate (Roundup); however, this practice is not recommended for young trees when used in combination with glyphosate. Improved broadleaf weed control is possible when tank-mixed with the recommended rate of such herbicides as simazine (Princep) or diuron (Karmex).

ORYZALIN (SURFLAN A.S.) is formulated as a 4 lb per gal aqueous solution (4AS). Recommended rates are 2.0 to 6.0 qt of the 4AS per acre. Use lower rates for short-term control (4 months) and higher rates for long-term control (6-8 months). Highest rates (4.0-6.0 lb ai) are for fall application only. Oryzalin may be used around newly transplanted apple, pear, cherry, nectarine, peach, and plum trees after the soil has settled and no cracks are present as well as around established trees. Trash should be removed or thoroughly mixed into the soil before application. Oryzalin is effective in controlling annual grasses and broadleaf weeds such as barnyardgrass, annual bluegrass, panicums, crabgrass, foxtails, goosegrass, seedling johnsongrass, carpetweed, common purslane, common lambsquarters, pigweeds, and common chickweed. Oryzalin may be tank-mixed with diuron (Karmex), simazine (Princep), or terbacil (Sinbar) to control many more broadleaf weeds. Observe precautions and time limitations for diuron, simazine, or terbacil. Oryzalin is currently unavailable.

OXYFLUORFEN (GOAL 2XL, GOALTENDER) is formulated as Goal 2XL, a 2 lb/gallon emulsifiable concentrate,

or as GoalTender, a 4 lb/gallon liquid, and both are registered as a dormant application for bearing and non-bearing peach, cherry, apple, nectarine, pear and plum. Oxyfluorfen, which controls most annual broadleaf weeds and certain annual grasses, can be tank-mixed with oryzalin (Surflan), napropamide (Devrinol) or norflurazon (Solicam) for improved annual grass control. Oxyfluorfen has postemergence activity on small weed seedlings but should be combined with glufosinate, glyphosate, or paraquat where labeled for consistent control of emerged weeds. Application rates for Goal 2XL range from 2.0-8.0 pints per acre or 1.0-4.0 pints per acre when applied as a banded application.

PENDIMETHALIN (PROWL H2O, 3.3 EC) is available as a 3.8 lb per gallon capsule suspension for use in bearing and nonbearing apple, pear, cherry, nectarine, peach, and plum under the name Prowl H20. Applications rates are 2 to 4 quarts per acre. Do not apply within 60 days of harvest. Pendimethalin is also available as a 3.3 pound per gallon emulsifiable concentrate for use in nonbearing apple, pear, cherry, nectarine, peach, and plums. Pendimethalin provides preemergence control of annual grasses and certain small-seeded broadleaf weeds. Apply to new plantings only after the ground has settled and no cracks are present. Apply as a direct spray, avoiding contact with leaves, shoots, or buds. Pendimethalin controls barnyardgrass, crabgrass, foxtails, goosegrass, johnsongrass (seedlings), fall panicum, and a few broadleaves including carpetweed, common chickweed, henbit, velvetleaf, pigweed, and Pennsylvania smartweed. Pendimethalin may be tank-mixed with a contact herbicide to control existing vegetation.

PRONAMIDE (KERB 50W, KERB SC) is formulated as a 50% wettable powder (Kerb 50W) or as a 3.3 lb per gallon liquid (Kerb SC). Rates of 2.0 to 8.0 lb Kerb 50 W or 2.5 to 9.5 pints Kerb SC per acre can be applied in fall or early winter application for specialized weed problems in orchards to control cool-season grasses such as fescues, orchardgrass, bluegrass, and quackgrass. Pronamide is absorbed by root systems of weeds, therefore it will control established cool-season grasses and certain broadleaf weeds. Pronamide also has preemergence activity to prevent the reestablishment of many weeds that normally emerge early in the spring. Pronamide does not provide full-season control of many summer annual weeds; therefore, it should be used in conjunction with other herbicides to obtain full-season control of most annual weeds. Use lower rates on coarse soils and higher rates on clay soils.

RIMSULFURON (MATRIX FNV) is formulated as a 25% dry flowable formulation. It can be applied to apple, pear, apricot, cherry, nectarine, peach and plum trees established at least one year. Matrix FNV at 4 ounces per acre will provide preemergence control of certain annual grass and broadleaf weeds and will suppress dandelion and yellow nutsedge. It provides postemergence control of small seedlings of annual grass and broadleaf weeds with suppression of certain perennial weeds. It should be tank-mixed with other postemergence herbicides, such as glyphosate, glufosinate, or paraquat, for broader-spectrum control of emerged weeds. Combinations with other preemergence herbicides, such as oryzalin or pendimethalin, will also broaden the spectrum of weed control. Matrix SG and Solida are 25% WDG formulations of rimsulfuron. Do not apply within 14 days of harvest.

SIMAZINE (PRINCEP, CALIBER 90 or 4L) is formulated as a 90% water dispersable granule and as a 4 lb/gallon liquid; it is recommended for use around apple, pear, cherry, and peach trees established at least one year. Princep 4L at 2.0 to 4.0 qt per acre, and Princep Caliber 90 at 2.2 to 4.4 lb per acre are recommended for all trees listed above. Simazine should be applied to the soil before weeds emerge or after removal of weed growth. It does not kill emerged weeds, but may be used in combination with paraquat or glyphosate. Simazine controls a wide variety of annual broadleaf weeds and grasses. Use lower rates on light soils and soils low in organic matter; higher rates on heavy soils and soils high in organic matter. Do not use on sandy or gravelly soils. The full rate of simazine may not be required when used in conjunction with other herbicides e.g. napropamide (Devrinol), oryzalin (Surflan), or norflurazon (Solicam) for season-long control of annual grasses. Avoid spray contact with crop foliage or fruit. Use tank-mixes with other preemergence herbicides if triazine-resistant pigweed or lambsquarters are present.

TERBACIL (SINBAR WDG) is formulated as an 80% water dispersible granule and can be used in apple and peach trees established at least 3 years for preemergence and early postemergence weed control. It can be applied at 2.0 to 4.0 lb of Sinbar WDG per acre either in spring or after harvest in the fall but it usually is applied at lower rates (0.5 to 2.0 lb per acre) in combination with other preemergence herbicides, such as diuron (Karmex), which allows for application in younger orchards**.** Sinbar can be applied to trees established less than 3 years if lower rates (0.5 to 1.0 lb formulation per acre) are used and the soil has at least 2% organic matter and is not coarser than a sandy loam. Combinations with other herbicides would be beneficial when these lower rates of Sinbar are used. Check tree tolerance on a small scale prior to widespread use when treating young fruit trees. Terbacil controls seedling johnsongrass, barnyardgrass, annual bluegrass, chickweed, crabgrass, dandelion, dogfennel, foxtails, henbit, knotweed, common lambsquarters, mustard, black nightshade, orchardgrass, panicums, plantains, pigweeds, purslane, ragweed, and smartweed. The high rate is required for control of quackgrass, yellow nutsedge, horsenettle, and red sorrel. Apply terbacil plus surfactant at early stages of fruit development for control of horsenettle. Use lower rates on light soils and soils with low organic matter (1 to 2%); higher rates on soils with higher organic matter content. Do not use on soils with less than 1% organic matter or in areas with exposed tree roots. Do not replant treated areas to any crop within 2 years after application.

Postemergence

BENTAZON (BROADLOOM) is a 4 lb/gallon liquid that is applied at 1-2 pints per acre for control of yellow nutsedge and certain broadleaf weeds, such as Canada thistle, cocklebur, jimsonweed, smartweed, and velvetleaf. Repeat the application in 10 days for yellow nutsedge control. Apply only to nonbearing apples, cherries, nectarines, peaches, and pears. Include a crop oil concentrate at 1% v/v.

CARFENTRAZONE (AIM) is formulated as a 1.9 lb/gallon EW or as a 2 lb/gallon EC for the postemergence control of small annual broadleaf weeds. Applications rates for this contact herbicide are 1 to 2 fluid ounces per acre. Apply when annual broadleaf weeds are less than 6 inches in height and actively growing. Carfentrazone does not control grasses. Carfentrazone can be tank mixed within other postemergence herbicides for broader-spectrum control or with preemergence herbicides since carfentrazone does not provide residual weed control. Adding a crop oil concentrate or nonionic surfactant may improve weed control. Do not allow spray to contact green stems, leaves, flowers, or fruit of fruit trees.

CARFENTRAZONE + SULFENTRAZONE (ZEUS PRIME XC) is a prepackaged combination containing 3.53% carfentrazone and 31.77% sulfentrazone. For use only in apples. Trees must be established at least 2 years. Application rates are 7.7-15.2 fl oz/acre. Addition of an adjuvant (nonionic surfactant, methylated seed oil, or crop oil, depending on the situation), will improve postemergence weed control. Do not allow spray to contact apple stems or leaves. Controls small emerged annual broadleaf weeds and yellow nutsedge, while providing preemergence control of certain annual broadleaf weeds. Add a preemergence grass herbicide, such as oryzalin, pendimethalin, or norflurazon, for improved annual grass control. Add glyphosate, glufosinate, or paraquat for nonselective postemergence weed control.

CLETHODIM (SELECT 2 EC, SELECT MAX) is formulated as an emulsifiable concentrate at 2 lb per gal (Select 2EC) or as a 0.97 lb/gal emulsifiable concentrate (Select Max), and is effective for controlling annual and perennial grasses in nonbearing apple, pear, cherry, nectarine, plum, and peach trees. Do not harvest within 1 year after application. Select Max can be applied to bearing peach, with at least 14 days between application and harvest. Application rates are 6-8 fl oz Select 2EC or 9-16 fl oz Select Max per acre. For spot treatment, use 0.33-0.65 fl oz Select 2EC or 0.44-0.85 fl oz Select Max per gallon. Add nonionic surfactant at 0.25% (1 qt/100 gal or 0.33 fl oz/gal). Visual symptons appear only after 7 to 14 days after application. Grasses controlled by clethodim include barnyardgrass, crabgrass, fall panicum, foxtails, goosegrass, lovegrass, ryegrass, johnsongrass, shattercane, and witchgrass. Clethodim provides essentially postemergence control only. A preemergence herbicide could be applied to prevent reestablishment of annual grasses in a young orchard.

CLOPYRALID (STINGER) is formulated as a 3 lb per gallon liquid and is registered for use only in apples and stone fruit. It provides postemergence control of certain broadleaf weeds, including white clover, red clover, vetch, common ragweed, and horseweed, with suppression of mugwort, Canada thistle, dandelion, and buckhorn plantain. It will not affect grasses. Apply at 1/3 to 2/3 pint per acre and do not apply within 30 days of harvest. Stinger can be tank-mixed with other herbicides registered for apples and stone fruit to broaden the spectrum of control.

FLUAZIFOP-P (FUSILADE DX) is formulated as a 2 lb active ingredient/gallon emulsifiable concentrate and is effective for controlling emerged annual and perennial grasses in newly planted and established orchards. Fluazifop-P-butyl can be applied to bearing and nonbearing cherries, nectarines, peaches and plums. Do not harvest within 14 days of application. Fluazifop-P-butyl can also be applied to nonbearing apples and pears - do not harvest within one year of application. The recommended rate is 12 fl oz per acre for Fusilade DX for stone fruits and 16-24 fl oz per acre for non-bearing apples and pears. Add 1 qt of crop oil concentrate or 1/2 pint nonionic surfactant per 25 gallons of water. Fluazifop-P-butyl selectively controls grasses and does not kill or injure broadleaf weeds or crops. Applications should be made to young (2 to 8 inch) actively growing annual grasses before seedhead development. Since fluazifop-P-butyl is systemic, visual symptoms may not appear in treated grasses for 7 to 14 days after application. Fluazifop-P-butyl leaves no soil residues, therefore, one of the preemergence herbicides used for grass control (napropamide, norflurazon, or oryzalin) should be applied to prevent the reestablishment of annual grasses in the young orchard. Fluazifop-P-butyl is also recommended for control of established perennial grasses such as bermudagrass, johnsongrass, nimblewill, paspalums, purpletop, quackgrass, or orchardgrass.

FLUROXYPYR (STARANE ULTRA) is formulated as a 2.8 pound (acid equivalent) per gallon liquid and is used for the selective control of certain annual and perennial broadleaf weeds in pome fruit only (apple and pear). Application rates are 0.4 to 1.4 pints/acre, which corresponds to 0.14 to 0.49 lb acid equivalent per acre. Avoid contact with the leaves of tree fruit. It controls broadleaf weeds such as hemp dogbane, wild blackberry, poison ivy, and white clover but it should be combined with 2,4-D or glyphosate for broader spectrum broadleaf weed control. Fluroxypyr does not control grasses. Do not apply more than 1.4 pints per acre per year and make only one application per year. Do not apply during bloom. Do not apply to fruit trees less than 4 years old. Apply when broadleaf weeds are young and actively growing under warm conditions and good soil moisture. Do not apply within 14 days of harvest.

GLUFOSINATE (RELY 280) is formulated as a 2.34 lb per gallon formulation as Rely 280, which is applied at the rate of 48 to 82 fl oz per acre. Rely 280 is registered for use on pome and stone fruit. Use the lower rate for control of annual weeds less than 6 inches tall and higher rates for control of taller weeds and for perennials. Rely is primarily a contact herbicide so repeat treatments may be required, especially for perennial weeds. It is a nonselective herbicide so avoid contact with

the leaves or bark of fruit trees. Do not allow the spray to contact green, uncallused, or thin bark. Bark can be protected by using nonporous wraps or grow tubes. Use only on trees established at least one year. Thorough coverage of weeds is required for control. Rely does not provide residual control so a preemergence herbicide can be added to control weeds germinating after application. Additional surfactant is not needed for Rely 280.

GLYPHOSATE (ROUNDUP POWERMAX, ROUNDUP WEATHERMAX, others) is recommended for controlling emerged annual and perennial weeds around apple, pear, cherry, peach, plum, and nectarine trees; however, only wick applicators may be used around peach, plum, or nectarine trees. Application rates range from 0.75-3.75 lb glyphosate acid equivalent per acre. Commonly available formulations contain 3, 3.7, or 4.5 lb per gallon of glyphosate acid, the active ingredient. Check the label to see if addition of a surfactant is recommended. Do not allow spray to contact foliage, branches, suckers, open wounds, immature bark, or other green parts of the crop. Application rates are 22 fl oz to 3.3 qt/A for Roundup PowerMax or Roundup WeatherMax, or 1-5 qt/A for Touchdown. For spot treatment, use 1.3-2 fl oz Roundup PowerMax or Roundup WeatherMax per gallon. For wiper applications, use a 33-75% solution of Roundup PowerMax or Roundup WeatherMax. Glyphosate is also formulated and sold under other trade names. Check the label for specific use instructions. Small annual weeds can be controlled using the lower end of the rate range. For most perennial weeds, glyphosate is best applied in late summer or early fall prior to frost when these weeds are in the flowering/fruiting stage. Established perennial grasses such as fescues, orchardgrass, purpletop, paspalums (field paspalum, vaseygrass, dallisgrass) require higher use rates (middle to higher end of the rate range) while hard to control woody plants like poison ivy and brambles require rates at or near the high end of the rate range. For spot treatment use 1.3-2.6 fl oz Roundup PowerMax II/gallon and spray to wet but not the point of runoff. For wiper applications use 1 part Roundup PowerMax II/gallon to 2 parts water. Apply when weeds are actively growing and not under drought stress. WARNING: Do not mix, store, or apply spray solutions in galvanized metal or unlined steel tanks. Chemical reaction produces hydrogen gas, which is very explosive.

HALOSULFURON (SANDEA) is formulated as a 75% dry flowable, and can be applied at 0.5 to 1 oz/A to apple and pear trees established at least one year. Halosulfuron controls yellow nutsedge and certain broadleaf weeds (see label for weeds controlled) primarily after emergence but has residual (preemergence) activity also. For optimum control of yellow nutsedge, apply a minimum of 0.75 oz/A when the weeds have reached the 3-5 leaf stage. Add a nonionic surfactant when applied to emerged weeds. Do not apply under windy conditions or when air-temperature is >85˚F to avoid injury to foliage and/or fruit. Do not apply more than 2 oz of Sandea per acre during 12 months. Do not harvest within 14 days after application.

PARAQUAT is available as a 2.0 lb paraquat cation per gallon (Gramoxone SL 2.0) and as a 3.0 lb paraquat cation per gallon (Gramoxone SL 3.0). Apply Gramoxone SL 2.0 at 2.5 to 4.0 pints/A and Gramoxone SL 3.0 at 1.7 to 2.7 pints/A. Paraquat can be applied to apple, pear, cherry, nectarine, peach, and plum trees. Apply this contact herbicide as a directed spray when weeds are small and actively growing. Add a nonionic surfactant at the rate of 8.0 to 32.0 fl oz per 100 gal. Repeated applications will be necessary to give sustained control. Do not allow spray to contact green stems, fruit, or foliage as injury may result. WASH THE TANK AND SPRAYER THOROUGHLY WITH CLEAR WATER AFTER SPRAYING. PARAQUAT IS EXTREMELY TOXIC. HANDLE WITH CAUTION!

SETHOXYDIM (POAST) available as a 1.5 lb active ingredient per gal liquid, is effective for controlling emerged annual and perennial grasses in bearing and nonbearing apples, cherries, nectarines, peaches, and pears - do not apply within 14 days of apple or pear harvest. Do not apply within 25 days of cherry, nectarine or peach harvests. Apply to nonbearing plums only. Recommended rates are 1.5 to 2.5 pt per acre on actively growing grasses. Apply 1.5 pt per acre to annual grasses up to 6 inches high and apply 2.5 pt per acre to annual grasses up to 12 inches high and to perennial grasses. A crop oil concentrate should be added at the rate of 1 quart per acre. Sethoxydim controls grasses and does not kill or injure broadleaf weeds or crops. Since sethoxydim is systemic, visual symptoms may not appear in treated grasses for 7 to 14 days after application. Sethoxydim leaves no soil residue; therefore, one of the preemergence herbicides used for grass control [napropamide (Devrinol), norflurazon (Solicam), or oryzalin (Surflan)] should be applied to prevent the reestablishment of annual grasses in the young orchard. Sethoxydim is also recommended for use in newly established peaches, nectarines and vineyards to control established grasses such as bermudagrass, quackgrass, johnsongrass, nimblewill, paspalums, purpletop, fescues, or orchardgrass.

2,4-D AMINE (WEEDAR 64, ORCHARD MASTER) AND 2,4-D CHOLINE (EMBED) are formulated as a 3.8 lb active ingredient per gallon liquid and is recommended for control of broadleaf weeds in apples, pears, and stone fruits. This treatment is particularly useful for controlling troublesome broadleaf weeds that escape preemergence treatments recommended for new plantings. Apply 2,4-D amine as a directed spray at 1.5 qt per acre or apply 2,4-D choline (Embed) at 1-4 pints per acre to actively growing broadleaf weeds. 2,4-D will not control grasses and certain perennial broadleaf weeds. Do not allow spray to contact fruit, branches, or trunks of trees. Use a coarse spray and low pressure to avoid drift to susceptible crops. Addition of a surfactant may improve weed control. Do not apply within 14 days of apple or pear harvest, or within 40 days of cherry, peach, or plum harvest. Embed (2,4-D choline) is a low volatility formulation of this herbicide and thus less likely to drift and damage sensitive broadleaf crops.

Orchard Master, Weedar 64, and Embed are also registered for use on peaches. Application can be made in fall or early spring for control of such weeds as dandelion but treatments should be made prior to bloom of peach. Better coverage of broadleaf weeds may be obtained in the spring because of lower grass cover.

Table 15. Relative Effectiveness of Preemergence Herbicides in Tree Fruits

(E=excellent; G=good; F=fair; P=poor; N=none)

	Dichobenil (Casoron)	Diuron (Karmex)	Flumioxazin (Chateau)	Indaziflam (Alion)	Norflurazon (Solicam)	Oryzalin (Surflan)	Oxyfluorfen (Goal)	Pendimethalin (Prowl)	Pronamide (Kerb)	Rimsulfuron (Matrix)	Simazine (Princep)	Terbacil (Sinbar)
ANNUAL GRASSES												
Barnyardgrass	G	G	-	G	E	G	F	G	F	F	F-G	G
Cheat	G	G	-	G	G	G	-	G	G	-	G	G
Crabgrass	G	G	F-G	G	E	E	F	G	G	F	F-G	F-G
Fall panicum	G	F	-	G	E	G	-	G	F	F	F-G	F-G
Foxtails	G	G	F	F-G	E	E	F	G	G	G	G	G
Goosegrass	G	G	-	G	G	E	F	F	G	P	E	-
Johnsongrass (seedling)	F	P-F	P-F	-	G	F-G	P	F	-	-	P	-
ANNUAL BROADLEAF WEEDS												
Annual fleabane	E	G	-	-	F	G	-	-	F	-	G	E
Annual morningglory	G	G	G	P	F	P-F	F	P	F	P	G	G
Black nightshade	G	G	G	-	F-G	P-F	G	N	F	F	E	-
Carpetweed	G	E	E	G	G	G	G	G	G	-	E	E
Common chickweed	G	E	F-G	G	G	G	G	G	G	-	E	G
Common lambsquarters	G	E	E	G	G-E	G	G	G	F	F	E	G
Common ragweed	G	E	E	G	F	P	F	N	P	F	E	G
Hairy galinsoga	P	E	G	-	-	G	G	N	-	-	E	E
Henbit	G	E	E	G	-	P	G	G	G	G	E	G
Horseweed	G	G	-	-	G	F	F	P	P	G	E	G
Knotweed	G	G	-	-	F	G	G	-	E	-	G	G
Mustards	G	G	-	E	F	P-F	G	-	G	-	G	E
Pennsylvania smartweed	G	G	-	-	-	P-F	G	P	-	-	E	G
Pigweeds	G	E	E	E	F	G	G	G	N	E	E	G
Prickly lettuce	G	G	-	-	-	F	G	-	-	-	E	G
Prickly sida	G	G	G	-	P	P-F	E	N	N	F	G	-
Purslanes	G	E	-	-	G	G	G	G	-	G	E	E
Shepherd's-purse	G	G	-	-	G	G	-	G	G	-	E	G
Speedwells	G	-	-	E	-	-	G	-	P	-	-	-
Velvetleaf	P	F	E	E	-	P-F	G	G	P	F	G	G
Virginia pepperweed	G	G	-	-	G	G	-	-	P	-	E	-
PERENNIAL GRASSES AND SEDGES												
Fescues	G	F	-	P	F	N	N	N	G	-	P	F
Johnsongrass (rhizome)	-	P	N	-	P	N	N	N	P	-	P	P
Nimblewill	-	P	-	-	F	N	N	N	P	-	P	P
Orchardgrass	G	P-F	-	-	F	N	N	N	G	-	P-F	G-E
Quackgrass	G	F	-	-	P	N	N	N	G	-	P-F	G

Table 15. Relative Effectiveness of Preemergence Herbicides in Tree Fruits (cont.)

(E=excellent; G=good; F=fair; P=poor; N=none)

	Dichobenil (Casoron)	Diuron (Karmex)	Flumioxazin (Chateau)	Indaziflam (Alion)	Norflurazon (Solicam)	Oryzalin (Surflan)	Oxyfluorfen (Goal)	Pendimethalin (Prowl)	Pronamide (Kerb)	Rimsulfuron (Matrix)	Simazine (Princep)	Terbacil (Sinbar)
Yellow nutsedge	P-F	P	N	N	P	N	N	N	N	F	N	F-G
Purpletop, Redtop	-	P	-	-	F-G	N	N	N	-	-	N	F-G
Dallisgrass	-	F	-	N	P	N	N	N	-	-	N	F-G
Bermudagrass	N	N	N	N	P	N	N	N	P	N	N	F
PERENNIAL BROADLEAF WEEDS												
Broadleaf plantain	G	P-F	-	-	P	N	N	N	F	-	G	F
Buckhorn plantain	G	P-F	-	-	P	N	N	N	F	-	G	F
Canada thistle	F	N	-	-	N	N	N	N	-	-	N	N
Chicory	G	G	-	-	N	N	N	N	-	-	P-F	G
Common mallow	G	F	-	-	N	N	N	N	-	-	N	-
Common milkweed	-	N	-	-	N	N	N	N	-	-	N	N
Common yarrow	-	N	-	-	N	N	N	N	-	-	-	N
Dandelion	G	P-F	-	-	N	N	N	N	P	F	P-F	G-E
Docks (broadleaf, curly)	G	F	-	-	N	N	N	N	F	-	N	F
Goldenrod	F-G	-	-	-	N	N	N	N	-	-	N	P-F
Ground ivy	E	N	-	-	N	N	N	N	-	-	N	N
Hemp dogbane	N	N	-	-	N	N	N	N	-	-	N	N
Horsenettle	N	P-F	-	-	N	N	N	N	-	-	P	F-G
Mugwort	G	P	-	-	N	N	N	N	-	-	N	P
Red sorrel	G	N	-	-	N	-	N	N	F-G	-	N	P
Thistles (bull, musk, plumeless)	G	N	-	-	N	N	-	N	P	-	N	-
White flowered aster	F	N	-	-	N	N	N	N	-	-	N	N
Wild carrot	G	P	-	-	F	N	-	N	-	-	N	F
Wild strawberry	G	G	-	-	P	N	-	N	-	-	N	N
Yellow rocket	G	P	-	-	F	N	-	N	P-F	-	P	G
Yellow woodsorrel	G	F	-	-	F	N	G	N	-	-	F	G
SPECIAL PERENNIAL WEED PROBLEMS												
Bigroot morningglory	-	N	-	-	N	N	N	N	N	-	N	N
Brambles (Rubus spp.)	N	N	-	-	N	N	N	N	N	-	N	N
Common greenbriar	N	N	-	-	N	N	N	N	N	-	N	N
Japanese honeysuckle	N	N	-	-	N	N	N	N	N	-	N	N
Poison-ivy	N	N	-	-	N	N	N	N	N	-	N	N
Virginia creeper	N	N	-	-	N	N	N	N	N	-	N	N
Wild garlic	N	N	-	-	N	N	N	N	N	-	N	N

Table 16. Relative Effectiveness of Postemergence Herbicides in Tree Fruits

(E=excellent; G=good; F=fair; P=poor; N=none)

CHEMICALS	Bentazon (Broadloom)	Carfentrazone (Aim)	Clopyralid (Stinger)	Fluazifop-P (Fusilade DX)	Fluroxypyr (Starane)	Glufosinate (Rely)	Glyphosate (Various)	Paraquat (Gramoxone)	Sethoxydim (Poast)	2,4-D	Clethodim (Select)
ANNUAL GRASSES											
Barnyardgrass	N	N	N	E	N	G	E	G-E	E	N	E
Cheat	N	N	N	G	N	-	E	G-E	-	N	G
Crabgrasses	N	N	N	E	N	G	E	G-E	E	N	E
Fall panicum	N	N	N	E	N	G	E	G-E	E	N	E
Foxtails	N	N	N	E	N	G	E	G-E	E	N	E
Goosegrass	N	N	N	E	N	G	E	G-E	E	N	E
Johnsongrass (seedling)	N	N	N	E	N	-	E	G-E	E	N	E
ANNUAL BROADLEAF WEEDS											
Annual fleabane	-	-	G	N	-	-	E	E	N	G	N
Annual morningglory	-	F	N	N	F	G	F-G	G	N	E	N
Black nightshade	-	G	F	N	P	G	E	G	N	F-G	N
Carpetweed	-	-	-	N	-	-	E	E	N	E	N
Cocklebur	-	G	G	G	G	G	G	G	G	G	G
Common chickweed	-	P	N	N	G	G	E	E	N	P	N
Common lambsquarters	G	G	G	G	G	G	G	G	G	G	G
Common ragweed	G	G	G	G	G	G	G	G	G	G	G
Hairy galinsoga	-	-	-	N	-	-	E	E	N	G	N
Henbit	-	G	-	N	-	G	E	E	N	P	N
Horseweed	-	-	G	N	F	G	E	G	N	P	N
Jimsonweed	G	G	G	G	G	G	G	G	G	G	
Knotweed	-	-	-	N	-	-	E	F-G	N	F	N
Mustards	G	-	N	N	-	G	E	P-F	N	G	N
Pennsylvania smartweed	G	G	G	G	G	G	G	G	G	G	N
Pigweeds	-	G	P	N	-	G	E	G	N	G	N
Prickly lettuce	-	-	-	N	G	G	E	G	N	P	N
Prickly sida	-	-	-	N	-	G	E	E	N	G	N
Purslanes	-	-	-	N	-	G	E	G	N	G	N
Shepherd's-purse	-	-	-	N	-	G	E	F-G	N	G	N
Speedwells	-	-	-	N	-	-	E	P	N	P	N
Velvetleaf	-	E	P	N	G	G	E	E	N	G	N
Virginia pepperweed	-	-	-	N	-	-	E	G	N	G	N
PERENNIAL GRASSES AND SEDGES											
Fescues	N	-	N	P-F	N	F	E	F	F	N	F
Johnsongrass (rhizome)	N	-	N	G	N	-	E	P	G	N	G
Nimblewill	N	-	N	F-G	N	-	G-E	P	-	N	-

Table 16. Relative Effectiveness of Postemergence Herbicides in Tree Fruits (cont.)

(E=excellent; G=good; F=fair; P=poor; N=none)

CHEMICALS	Bentazon (Broadloom)	Carfentrazone (Aim)	Clopyralid (Stinger)	Fluazifop-P (Fusilade DX)	Fluroxypyr (Starane)	Glufosinate (Rely)	Glyphosate (Various)	Paraquat (Gramoxone)	Sethoxydim (Poast)	2,4-D	Clethodim (Select)
Orchardgrass	N	-	N	F	N	-	E	F	F	N	-
Quackgrass	N	-	N	G	N	P	G	P	G	N	G
Yellow nutsedge	N	-	N	N	-	G	G	P	N	N	N
Purpletop, Redtop	N	-	N	G	N	-	E	P	-	N	-
Dallisgrass	N	-	N	G	N	-	E	P	G	N	-
Bermudagrass	N	-	N	F-G	N	F	G	P	F-G	N	F-G
PERENNIAL BROADLEAF WEEDS											
Broadleaf plantain	-	-	F	N	-	-	E	P	N	G	N
Buckhorn plantain	-	P	F	N	P	F	E	P	N	G	N
Canada thistle	-	-	F	N	-	-	F-G	P	N	F-G	N
Chicory	-	-	-	N	-	-	E	P	N	G	N
Common mallow	-	-	-	N	-	-	E	P	N	-	N
Common milkweed	-	-	-	N	P	-	G	P	N	P-F	N
Common yarrow	-	-	-	N	-	-	G	P	N	F	N
Dandelion	-	P	F	N	G	G	E	P	N	G	N
Docks (broadleaf, curly)	-	P	-	N	-	-	G	P	N	F-G	N
Goldenrod	-	-	-	N	-	-	E	P-F	N	P-F	N
Ground ivy	-	-	-	N	-	G	G	P-F	N	P-F	N
Hemp dogbane	-	-	-	N	F-G	P	F	P	N	P-F	N
Horsenettle	-	-	-	N	-	G	F-G	P	N	P	N
Mugwort	-	-	P	N	-	-	F	P	N	P	N
Red sorrel	-	-	-	N	-	G	G	P	N	P	N
Thistles (bull, musk, plumeless)	-	-	G	N	-	-	G	P	N	F-G	N
White flowered aster	-	-	-	N	-	-	E	P-F	N	N	N
Wild carrot	-	-	-	N	-	-	E	P	N	G	N
Wild strawberry	-	-	-	N	-	-	E	P-F	N	P-F	N
Yellow nutsedge	-	F	N	N	N	N	N	N	N		
Yellow rocket	-	-	-	N	-	-	E	F	N	P-F	N
Yellow woodsorrel	-	-	-	N	-	G	E	P	N	F	N
SPECIAL PERENNIAL WEED PROBLEMS											
Bigroot morningglory	-	-	-	-	-	-	-	-	-	-	-
Brambles	-	-	-	-	-	-	-	-	-	-	-
Common greenbriar	-	-	-	-	-	-	-	-	-	-	-
Japanese honeysuckle	-	-	-	-	-	-	-	-	-	-	-
Poison-ivy	-	-	-	-	-	-	-	-	-	-	-
Virginia creeper	-	-	-	-	-	-	-	-	-	-	-
Wild garlic	-	-	-	-	-	-	-	-	-	-	-

Herbicide Recommendations

Tables 15, 16 and 17 should be utilized to assist in the selection and use of appropriate herbicides and/or their combinations. For Tables 15 and 16, herbicide effectiveness is rated as follows: E = 90-100% control, G = 80-90% control, F = 70-80% control, P = 30-70% control, and N = no control.

- The first column in Table 17 gives a generalized statement about the type of weeds controlled.
- The second column of Table 17 gives the common chemical name of the active ingredient followed by the trade name and formulation in parenthesis. There may be several trade names and formulations of a single active ingredient.
- The amount of herbicide on a sprayed-acre basis is given in the third column of Table 17. Remember that a sprayed acre is not the same as an acre of orchard because herbicides are normally applied in a band within the tree row. The first figure represents the amount of active ingredient per acre, and the amount of commercial product is in parenthesis. Always consult the label to get specific directions for use.

APPLES AND PEARS

Table 17. Herbicides and Rates Recommended for Use in Apple and Pear Orchards.

For more complete information see discussion on individual herbicides.[a]

Weeds Controlled	Herbicide Chemical Name (Trade Name)	Amount Per Acre Sprayed Active Ingredient (Formulated Product)
Year of Planting		
Preemergence		
Annual grasses and some broadleaf weeds; suppression of some perennial grasses	norflurazon (Solicam DF)	2.0-4.0 lb a.i. (2.5-5.0 lb)
Annual grasses and some broadleaf weeds	oryzalin (Surflan 4AS)	2.0-6.0 lb a.i. (2.0-6.0 qt)
Annual grasses and some broadleaf weeds	pendimethalin ([b]Prowl 3.3EC, Prowl H2O)	1.9-3.8 lb a.i. (2.4-4.8 qt Prowl 3.3EC, 2-4 qt Prowl H2O)
Annual broadleaves and some annual grassy weeds	oxyfluorfen (Goal 2XL, GoalTender)	0.5-2.0 lb a.i. (2.0-8.0 pt/A Goal 2XL or 1.0-4.0 pts/A for GoalTender banded applications)
Annual grasses and broadleaves and some perennial grasses and broadleaves	dichlobenil (Casoron 4G)	4-6 lb a.i. (100-150 lb)
Postemergence		
Annual and perennial grasses	[b]fluazifop-P (Fusilade DX)	0.25-0.37 lb a.i. (16-24 fl oz) + 1 qt crop oil concentrate or 1/2 pt of a nonionic surfactant per 25 gal
Annual and perennial grasses	[b]clethodim (Select 2EC, Select Max)	0.1-0.125 lb a.i. (6-8 fl oz Select 2EC or 9-16 fl oz Select Max per acre plus 0.25% nonionic surfactant
Annual and perennial weeds	glyphosate (various)	0.75-3.75 lb a.e. (Roundup PowerMax II, Roundup WeatherMax 22 fl oz - 3.3 qt, or other labeled formulation) (For spot treatment use 1.3-2.6 fl oz/gallon) (For wiper applications use a 33% solution)
Annual weeds upon general contact	paraquat (Gramoxone SL)	0.64-1.0 lb a.i. Gramoxone Inteon 2.5-4.0 pt/A + 8-32 fl oz of nonionic surfactant per 100 gal
Annual and perennial grasses	sethoxydim (Poast)	0.5 lb a.i. (1.5-2.5 pt) + 1 qt crop oil concentrate per acre
Annual broadleaf weeds	carfentrazone (Aim EC, Aim EW)	1.0-2.0 fl oz/A + 0.25% v/v nonionic surfactant or 1% v/v crop oil concentrate
Yellow nutsedge and certain broadleaf weeds	bentazon (Broadloom)	1-2 pt 0.5-1.0 lb. Nonbearing only. Add a crop oil concentrate at 1% v/v. Treat when yellow nutsedge is 4-6 inches tall and repeat the application 10 days later. Do not allow spray to contact green stems, bark, or crop foliage.

[a] Pesticide applications must be made according to the manufacturer's label directions. Always read and follow the pesticide label directions prior to use. Some herbicides require a waiting period between application and replanting and/or harvesting.
[b] Labeled for non-bearing trees only.

Table 17. Herbicides and Rates Recommended for Use in Apple and Pear Orchards. (cont.)

For more complete information see discussion on individual herbicides.[a]

Weeds Controlled	Herbicide Chemical Name (Trade Name)	Amount Per Acre Sprayed Active Ingredient (Formulated Product)
Trees established one full year		
Any of the Treatments for Bearing Trees Listed Previously or One of the Following		
Postemergence		
Broadleaf weeds	2,4-D (Weedar 64, Orchard Master)	1.4 lb a.i. (1.5 qt/A)
	2,4-D choline (Embed)	0.47-1.9 lb ai/A 1-4 pints/A
Annual and perennial weeds	glufosinate (Rely 280)	0.88-1.5 lb a.i./A (48-82 fl oz/A)
Certain broadleaf weeds (apples only)	clopyralid (Stinger)	0.09-0.25 lb ai (1/4-2/3 pt/A)
Yellow nutsedge	halosulfuron (Sandea)	0.023-046 lb a.i. (0.5-1.0 oz/A)
Preemergence		
Most annual and some perennial weeds	diuron (Karmex DF)	3.2 lb a.i. (4.0 lb)
Annual and perennial grasses	pronamide (Kerb 50W or Kerb SC)	1.0-4.0 lb a.i. (Kerb 50W 2.0-8.0 lb or Kerb SC 2.5-9.5 pt)
Annual grasses and broadleaf weeds	rimsulfuron (Matrix FNV)	0.66 lb a.i. (4 oz)
Most annual weeds	simazine (Princep, Caliber 90 or 4L)	2.0-4.0 lb a.i. (2.2-4.4 lb or 2.0-4.0 qt)
	flumioxazin (Chateau WDG)	0.19-0.38 lb ai (6-12 oz)
Trees Established at least 2 years		
Annual broadleaf weeds and yellow nutsedge	carfentrazone + sulfentrazone (Zeus prime XC)	0.21-0.42 lb ai (7.7-15.2 fl oz)
Trees Established Two Full Years		
Any of the Treatments for Bearing Trees Listed Previously or One of the Following:		
Most annual and some perennial weeds	diuron (Karmex DF) plus terbacil (Sinbar WDG) (apples only)	0.8-1.6 lb ai (1.0-2.0 lb)+0.8-1.6 lb a.i. (1.0-2.0 lb)
Trees Established Three Full Years		
Any of the Treatments for Bearing Trees Listed Previously or One of the Following:		
Annual and many perennial weeds	terbacil (Sinbar WDG) (apples only)	1.6-3.2 lb ai (2.0-4.0 lb)
Most annual weeds	indaziflam (Alion) (apple and pear)	0.065-0.085 lb ai/A (5-6 oz/A)
Trees Established Four Full Years		
Any of the Treatments for Bearing Trees Listed Previously		
Annual and perennial broadleaf weeds	fluroxypyr (Starane Ultra) (apples and pears only)	0.14-0.49 lb ai (0.4-1.4 pint)

[a] Pesticide applications must be made according to the manufacturer's label directions. Always read and follow the pesticide label directions prior to use. Some herbicides require a waiting period between application and replanting and/or harvesting.

[b] Labeled for non-bearing trees only.

STONE FRUITS

See introductory discussion and specific remarks under "Apples and Pears". The same principles of safe and effective herbicide use apply to other tree fruit crops as well. An "X" in any block of the table below indicates that the herbicide in the left column is registered and may be used for weed control in that crop at the same rate(s) and under the same conditions as recommended for use in apples and pears. If the space is blank, the herbicide is not registered for use in that particular crop.

Most research on the herbicide performance and safety to fruit crops at Virginia Tech and West Virginia University has been conducted on apples and peaches. However, the use of herbicides and their combinations mentioned for other tree fruits is also believed to be valid, based on the best information available from other sources and limited experimentation in Virginia and West Virginia.

Table 18. Herbicides for Use in Stone Fruit Orchards[1]

Herbicide	Cherries	Nectarines	Peaches	Plums
bentazon	X	X	X	X
cafentrazone	X	X	X	X
clethodim[5]	X	X	X	X
clopyralid	X	X	X	X
dichlobenil	X			
diuron[3]			X	
fluazifop-P	X	X	X	X
flumioxazin[2]	X	X	X	X
glufosinate	X	X	X	X
glyphosate[4]	X	X[4]	X[4]	X[4]
indaziflam[3]	X	X	X	X
norflurazon[6]	X	X	X	X
oryzalin	X	X	X	X
oxyfluorfen	X	X	X	X
paraquat	X	X	X	X
pendimethalin	X	X	X	X
pronamide[2]	X	X	X	X
rimsulfuron[2]	X	X	X	X
sethoxydim	X	X	X	X
simazine[2]	X		X	
terbacil[3]			X	
2,4-D (Orchard Master)	X		X	X
2,4-D (Weedar 64, Embed)	X	X	X	X

[1] For recommended rates of herbicides and directions, see Table 16, "Herbicides and Rates Recommended for Use in Apple and Pear Orchards". See p. 133 for oxyfluorfen.
[2] Use on trees established at least one year.
[3] Use on trees established at least three years. A diuron-terbacil combination may be applied to peach trees established at least two years. See label for maximum combined rates.
[4] Use with wick applicator only.
[5] Nonbearing trees only, except for Select Max, which can be applied to bearing peaches.
[6] Apply at least 18 months after planting cherries, 6 months after planting nectarines or peaches or at least 12 months after planting plums.

PLANT GROWTH REGULATORS FOR FRUIT TREES

Introduction

Plant growth regulators are used in commercial fruit production to modify plant growth and development. Some growth regulators primarily affect vegetative growth, others influence the reproductive organs, including flowers and/or fruit, and still others may induce responses in both vegetative and fruiting parts of the plant. Plant response to a particular growth regulator depends upon the target plant species, cultivar, health, chemical concentration, adjuvants mixed in the spray solution, environmental conditions, and application timing. There are sizable differences in responsiveness among plants, and each species and cultivar should be considered separately.

A tree's overall health integrates many biotic and abiotic factors including the previous year's crop load, stress from excessive or inadequate moisture, damage from diseases or pests, nutrient deficiencies, as well as general vigor. Growth regulator treatments should be adjusted on the basis of the condition of the plant to both maximize the benefits and minimize the risks from using these chemicals.

Chemical considerations relate to the specific compound, the amount applied and, more specifically, how much chemical is actually absorbed into the plant. Absorption can be altered by the chemical formulation and concentration, the use of adjuvants, as well as spray coverage. It should be kept in mind that growth regulator effects are often dose dependent and there is often a very small margin for error. Overdoses can cause injury and/or crop loss, while inadequate doses may give a suboptimal response.

Environmental conditions also play a significant role in growth regulator treatments. Of major consequence are temperature, rainfall, sunlight, and relative humidity. Since most growth regulators are readily absorbed while still in solution on the plant, spray drop drying rates must be considered. Conditions such as moderate temperatures and high humidity slow drying time, and may increase growth regulator uptake compared to a period of high temperature and low humidity. Rainfall within several hours of a growth regulator application can wash the material off the plant and reduce the response. Therefore, it is advisable to only make growth regulator applications when several hours of rain-free weather are expected to follow. Temperature extremes should also be avoided. Optimal growth regulator responses result from applications made at temperatures between 65 and 85ºF. Temperatures below 65ºF tend to lead to suboptimal responses; above 85ºF, response may be excessive and injury or crop loss may occur.

A final factor is timing of treatment. Although with some growth regulators there is considerable flexibility, for others there may be only a day or two when the ideal response can be obtained.

Always leave untreated or check plants to compare with the treated plants. Without such checks, it is impossible to evaluate the effectiveness of the treatment. It is also important to keep detailed records, including treatment date and time, plant or fruit stage of development, weather conditions, concentration, gallons per acre, so that favorable results can be replicated and negative results can be avoided.

Chemical Thinning of Apple Fruit

Fruit thinning increases profitability by promoting return bloom and thus annual bearing, reducing limb breakage, and improving fruit size and color. For trees with a heavy set, it may be necessary to remove 70 to 80% of the fruit. Fortunately, over-thinning seldom occurs. Crop load management failures are usually due to under-thinning.

Keeping accurate records, observing conditions in the orchard, and understanding the factors affecting chemical thinning response all contribute to selecting the best material, rate, and timing for a successful crop load management program.

FACTORS AFFECTING THINNING RESPONSE

Responses to chemical thinners are affected by multiple interacting variables making it difficult to separate the effects of individual factors. Some degree of judgment, based on experience, is necessary when selecting chemicals, rates, and timing for any given block of trees. Below are the primary factors to consider.

Absorption of chemical thinner by the leaf is necessary for activity and is affected by the waxy cutin layer on the leaf surface. Dry, sunny conditions for one or more weeks before thinning increases the thickness of the leaf cuticle and reduces absorption. Prolonged cool periods condition leaves for increased absorption. Exposure of blossoms and young leaves to freezing conditions increases absorption.

Cultivar (variety). Responses to chemical thinning can differ substantially amongst cultivars. For example, 'Golden Delicious' is difficult to thin with carbaryl, but may be over-thinned with ethephon. Table 19 lists the relative sensitivity to chemical thinners.

Drying time. Slow drying time usually causes greater absorption and response. Low humidity, wind, and inadequate spray volume can result in fast drying, low absorption, and poor thinning. Warm temperatures accompanied by high humidity before or soon after the chemical application can favor high absorption. Applications when temperatures are below 60ºF are usually ineffective, particularly with NAA. Optimum temperatures are 70 to 75ºF. Above 85ºF, the thinning response is increased. Sometimes rain occurs shortly after thinners are applied. However, thinning chemicals should be effective if the spray dries before a rain event. Inadequate thinning may result if the rain occurs before the thinning spray dries completely.

Frost events from bud break to the time of fruit set can damage plant tissues and cause stress on the tree. This stress may induce additional thinning, or cause chemical thinning materials to cause more fruit drop than would otherwise occur. In years with spring frosts, it is advisable to reduce application rates to prevent over-thinning.

Fruit set should be carefully evaluated prior to chemical thinning. Following bloom, the developing fruit compete for carbohydrates in the tree. The number of viable seeds affects fruitlet strength, and, consequently, poor pollination and low temperatures can reduce set. However, evaluating seed number when fruitlets are small is difficult because fertilized and non-fertilized seeds look similar. Cool, overcast weather and low temperature will reduce photosynthesis and can result in weak fruit and poor set. Warm, overcast weather will cause fruit abscission. Chemical thinners act to intensify the fruit-to-fruit and fruit-to-shoot competition. On trees with light return bloom, chemical thinning may be inadequate due to minimal fruit-to-fruit competition. If poor fruit set is anticipated, chemical thinners should be applied at a slightly later fruit development stage.

Sunlight, Temperature, and Carbohydrate Status.

During the spring, apple trees rely on carbohydrates stored in the woody tissues to supply the necessary energy for early season growth and flowering. As fruitlets grow to about 15 mm diameter, they are very sensitive to the relative carbohydrate status within the tree. In general, sensitivity to chemical thinners is associated with low carbohydrate reserve levels in the tree. Environmental conditions such as sunlight and temperature greatly affect carbohydrate status. As a general rule, sunny days and cold nights promote the accumulation of photoassimilates, whereas cloudy days and warm nights result in carbohydrate deficit. This associating between weather conditions and tree carbohydrate reserve has encouraged researchers at Cornell University to develop a model known as "The Cornell apple carbohydrate-thinning model" that calculates the daily carbohydrate surplus or demand of an apple tree and provides instructions on the dose and timing of thinning applications, based on the solar radiation, temperature and day length records acquired from local weather stations. This model can be accessed online at the Network for Environment and Weather Applications (NEWA) webpage: http://newa.cornell.edu/index.php?page=apple-thin. For the 2018 season, Dr. Sherif will be running the model using weather data for Winchester, Central Virginia, and probably other locations. Model outputs and interpretations will be shared at extension meetings and posted online at: www.ext.vt.edu/topics/agriculture/commercial-horticulture/tree-fruit/index.html.

Crop developmental stage: Crop load management by chemical thinners can start at bloom stage and continues until fruits reach 25 mm in diameter. Although bloom thinning is not an appealing option for apple fruit growers in Virginia and other Mid-Atlantic states, due to the high likelihood of spring freezes that can damage all the primary blossoms; chemicals and models to aid this thinning treatment are well-established. Thinning at this stage is often based on chemicals that cause damage to flower parts (e.g. liquid lime sulfur and fish oil), thereby preventing flower fertilization and fruit set. To achieve optimal thinning at this stage, researchers at the Virginia Tech's AHS Jr. AREC, Winchester, have developed a model known as "The pollen tube growth model", that predicts the optimal application timing by calculating the time required to fertilize the king bloom after pollination. Researchers from Cornell and Virginia Tech universities are currently working on including this model to the NEWA webpage and it is anticipated that the model will be accessible for beta-testing by the 2018 apple bloom season.

Fruit size is another major factor that determines the efficiency of chemical thinning. When fruits are small in size (~ 6 mm), their demand of carbohydrate is not too much to cause a significant reduction in the tree carbohydrate reserve, therefore fruits become less prone to thinning. However, chemical thinners such as naphthaleneacetic acid (NAA) and 1-naphthyl methylcarbamate (carbaryl) and, to some extent, naphthaleneacetamide (NAD) can exert some influence at this stage. As fruits grow to 7-14 mm, their cells divide rapidly and their demand of carbohydrate becomes greater than what vegetative tissues can supply, particularly if weather conditions do not support carbohydrate surplus. At this stage, thinning can be achieved by 6-benzyladenine (BA), NAA, NAD and/or carbaryl. At a diameter of 20 mm or more, fruits would have enough carbohydrate reserve and their seeds would produce auxin that interferes with ethylene-mediated fruit abscission; therefore, fruits become more tolerant to thinning applications. Thinning at this stage, also known as delayed/ rescue thinning, relies mostly on the combined application of 2-chloroethylphosphonic acid (ethephon) and carbaryl. Table 21 shows the recommended thinning applications in each stage of flower/fruit development and the dose of each chemical thinner.

Tree age. Young trees with good vigor tend to be easier to thin than more mature trees.

Tree vigor. Low tree vigor intensifies fruit-to-fruit competition and results in trees being easier to thin. Stress can be induced by inadequate or excessive soil moisture, and nutrient deficiencies.

Table 19. Relative Sensitivity Of Common Cultivars to Chemical Thinners

Easy to Thin	Moderate to Thin	Hard to Thin
Granny Smith, Jonagold, Jonathon, Pink Lady, McIntosh, Idared, Cortland, Ginger Gold, Mutsu, Northern Spy, Zestar	Ambrosia, Honeycrisp, Cameo, Empire, Red Delicious, Braeburn, Stayman	Gala, Golden Delicious, Rome, Fuji, Newton Pippin, York, Winesap, Lodi, Macoun

MATERIALS USED FOR CHEMICAL THINNING

1-NAPHTHYLACETAMIDE (NAD, NAAm) (AMID-THIN W) is usually applied 4 to 8 days after full bloom (generally at petal fall). Although NAD is most often used for summer cultivars, the same timing has been effective on fall and winter cultivars. Some fall and winter cultivars may also been satisfactorily thinned when NAD is applied from petal fall to 2½ weeks after full bloom. This material may cause pygmy fruit and should not be used on Red Delicious, Fuji, and other pygmy-prone cultivars when applied after petal fall.

1-NAPHTHALENEACETIC ACID (NAA) (Fruitone-L, Fruitone-N, PoMaxa) is usually applied 14 to 18 days after full bloom (7 to 12 mm average fruit diameter). This material may induce pygmy fruit on spur strains of Red Delicious, Fuji, and other pygmy-prone cultivars. Cool weather following NAA application may cause pygmy fruit development on all cultivars. Application of NAA when fruit are smaller than 10 mm will cause greater thinning response and induce fewer pygmy fruit. When combined with carbaryl, reduce NAA to ¼ to ¾ of full rate for the cultivar depending on the desired amount of thinning. NAA should be applied when the air temperature is between 70 – 75°F. Temperatures above 85°F might lead to over-thinning and pygmy/misshapen fruits; whereas temperatures below 60°F will not be too effective.

6-BENZYLADENINE (6-BA) [EXILIS PLUS (2% W/W), MAXCEL (1.9% W/W), AND RITEWAY (1.9% W/W)]. 6-BA is applied at 75 to 200 ppm when the average diameter of king fruitlets is about 10 mm. Fruit thinning activity increases with warmer temperatures (> 65°F). 6-BA has minimal negative impacts on bees and mite predators. For fruit thinning, the maximum amount of 6-BA to be used per acre per season should not exceed 308 fl oz (481.25 ppm).

Perlan and Promalin are mixtures of 6-benzyladenine (1.8% w/w) and gibberellins A_4A_7 (1.8% w/w). In Virginia, relatively poor thinning occurred when these materials were combined in a formulation called Accel and applied at the recommended rates and timing. These materials are no longer labeled or recommended for thinning apple fruit.

ETHEPHON (ETHEPHON 2, ETHEPHON 2SL, ETHREL) are all formulated with 21.7% active ingredient. Ethephon is most effective when fruit size is 14 to 28 mm in diameter. Ethephon is usually combined with carbaryl or Vydate on difficult to thin cultivars and where return bloom has been a severe problem. Ethephon has variable responses due to air temperature and humidity, as well as spray water volumes. Over-thinning is more likely with this material than with other thinners. For this reason, ethephon has been primarily used where earlier thinning applications have not been successful or on very difficult to thin cultivars and where return bloom has been a severe problem. Thinning results with ethephon varies greatly among cultivars. Ethephon is not very effective on Gala, but it is very effective on Golden Delicious and Rome. For alkaline water, buffering the spray solution to a pH of 3 to 5 will increase chemical stability and effectiveness. Do not use before a light rain or dew or when temperatures above 90˚F are expected soon after the application because excessive thinning will likely occur.

CARBARYL (SEVIN XLR PLUS, CARBARYL 4L) is most often applied by itself at petal fall and/or in combination with another active ingredient such as NAA, NAD, or 6-BA when fruitlets are approximately 10 mm in diameter. Carbaryl is a carbamate insecticide that is toxic to bees and predatory mites and should not be applied when flowers are in bloom or beehives are still in the orchard. Additionally, wettable powder formulations leave a residue with pollen-sized particles that may be picked up by bees and brought back to hives. Liquid formulations, such as Sevin XLR Plus and Carbaryl 4L, are considered to be safer because they are less likely to be picked up by bees and brought back to the hive. Observe young trees periodically for mite development that may occur following the use of carbaryl. Treat with a recommended miticide if necessary to maintain tree vigor.

OXAMYL (VYDATE L) applied at the rate of 2 to 4 pints per acre at petal fall to 14 mm fruit diameter has comparable thinning activity to carbaryl applied at 1 pt per acre. Do not apply Superior Oil with Vydate because fruits may develop a dark dull red color at harvest. Oxamyl is a carbamate insecticide that is toxic to bees and predatory mites. Vydate is labeled for apple thinning in Virginia and West Virginia, but not in Maryland.

OIL. The addition of 1 to 2 qt per 100 gal of a 70-sec superior oil increase the thinning activity of plant growth regulators. However, the addition of oil may cause russetting on some cultivars. On its own, oil is not a strong thinner. Other oils, such

as Stylet, fish, and vegetable will provide a similar thinning activity to superior oils, though rates may differ. Captan and potentially other pesticides can cause russeting if used within 7 days of an oil application.

SURFACTANTS. The addition of a surfactant, such as Regulaid or LI-700, to a chemical thinning application will increase the thinning response. Surfactants are very useful in years when trees need to be more aggressively thinned. However, for most growth regulators used for thinning they are not necessary. Follow the manufacturers' labels for specific rate recommendations.

TIMING CHEMICAL THINNING APPLICATIONS

Response of fruit to thinners, particularly NAA, depends partly on the stage of fruit development at time of application. Weather conditions following bloom can influence the rate of fruit development—cool weather slows fruit growth while warm weather accelerates fruit growth. Different varieties, as well as blocks in different locations may grow at different rates. Consequently, days-after-full-bloom may not be the best method to determine application time. Fruit diameter is a better metric for determining application timing (Figure. 5).

Figure 4. Selected Diameters (mm) For Timing Chemical Thinners

Results from chemical thinners can vary depending on the average fruit size at the time of thinning. Measuring many individual fruits is time consuming. Fruit diameter can be estimated accurately by weighing 100 fruits (with stems attached) per block. Collect 4 spurs from each of 10 trees per block. Remove all the fruits (with stems attached) from a spur that appear as if they are still growing. Place the fruits in a bag and record the weight in ounces or grams. To convert from ounces to grams multiply ounces by 28.4. Table 20 gives the fruit diameter corresponding to the weight of 100 fruits for conical (for example, Red Delicious, Golden Delicious, and Gala) and round varieties (for example, Fuji, York, Rome, and Empire).

Table 20. Fruit Weight to Fruit Diameter Conversion Table

Weight of 100 Fruit with Stems		Average Fruit Diameter in Millimeters	
(ounces)	(grams)	Conical Varieties	Round Varieties
0.88	25	5.1	5.4
1.06	30	5.9	6.4
1.4	40	7.1	7.9
1.8	50	8.0	9.0
2.5	70	9.3	10.5
3.2	90	10.3	11.6
3.9	110	11.1	12.6
4.6	130	11.8	13.2
5.6	160	12.7	14.2
7.0	200	13.7	15.2
8.5	240	14.6	16.2
9.9	280	15.4	16.9
11.6	330	16.4	17.7
13.8	390	17.5	18.5
15.9	450	18.6	19.5
18.4	520	19.7	20.5
20.8	590	20.9	21.7

Example 1: If 100 'Red Delicious' fruit weigh 4.6 ounces (130 grams), then average fruit diameter is 11.8 mm.
Example 2: If 100 'York' fruit weigh 9.9 ounces (280 grams), then average fruit diameter is 16.9 mm.

Fruit with diameters greater than 14.0 mm will usually not respond to recommended rates of 6-BA or NAA. Fruit with diameters of 8.0 to 12.0 mm exhibit optimal thinning for these materials. Ethephon is a mild thinner if applied when average

fruit size is less than 10.0 mm. Optimum thinning with ethephon occurs when fruit are 14.0 to 24.0 mm; however, under some conditions combinations of ethephon plus carbaryl or oxamyl may be very effective on fruit diameters of up to 28 mm.

The smaller fruit on a tree on the day of treatment are the most susceptible to most thinning materials, and the larger fruit tend to be preferentially retained. However, ethephon usually removes large and small fruit on the tree to a similar extent.

If the crop is light due to frost or light bloom, a larger number of fruit may be retained on trees by waiting until the desired number of large fruit are 13.5 mm and larger.

If the crop load is heavy and maximum thinning is required, average fruit size should be approximately 10.0 mm in diameter and the largest fruit about 12.0 mm for 6-BA and NAA applications.

Fruit set is reduced when conditions are poor for pollination and fertilization. Thinners remove a similar percentage of fruit regardless of pollination. To avoid over-thinning in years with poor pollination, mild thinners should be applied or thinners should be applied when average fruit diameter is larger than normal.

Earlier timing (8.0 to 10.0 mm) on spur strains of Red Delicious and most other apple cultivars will improve thinning when NAA is used. NAA, when used alone or in combination with other materials, is often ineffective on spur Red Delicious.

Often a single thinner application will not provide adequate thinning. In many situations, multiple thinning applications may be required.

Table 21. Effective Thinning Sprays According to Fruit Growth Stage

THINNING SPRAYS	APPLICATION RATES/ACRE	THINNING ACTION
Effective thinning sprays at bloom		
Liquid Lime Sulfur + Oil	1-2% + 1-2%	Moderately Aggressive
Effective thinning sprays at petal fall to 5 mm fruit diameter		
NAA	0.5-4.0 fl oz	Moderately Aggressive
NAD	0.25-0.5 lbs	Moderately Aggressive
Carbaryl	1-3 quarts	Moderately Aggressive
Effective thinning sprays at 6-15 mm fruit diameter		
NAA + 6-BA	0.5-4.0 fl oz + 48-128 fl oz	Moderately Aggressive
NAA + Carbaryl	0.5-4.0 fl oz+ 1-3 quarts	Very Aggressive
6-BA + Carbaryl	48-128 fl oz + 1-3 quarts	Moderately Aggressive
NAA	0.5-4.0 fl oz	Moderately Aggressive
6-BA	48-128 fl oz	Slightly Aggressive
NAD	0.15-0.5 lbs	Slightly Aggressive
Carbaryl	1-3 quarts	Slightly Aggressive
Effective thinning sprays at 16 mm-25 mm fruit diameter		
Ethephon	1.5-4.0 pints	Moderately Aggressive
Ethephon + Carbaryl	0.5-4.0 pints + 1-3 quarts	Very Aggressive

Application rates are based upon a concentrate spray volume of 100 gallons per acre and product labels at the time of publication. When applying chemical thinners, follow the rates indicated on the labels of the products that you are using. Always follow the label when applying chemical thinners. The degree of thinning action is listed according to the authors' personal field experiences. The degree of thinning action may vary from orchard to orchard and block to block. Addition of oil and/or non-ionic surfactants to tank mixtures can significantly increase the efficacy of fruit thinning materials. Growers should use oils and surfactants with caution unless heavy fruit thinning is desired.

DEFRUITING YOUNG APPLE TREES

Apple trees, particularly spur-types and trees on dwarfing rootstocks, will often set more fruit than desirable before the tree is large enough to support the crop. Fruit compete with shoot growth when maximum tree growth is desired to fill the allotted bearing space. Allowing fruit to develop on the central leader can cause the leader to bend out of position and ruin attempts to develop a good tree structure. In addition, fruit on young trees are usually large, irregular in shape, and of poor keeping quality.

The fruit can be removed by hand shortly after bloom; however, this is a slow and labor-demanding process. Chemical sprays can be used to remove most of the fruit.

NAA + Carbaryl. This combination removes a large portion of the fruit on some varieties. Use 5 to 8 ppm NAA tank mixed with 1 to 2 pt of carbaryl and a non-ionic surfactant or 1 qt of Superior oil per 100 gal of water. Apply the spray 7 to 14 days after bloom, preferably using a dilute application with a high-pressure handgun before fruit reaches an average of 8 mm in diameter. Select a calm day when temperatures are expected to be between 70 and 90°F. Although this treatment usually will not remove all fruit, it will reduce the amount that must be removed by hand. It is critical to follow-up chemical spray with hand removal because only a couple of fruit too many can damage the central leader.

Ethephon + Carbaryl. This combination will remove most fruit, but may cause tree growth reduction and increase flowering the following year. Use 1.0 to 1.5 pt of ethephon tank mixed with 1 to 2 pt of carbaryl and a surfactant or 1 qt of Superior oil. Apply when fruit are between 10 and 15 mm in diameter as a dilute, high-pressure, handgun treatment. Select a day when daytime high temperatures are expected to be between 70 and 90°F.

Additional Uses of Plant Growth Regulators

IMPROVING FRUIT SHAPE OF APPLE

Promalin or Perlan applied at bloom, can increase typiness (elongated fruit shape) in Red Delicious. Typiness is a desirable market characteristic for Red Delicious and crop value can be increased when fruit length is increased in relation to fruit diameter. Responses may be best with strains that are naturally more typey and under seasonally cool conditions that are naturally better for development of typiness.

Apply Promalin or Perlan from early king bloom to first petal drop of king bloom. Response is improved under maximum absorption conditions—warm temperatures or high humidity with slow drying. A rain-free period of several hours is desired after application. Do not apply when windy, after a rain when plants are wet, or when air temperatures are below 40º or above 90ºF.

Use 1 to 2 pt of Promalin or Perlan per acre in 50 to 200 gal of water. Dilute applications are not recommended. Using a clean spray tank, add Promalin or Perlan to half the water to be used in the spray tank, then agitate while adding the rest of the water needed. Do not combine other spray materials with Promalin or Perlan, although a nonionic wetting agent such as Regulaid or LI 700 may be added.

In some tests, this mixture of plant growth regulators has caused thinning of Red Delicious. An increase in fruit size should be expected if thinning occurs. Thinning may or may not be desirable, depending on fruit set, which cannot be determined at the time of application.

CONTROLLING ROOT SUCKERS AND WATER SPROUTS ON APPLE TREES

Tre-Hold Sprout Inhibitor A-112, an ethyl ester form of NAA, can be used to control root suckers and water sprouts by reducing regrowth. Root suckers can interfere with orchard operations and contribute to aphid problems. Water sprouts also reduce spray penetration and light exposure. Water sprouts and root suckers are usually removed by pruning; however, they usually regrow by the next year.

Root Sucker Control. Use Tre-Hold at 10 oz per gal (10,000 ppm). For best results, prune off the existing root suckers at ground level during the dormant season and treat when new root sucker growth is 4 to 12 inches tall. A second application may be necessary the following year if root suckers are vigorous and regrowth occurs.

Do not apply from bloom to 4 weeks after petal fall because fruit thinning may result. Experience in Virginia and West Virginia indicates that root suckers often reach the 4- to 12-inch stage before 4 weeks after petal fall. In this case, root suckers can be burned down with paraquat. Tre-Hold can then be applied to regrowth when the root sucker reaches the optimum length. Apply with a handgun or backpack sprayer as a low-pressure, directed spray to avoid spray drift.

Water Sprout Control Around Pruning Cuts. Use Tre-Hold at 10 oz per gal (10,000 ppm). Apply with a brush, roller, or small low-pressure pump-up sprayer to pruning cut and several inches around the cut after time of pruning but before growth starts in the spring.

Do not apply with a pressurized handgun. Do not spray into the trees, permit contact with fruit buds, or apply when green growth is present because serious damage can occur. White exterior latex paint can be mixed at the rate of 1 to 4 pt per gal of water to mark where treatments are made. Do not use oil based or latex paints that contain oil.

INCREASING LATERAL BRANCHING

Some varieties, such as spur-types of Red Delicious, tend to produce long, vigorous, unbranched scaffolds, particularly in the early years. This characteristic results in the slow and often inadequate development of fruiting spurs and lateral shoots. Additionally, some high-density orchard systems require highly feathered trees.

Branching is primarily limited to stimulation of growth on 1-year-old wood. Thus, the spray can be directed to these areas of scaffold limbs. Directed sprays can also be used to induce branches for a second or third whorl of scaffolds on the central leader. Treatment of low-vigor trees or trees under drought or low fertility conditions will likely be ineffective, and may injure trees. High vigor is necessary for optimum response.

For small trees, applications with a small hand sprayer or handgun are the most practical for directing the spray. Thoroughly wet bark and foliage surface of areas where response is desired.

Promalin can be used as a single foliar application to apple, non-bearing pear, and non-bearing sweet cherry, including nursery stock to induce branching and help improve tree framework for early cropping. Apply foliar applications of the Promalin at 0.5 to 1.0 pt per 5 gal water (250 to 500 ppm) when new terminal shoots are 1 to 3 inches long (about 1 to 2 weeks after full bloom). Adjuvants or wetting agents may improve the response but have also resulted in phytotoxicity in some cases. Use wetting agents at the rate of 1.0 oz per 5 gal water. The wetting agent should be added to the spray tank before the Promalin or Perlan. The final spray mixture should not be alkaline. If the spray mixture tests alkaline, add an acidifying agent such as vinegar or a buffered surfactant. Promalin can also be applied to bearing apple and non-bearing cherry trees as a latex paint application at the rate of 5,000 to 7,500 ppm (0.2 to 0.33 pt), to increase branching and improve branch angles. Latex applications should be made in the spring at the bud swelling stage and before shoots emerge. Scoring branches first with a Sheetrock knife can increase the effectiveness of Promalin paint.

Promalin at the rate of 250-500 ppm can cause fruit set and can also prevent flower bud formation for the next year. Thus, whole tree treatments should be limited to young, non-bearing trees.

6-Benzyladenine (6-BA) can effectively induce branching on current season and one-year-old apple branches. Recommended rates range from 250 to 500 ppm (128 oz per 40 gal water) for spray applications. Multiple applications are needed to ensure branching along the length of the leader. The first 3-4 spray applications should be made at 28-30 inches of growth and continue at 5-10 day intervals. MaxCel can also be painted onto trees at the desired location for branch initiation by using 5,000 to 7,500 ppm (0.2 to 0.33 pt of MaxCel per pint of latex paint). Latex application should be made when terminal buds begin to swell and before shoots emerge. MaxCel latex paint mixture should be applied by a brush or sponge to the bark surface where branching is desired. MaxCel is also labeled for increasing branching in pear and cherry trees. Exilis Plus is another 6-BA that is labelled for increasing branching and feathering of non-bearing apple, pear and cherry trees.

PROMOTING FLOWER INITIATION AND CONTROLLING VIGOR IN YOUNG APPLE TREES

Various orchard practices can be employed to initiate flowering and fruiting and control vegetative growth. These include limb spreading, proper pruning, proper nitrogen fertilization, scoring, and growth regulator treatments.

Ethephon for Non-bearing Trees. Young, vigorously growing apple trees can be slow to come into bearing, especially varieties such as Red Delicious and trees with more vigorous rootstocks. Along with other cultural practices, ethephon can help to bring such trees into bearing. This treatment should only be done on young, non-bearing trees that have developed an adequate structure to support a crop. Stunting may occur if applied to weak or very young trees, particularly spur types, because ethephon will likely slow shoot growth.

INCREASING FRUIT SET

ReTain (Aminovinylglycine) is labeled for increasing fruit set of apple, cherry, and European pears. Use rate is 333 g per acre applied at early flowering to petal fall.

Promalin, a mixture of cytokinin (6-BA) and gibberellins, has received a Section 2(ee) label for use through December 2015 as a post frost "rescue" treatment for apple trees in early to full bloom. Apply at 16 to 32 oz per acre in 75 to 150 gal water within 24 hours before or after a frost event. Do not apply to frozen foliage, flowers, or developing fruit. Allow trees to completely thaw before prior to application. Do not use a surfactant.

This treatment will likely result in parthenocarpic (seedless) fruit because it mimicks the chemical responses needed for fruit set. Small fruit size and only a partial crop should be expected.

PROMOTING RETURN BLOOM IN APPLE

Ethephon (Ethephon 2, Ethephon 2SL, Ethrel) can promote flower bud formation when applied from petal fall to about 6 to 8 weeks after full bloom. The greatest effect is from applications made 0 to 4 weeks after bloom. However, since ethephon can cause substantial fruit thinning, multiple weekly applications at rates ½ that of the thinning rate are recommended starting when fruitlets are greater than 30 mm. When possible, it is best to wait until after "June" drop has occurred. At a minimum, wait 7 to 10 days after the last thinning application before starting ethephon return bloom sprays. Additionally, do not apply ethephon to trees that are stressed or trees that are low in vigor.

A single ethephon application can be used at a high rate (up to 900 ppm). However, more consistent results are often obtained from multiple (3 to 4) applications made at 10 to 14 day intervals using lower rates (150 to 300 ppm). One common, and often effective strategy is to make two applications in June and two applications in July.

Sensitivity to ethephon is very different amongst cultivars, thus it is important to choose a rate specific to each variety. Do not exceed 8 pints per acre per year. If trees are over-cropped ethephon may not effectively give adequate return bloom the following season. Higher soluble solids and lower starch levels at harvest may be expected with some cultivars, particularly with high rates and/or late season applications. No loss of firmness has been detected with 'Red Delicious' at the optimum harvest date.

Ethephon sprays can reduce tree growth (dependent on timing and amounts used) and thus may not be desirable for young non-bearing trees if maximum tree growth is desirable.

NAA (Fruitone-L, PoMaxa) applied six to eight weeks after petal fall at 5 to 20 ppm can also promote return bloom. Additional NAA applications at 7 to 14 day intervals will enhance the response.

Note: NAA pre-harvest applications, even at low rate, can cause early ripening, water core, and/or leaf drop in Early MacIntosh and some early summer varieties. Rates above 20 ppm can also affect fruit quality and tree vigor on any variety. A strategy for strongly biennial cultivars is to make 2 to 4 applications of ethephon at 150 ppm tank mixed with NAA at 5 to 10 ppm (or 2.5 to 5 ppm when tank mixed with spray oil).

CONTROLLING APPLE TREE GROWTH WITH PROHEXADIONE-CALCIUM (APOGEE)

The primary objectives of pruning are to control tree size, reduce shading within the tree canopy, increase spur vigor, promote spray penetration, maintain tree structure, and promote good fruit color, size, and quality. Many apple cultivars are grown on vigorous rootstocks and require much pruning, especially in tops of older trees. Ideally, growers should prune annually, but in order to cut costs and/or to reduce labor requirements, a grower may choose to prune every second or third year. Dense canopies caused by current season shoot growth and/or by not pruning in some years, may be detrimental to pest control, fruit quality, color, spray application costs, and yields in subsequent seasons. The advantage of Apogee sprays compared to pruning is that growth inhibition occurs early and continuously throughout the season, which cannot be accomplished by dormant pruning.

Prohexadione calcium (Apogee 27.5DF) applied soon after bloom when there is 1 to 3 inches of shoot growth and at intervals of approximately 3 weeks to apple trees will reduce the current season's shoot growth (shoot length and weight), reduce the number of pruning cuts, pruning time, and pruning weight per tree, and increase the number of nodes on the lower 40 cm of long shoots. Flower bud formation, fruit diameter, soluble solids, starch, individual fruit weight, fruit drop, and fruit cracking (Stayman), typically will not be affected, but fruit set per tree may be slightly increased. Apogee applications did not interfere with thinner activity if applied as a tank mix or before or after the spray. Fruit color and firmness were slightly increased in only one experiment. The amount of growth suppression will be related to tree vigor. Thus, growth will be suppressed more by Apogee when trees are cropped heavily or stressed by drought, and when trees are grown on dwarfing rootstocks. Registered rates for Apogee are 6 to 12 oz per 100 gal dilute or 24 to 48 oz per acre. Calcium in hard water or calcium chloride added to the spray solution will reduce or inactivate Apogee. To reduce interference from calcium in the spray water, ammonium sulfate should be added to the tank before Apogee, at the same rate per 100 gal of spray mix as for Apogee.

Based on research in Winchester, the combination of 6 oz of Apogee plus 6 oz of ammonium sulfate per 100 gal is suggested for moderately vigorous trees. An adjuvant such as Regulaid should be included to improve systemic uptake of Apogee. Vigorous trees might be more responsive to the 12 oz Apogee rate than to the 6 oz rate. Multiple applications are typically needed to obtain season-long growth suppression. Tree vigor, soil moisture, crop, load, rootstock, etc. will influence the need for additional applications. For maximum effectiveness it is critical that the first application be made in the late bloom (1 to 3 inches of shoot growth), the second application should be made before growth begins again at the most vigorous tips

(approximately 3 weeks). Since maximum growth suppression is obtained before growth resumes, the vigorous trees in the block should be observed so that any additional applications are well timed. If vigorous trees have no crop and adequate soil moisture, more than 4 applications may be required to obtain adequate shoot growth suppression. Do not apply more than 99 oz per acre per year or 48 oz per acre in any 21-day period. Do not apply to Empire as fruit cracking may occur.

SUPPRESSING FIRE BLIGHT SHOOT BLIGHT WITH PROHEXADIONE-CALCIUM (APOGEE)

Apogee (prohexadione-calcium) is registered for suppression of fire blight shoot blight. Shoot blight suppression results from hardening off of vegetative shoot growth starting about 10 days after the initial Apogee application, which should be made at late bloom when active shoot growth is 1 to 3 inches long. Studies in Winchester indicate that Apogee may be tank-mixed with Agri-Mycin, allowing Apogee to take effect while there is residual protection from streptomycin. Registered rates for Apogee are 6 to 12 oz per 100 gal dilute or 24 to 48 oz per acre. An adjuvant such as Regulaid or LI-700 should be included to increase systemic uptake of Apogee. To reduce interference from naturally occurring calcium in the water used for spraying, ammonium sulfate should be added to the tank **before** Apogee, at the same rate per 100 gal of spray mix as for Apogee. Based on research in Winchester, the combination of 6 oz of Apogee plus 6 oz of ammonium sulfate per 100 gal is suggested for moderately vigorous trees. Vigorous trees might be more responsive to the 12 oz Apogee rate than to the 6 oz rate.

Shoot blight suppression is related to early hardening off of shoot tip growth within 10 to 14 days after bloom. Vigorous trees might benefit from further protection with additional Apogee applications in mid-season if shoot growth is resumed. Studies in West Virginia showed that Apogee reduced shoot blight infections that occurred with hail injury in June. Do not apply more than 48 oz per acre within a 21-day period. Practical usefulness of Apogee for shoot blight suppression in a given year might be estimated by the potential severity of fire blight based on the number of infection days that occurred during the bloom period, as well as tree vigor, cultivar susceptibility, and disease history. Apogee is not to be considered a replacement for streptomycin sprays for blossom blight control. Apogee treatment for shoot blight suppression is strongly suggested for vigorous young trees that have nearly filled their tree space.

IMPROVING APPLE FRUIT FINISH

ProVide 10SG is a combination of gibberellins and may reduce the severity of russet on Golden Delicious when applied during the first 50 days after bloom.

Apply ProVide 10SG in 2 to 4 consecutive sprays, beginning sometime between late bloom to petal fall, and continuing at 7 to 10 day intervals for remaining sprays. Apply 2.1 to 3.5 oz (60 to 100 grams) of ProVide 10SG in 100 gallons of spray solution per acre. Do not apply more than 8 oz in a single season. Do not use spreader stickers or other spray adjuvants in combination with ProVide 10SG because they may aggravate russet development. ProVide 10SG can be used to suppress russet of varieties other than Golden Delicious.

REDUCING STAYMAN CRACKING

ProVide 10SG is a mixture of gibberellins that can reduce 'Stayman' cracking if applied before cracking begins. Apply ProVide 10SG 6 times at 14 to 21 day intervals, starting 2 to 3 weeks before cracking begins (mid-June to early July) at 3.6 to 7.0 oz (100 to 200 grams) per acre per application. Enough water should be used to wet the fruit (100 to 200 gallons per acre). If ProVide 10SG is used to suppress russet on Stayman, it cannot be used to suppress cracking.

Table 22. Growth Regulator Fruit Responses.

Growth regulator	Stayman cracking	Red color	Fruit firmness	Watercore	Preharvest drop	Ripening	Storage life
ProVide 10SG	-	~	~	~	~	~	~
Ethephon	~	+	-	+	+	+	-
NAA	~	+	-	~	-	+	-
AVG (ReTain)	~	?	+	-	-	-	+

(-) decreased response; (+) increased response; (?) variable response; (~) no response

INCREASING RED COLORING AND ADVANCING RIPENING

Ethephon (Ethephon 2, Ethephon 2SL, Ethrel) provides several fruit modifying effects on apple trees (Table 22). If used properly, ethephon can spread out picking time for selected parts of orchards by permitting earlier harvesting of better-colored fruit.

Ethephon response is greatest under good fruit-coloring conditions and cannot substitute for conditions associated with poor color development, such as hot weather and poorly pruned trees. Hot, dry conditions may stimulate ripening, softening, and watercore with inadequate red color, particularly on fruit treated with ethephon. Ethephon applications are not advised when trees are under severe water stress and/or high temperatures are anticipated after application.

Ethephon applied alone can cause early and severe fruit drop. The combination of NAA with ethephon will provide adequate drop control. Two sprays of NAA at 20 ppm may be needed. NAA will only prevent fruit drop for 7 to 10 days. Therefore, 7 days after the initial ethephon-NAA application, an additional NAA application should be used if treated fruit will not be harvested by 8 to 9 days after initial application. Since only two NAA applications are permitted for fruit drop control, all treated fruit must be harvested by 8 to 10 days after the second NAA application.

For stimulating red color on fruit to be marketed early, use a dilute spray combination of ethephon at 3/4 to 1 pt per 100 gal plus 4 oz of a surfactant plus NAA as shown in Table 23. Use ethephon 1 to 2 weeks before normal picking time. Do not spray ethephon earlier than 3 weeks before normal harvest date because response may be limited.

Check fruit development closely, and harvest when treated fruit are ready. Do not spray more fruit than can be harvested in a 2 to 3 day period. Watch fruit condition because ethephon reduces starch levels, increases soluble solids, and stimulates ripening and softening of apples on the tree and after harvest. It may be possible to begin harvest earlier in some seasons, or to pick more or most fruit with better color at normal picking time.

Ethephon absorption is decreased at low temperatures. Apply when air temperature is 60 to 85°F. Reduced response may be expected if application is followed by rain or excessive heat.

Table 23. Ethephon Timing and NAA Concentration.

Variety	Ethephon timing (weeks before normal picking date)	NAA Concentration (ppm)*
Golden Delicious	1	10
Jonathan	1-2	10
Red Delicious	1-2	10
Rome	1	10-20
Stayman	1	10-20
Winesap	1	10
York	1	10

*An additional NAA application should be made if fruit are not harvested by 8 to 9 days after initial application.

REDUCING PREHARVEST DROP

Naphthalene acetic acid (NAA) provides preharvest drop control. Proper timing and rates are important for effectiveness (Tables 23 and 24). Anticipating the expected time of drop is affected by weather conditions; however, the period is usually around the normal harvest period for a given variety. Heavy, late season rains or wind, particularly following drought conditions, have been associated with heavy preharvest drop.

Fruit should be harvested as near to the optimum harvest date as possible, even with the use of NAA. NAA reduces the drop of fruit, but fruit ripening continues at normal or even faster rates, especially for Rome and Golden Delicious. If allowed to remain on the tree too long, NAA treated fruit will be of poor quality and will have a decreased storage life.

NAA may not be effective when applied at low-volume concentrations. Use dilute or not higher than 3x rates, based on tree-row-volume calibration. Thorough coverage is necessary. Healthy leaves are necessary for maximum stop-drop spray effectiveness; severe mite injury on leaves can reduce response.

NAA may be most effective when applied before fruit loosen on the tree and applications are most effective if they are done before the fruit starts to drop. NAA becomes effective 2 to 3 days after application. It may be necessary to apply a second spray of NAA if fruit start to loosen. Do not make more than two applications. Additional applications may not be effective. Do not use within two days of harvest.

Aminovinylglycine (AVG, ReTain) provides preharvest drop control and delays fruit maturation. ReTain delays the loss of fruit firmness and starch after the normal harvest date of untreated fruit. The delay is less for 'Red Delicious' and 'York' than for 'Rome' or 'Golden Delicious'. The delay in maturity may allow a cultivar to be harvested several days after the normal harvest date since fruit quality is maintained better than with NAA. A delay in harvest will allow for an increase in fruit diameter and yields that may amount to 0.5% to 1% per day.

For single-pick varieties, ReTain should be applied 4 weeks prior to the anticipated harvest in sufficient water volume to ensure thorough coverage. An organosilicone surfactant must be used to maximize efficacy. Avoid applications of Captan or calcium chloride within one week of an organosilicone surfactant application. For multiple-pick varieties, ReTain can be applied 1 to 2 weeks prior to the anticipated beginning of the normal harvest period of untreated fruit. ReTain will not delay the start of the harvest (first pick), but will help control the maturation rate of later picks. Tank mixing ReTain with pesticides is not recommended.

Table 24. Rates of NAA and ReTain for Preharvest Drop Control

Variety	NAA (ppm)	AVG (ReTain) (g/acre)
Golden Delicious	10	333
Grimes Golden	5	333
Jonathan	10	333
Red Delicious	10	333
Rome	10-20	333
Stayman	10-20	333
Winesap	10-20	333
York	10-20	333
Other late varieties	10-20	333

The combination of ReTain at 333 g per acre applied 4 weeks before the anticipated harvest and NAA at 10 to 20 ppm applied 2 weeks before the anticipated harvest date, can be more effective at reducing pre-harvest fruit drop than when either material is applied alone. This combination of ReTain and NAA also maintained fruit firmness, which may otherwise be reduced by NAA, and fruit was as firm as when ReTain was used alone. Fruit treated with this combination ripened at the same time as untreated control fruit. Reduced ReTain rates of 166.5 to 250 g (1/2 to 2/3 lb) per acre tank-mixed with NAA at 10 to 20 ppm (6 to 8 oz per acre) may also be effective when applied 2 weeks before the anticipated harvest; however, full rates are recommended for blocks where pre-harvest drop is known to be an issue. (Rates assume a tree-row volume from 150 to 300 gallons per acre.)

Peach Flower and Fruit Thinning

Flower thinning promotes increased fruit size and yields, increased tree growth and flower bud numbers the next season compared to hand thinning 35 to 50 days after full bloom. Under cool conditions only 30% of the flowers may set fruit while under ideal conditions some cultivars may set 85% of the flowers. At the time of bloom it is desirable to have twice as many flowers set fruit as would be required for a full crop. This will allow enough fruit for subsequent freezes and/or poor fruit set. Several caustic chemicals, such as ammonium thiosulfate (ATS), liquid lime sulfur, and sulfcarbamide, can damage open peach flowers and reduce fruit set. Unfortunately, these materials have had inconsistent results in commercial orchards, and none are currently labeled for thinning peaches. More consistent results have been obtained with mechanical string thinners that are either hand-held or tractor mounted.

Hand thinning peaches to 6 to 8 inches apart on the branch will result in increased final fruit size and help prevent limb breakage. This activity will be most effective when completed by mid to late June. Hand thinning peaches later in the season will not have as much impact on final fruit size.

Calculating Parts Per Million

In this guide, the amounts of material to be added to 100 gal of water are often given along in parts per million (ppm). If a different formulation is used, the equations below calculate ppm. Labels on some materials present active ingredient (ai) as a salt (NAA-sodium salt) and as an acid equivalent. Here we assume that ai refers to the percentage of equivalent ai.

WETTABLE POWDERS

$$\frac{(lbs\ of\ material) \times (\%\ ai) \times 10{,}000}{(gal\ of\ water) \times 8.345} = ppm$$

Example 1. What is the concentration of a spray solution made by adding 0.072 lbs of a material containing 3.5% ai, into 300 gal of water?

$$\frac{0.72 \times 3.5 \times 10{,}000}{300 \times 8.345} = 10.07\ ppm$$

Example 2. How much of the same material must be added to the 300-gallon spray tank to obtain a 10 ppm solution?

$$\frac{ppm}{\%\ ai} \times \frac{(gal\ of\ water \times 8.345)}{10{,}000} = \frac{10}{3.5} \times \frac{300 \times 8.345}{10{,}000} = 0.715\ lbs\ of\ material$$

LIQUID FORMULATIONS

$$\frac{(oz\ of\ material) \times (\%\ ai) \times 10{,}000}{(gal\ of\ water) \times 8.345} = ppm$$

Example 1. What is the concentration of a spray solution made by adding 11 oz of a material containing 7% ai into 300 gal of water?

$$\frac{11 \times 7 \times 10{,}000}{300 \text{ x } 128} = 20.05\ ppm$$

Example 2. How much of the same material must be added to the 300-gallon spray tank to obtain a 20 ppm solution?

$$\frac{ppm}{\%\ ai} \times \frac{(gal\ of\ water) \times 128}{10{,}000} = \frac{20}{7} \times \frac{300 \times 128}{10{,}000} = 10.97\ oz\ of\ material$$

DETERMINING RATE PER ACRE IN APPLE ORCHARDS - TREE-ROW VOLUME

The use of dosage-dependent chemicals, such as chemical thinners and other growth regulators, in orchard blocks of different tree sizes requires a means of determining effective rate per acre for each tree size situation.

Tree-row-volume calibration is based on application of l gallon of spray material uniformly to every 1425 cu ft of tree canopy row. Standard trees, defined as trees 19.5 ft tall and 23.5 ft wide and planted in rows 35-ft apart, require a rate of 400 gallons dilute mix per acre. Many trees in production today are smaller than standard size and these should be sprayed with less than 400 gallons per acre so that chemical deposits are similar in plantings of different tree sizes.

A graph is presented to determine tree-row-volume of blocks in any orchard and the rate per acre necessary for spraying those blocks on a dilute basis (Fig. 4).

To use the graph, the following steps are provided:

1. Draw a line from 0 (bottom left-hand corner) to the number on the right side (midway up) of the chart that corresponds to the specific distance between rows in the block in question. This forms a baseline for any block that has that same row spacing.
2. Determine tree height and width of trees in block. Multiply height and width to obtain the number for use on left hand side of the graph (tree height x width).
3. Draw horizontal line from the calculated height x width value across graph to point where line intersects diagonal base line already present.
4. Draw line from the intersect point down to bottom line on graph (rate per acre). This point is the required gallons per acre for dilute spraying of the block of trees in question.

Two examples are shown on the graph. Example 1 illustrates 35 ft row spacings with trees that are 19 ft high and 23 ft wide. Draw a base line from 0 to 35, multiply 19 x 23 to get 437. Follow a horizontal line from 437 to the base line. Vertically below this, a base gallonage of 390 gpa dilute can be found. Example 2 shows a need of 313 gpa dilute for 25-ft rows and trees that are 16 ft high and 16 ft wide.

The lower row of numbers on the horizontal axis has been added to allow those using concentrate sprayers to compute the needed rate per acre. The base figure to use in this case is the rate of material per acre given on a product label. Whether spraying concentrate or dilute, the basis is that smaller, easier-to-spray trees need less material per acre than standard sized trees. This second row of numbers is used to compute the percentage of the full dilute rate per acre needed.

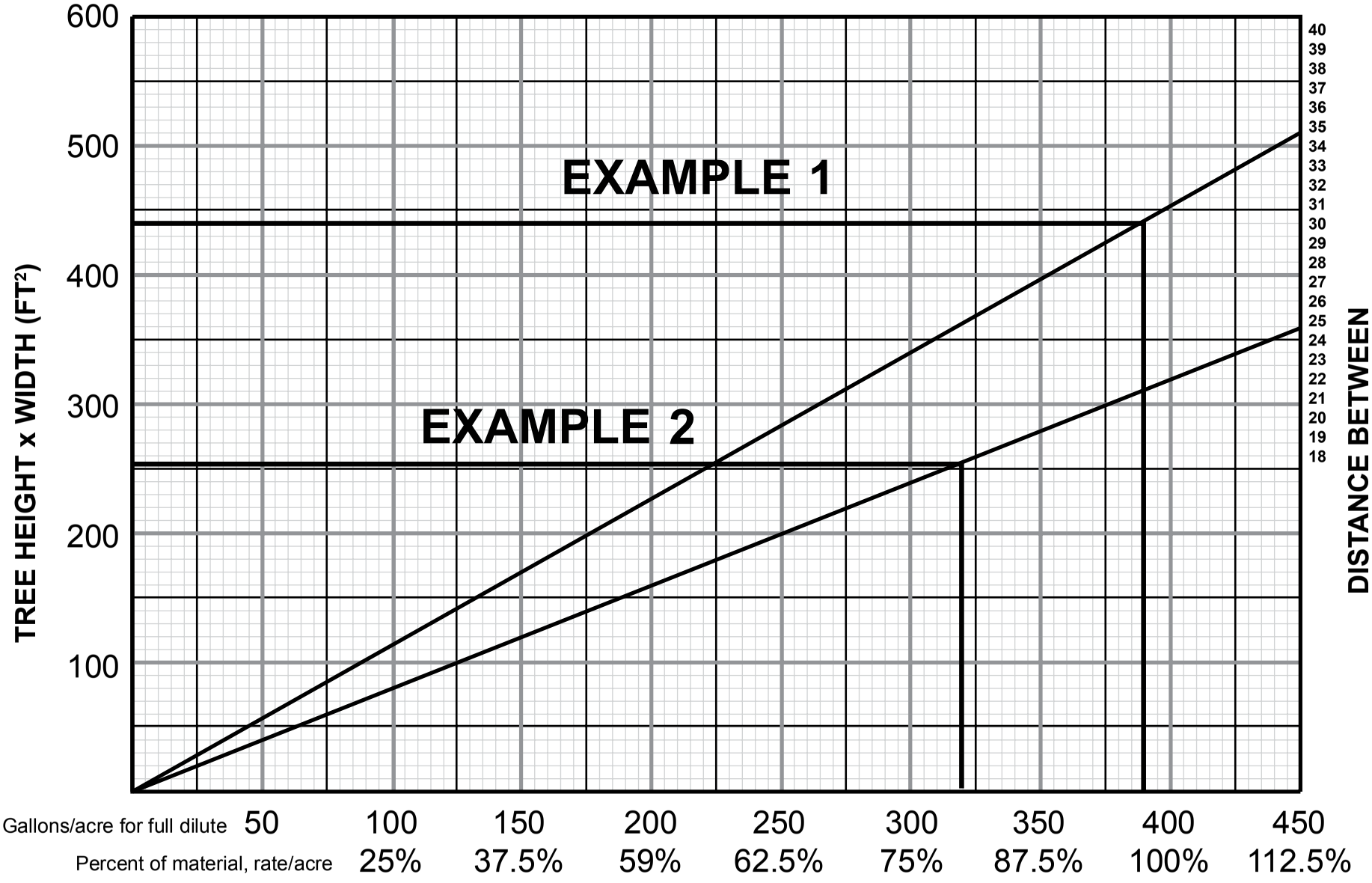
As with any other production procedure, grower judgment should be used. Where tree size is quite variable, calibration should be done for the average of the largest trees. Two-thirds of the spray is directed to the top of the trees. A well-pruned orchard may require only 85% of the base rate early in the season, while a full-foliaged processing orchard may need the full rate. Base-calculated rates may be increased or decreased by 10 to 20% when grower judgment dictates additional adjustments related to leaf density, pest pressure, or desired results from thinners and growth regulators. Most growth regulators should be applied dilute for maximum effectiveness.

Dr. Ross Byers developed a tree-row volume spraying rate slide rule calculator for apples. If you would like to obtain one, contact the Alson H. Smith, Jr. AREC in Winchester.

Failure to apply the proper rates per acre can lead to disastrous results when dealing with thinners, growth regulators, and other rate-sensitive materials. It is also important to note that tree-row-volume or any other concept for determining rate per acre will not make up for poor application techniques or improper timing. This method should allow growers to more precisely calibrate their equipment for the various blocks they must spray and thereby reduce problems that arise from too little or too much material per acre. But, it will only be effective if the necessary adjustments of equipment are made before spraying blocks of different sized trees.

Although many plant growth regulators are registered on the basis of the amount of active ingredient per acre, results may be related to concentration of active ingredient (amount of active ingredient per 100 gallons of spray solution). Therefore, when tree row volume calculations call for low volumes of spray solution per acre, be sure to add enough chemical to the tank to maintain an appropriate concentration of active ingredient. For some products it may not be possible to spray 300 gallons per acre at the effective concentration without applying more material per acre than is allowed on the label.

Figure 5. Tree-Row-Volume Determination In Apple Orchards



Example 1: Trees space 35' x 35'; 19' high, 23' wide; 390 gpa dilute or 98% of rate/acre.
Example 2: Trees space 16' x 25'; 16' high; 313 gpa dilute or 78% of rate/acre.

WILDLIFE DAMAGE MANAGEMENT

Damage inflicted by wildlife in commercial orchards can take many forms and involve a variety of different species. Producers undoubtedly recognize that the damage they incur varies from year to year. This year-to-year variability is affected by a number of population-based factors (e.g., changes in wildlife abundance/densities, competition among individuals and species), but a primary driver is the abundance and availability of naturally-occurring foods in the environment. In years of abundant natural food resource availability, damage typically is reduced. However, in years when natural food resources are scant (due to drought, acorn crop failure, recent destruction of nearby habitat by development activities), damage tends to increase as wildlife are forced to search for alternative food resources; unfortunately, this often means using resources cultivated by producers.

Another factor that significantly influences the likelihood that producers will experience conflict with wildlife is the location where the planting block occurs relative to adjacent habitat that supports wildlife. In general terms, the closer a block is situated to the forest edge and the more isolated that block is relative to human activity, the greater the likelihood of wildlife-caused damage. Blocks that have been carved into an intact forested tract or where forested habitat abuts a block on 2 or more sides represent cases of high vulnerability. The spacing and location of trees within a block also strongly influences the potential for damage. A block where trees have been planted close to the forest edge, rather than set back and separated from the forest edge by a wide open buffer area, will suffer greater damage. There are clear trade-offs between trying to make efficient use of the production area (i.e., maximizing the number of trees per block, which demands placing trees close to the edge) vs. foregoing some space efficiency (i.e., reducing the number of trees and increasing space/distance from the edge), but realizing reduced losses to wildlife damage.

In many cases, gains in reducing losses to wildlife damage can be attained by installing and maintaining a well-designed fence system, but producers must "do the math" prior to implementation to determine whether cost-effectiveness and true benefit actually can be realized for that particular site. Given the number of designs currently available, costs of materials and labor, maintenance needs, desired level of damage reduction, and other variable factors, decisions about fencing need careful thought and analysis to see what return on investment is possible. A good rule of thumb: if the costs associated with procuring, installing, and maintaining fencing exceed the economic level of damage being experienced, implementing a fencing program usually cannot be justified. Also, although fencing may be effective in reducing losses caused by certain species, it is not a cure-all for all wildlife-caused damage. It is important to accurately identify the type(s) of damage being inflicted and the species responsible for that damage — fencing designed for and effective against deer will have little or no effect on reducing losses to birds, rodents, or other small mammals. Therefore, you need to know who your true enemies really are and develop cost-effective strategies to address each particular problem.

In general terms, the majority of wildlife-inflicted damage in orchard operations will typically be caused by a handful of species with known associations to orchard management. The following sections present information for consideration when dealing with the types of damage most commonly associated with these species.

Rodent Control

Of the various wildlife species responsible for causing problems for producers, rodents rank high among the economically devastating culprits. In particular, damage caused by voles can be especially injurious because it often is difficult to recognize that damage is occurring. Most damage inflicted by woodland voles (formerly known as pine vole) and/or meadow voles occurs from late fall to early spring. In contrast to some other wildlife species, voles remain active year-round despite the decline in abundance of fresh green grass or seeds they may have used during the rest of the year. Instead, these animals shift to feeding on the roots and above ground stems of woody plants such as fruit trees. When dead grass and thick thatch beneath the trees have been allowed to accumulate, voles find perfect cover that prevents growers from easily seeing signs of vole activity . This thick cover also will interfere with proper treatment of the problem and natural predation. An optimal time to implement a vole management program typically begins in late October and extends throughout November or December, the anticipated period of severe damage. Rodenticides described in this section are registered for use in most states, but label specifications clearly emphasize that application should occur after the fall harvest and during the dormant season.

VEGETATION MANAGEMENT

A key strategy to minimize rodent damage is to manage the vegetation beneath trees and in the corridors between trees. Frequent mowing that restricts growth of the ground cover to no more than 2-3" in height at any time is desired, as this prevents the development of the tall thatch-forming hiding cover that voles seek and that complicates detection of vole activity. To maximize the reduction of vole activity, growers should consider converting the entire area within the dripline of trees to a vegetation-free zone (i.e., create an herbicide strip), which often will force voles to move into the vegetated corridors outside the dripline, detection of vole presence will be facilitated, and the success of pesticide applications will be enhanced because the vegetation has been reduced and managed.

POPULATION MONITORING

Monitoring of vole populations and their damage should occur both prior to and, where applicable, after rodentcide treatment. Growers can assess the feasibility of or justification for vole population treatment by placing apple slices within the dripline of every 5th to 8th tree in a row or wherever vole runs or tunnels are evident. To prevent consumption by other animals, these apple slices should be placed them beneath a split rubber tire, wood slab, a shingle, sheet of anchored tar paper, or other coverings that limits access; each monitoring location should be marked with flagging to facilitate relocation. Twenty-four hours after placement, return to each monitoring site and examine the apple slices for vole teeth marks, or, in worst case scenarios, the complete consumption of all slices. The percentage of apple slices that display evidence of gnawing provides an estimate to the size and activity level of the vole population; sections of the orchard where >25% of the apple slice baits, on average, exhibit vole foraging activity should receive toxicant treatment, given the explosive reproductive potential of voles. After the orchard has been treated, a second 24-hour apple slice assessment (after a 30-day interval and using new apples) will reveal the degree of control achieved. The maximum effect from hand-placed baits is realized about 20 days after treatment. If an herbicide strip (i.e., vegetation free zone) exists beneath the trees, monitoring must be done in adjacent vegetated areas because voles rarely range over bare ground.

APPLICATION OF RODENTICIDES

There are several broad categories of rodenticides available today, each of which works by different modes of action. A large number of products fall within the anticoagulant category that, as the name suggests, are designed to cause death by inducing internal bleeding in the target animal. Other rodenticides act as toxicants that disrupt certain physiological processes (e.g., neurologic system failure or induce edema). Rodenticide product development has changed significantly in recent years, leading to the creation of more products and formulations, many of which have proven to be more effective in accomplishing what they were designed to do, but they also have become more lethal to anything that is exposed to them. Within the anticoagulant group, two prominent categories now exist: first generation anticoagulant rodenticides (FGARs) and second generation anticoagulant rodenticides (SGARs). FGARs have been around for years (e.g., warfarin, diphacinone, chlorophacinone) and previously formed the backbone of traditional treatment of vole damage problems. In recent years, FGARs have somewhat fallen out of favor and are being replaced by a number of SGARs, given claims of greater effectiveness.

Unfortunately, as the use of SGARs has increased (formulated with ingredients such as brodifacoum, bromadiolone, flocoumafen, difethialone, difenacoum), so too have the negative environmental impacts associated from their use, especially unintended secondary lethal exposures. In addition to a large and growing number of lethal non-target animal exposures, there now is mounting evidence of bioaccumulation of some of these products in organisms that prey upon animals that have consumed SGARs. Similar concerns also have arisen as use of other potent toxicants (e.g., bromethalin) has increased. As a result, predators that actually help manage vole populations (especially hawks, owls, foxes, weasels) are dying from secondary pesticide exposure or the lethal effects of bioaccumulated toxins over time. A greater fear is that that the unintended secondary exposures potentially could include domestic/companion animals and small children where access to these more lethal materials exists. Another serious issue with rodenticide use relates to product registrations and compliance with labeling. Because pesticide registrations are approved and labeled for specific species and site applications, it is important that producers recognize that not all rodenticide products are registered for use on all voles equally. Therefore, growers are responsible for distinguishing and correctly identifying which species of voles are causing the damage and then becoming familiar with the products that are registered for use on woodland voles and for meadow voles — there are very distinct differences in what is allowed here in Virginia. Currently, no SGARs are registered for use on woodland voles, whereas several SGARs are registered for use on meadow voles. A grower who finds damage is being caused by both species in the same orchard must implement a treatment plan based on use of only FGARs, as dissemination of products available for meadow voles likely would be in violation of labeling restrictions for woodland voles.

Another consideration for growers contemplating use of rodenticides relates to methods of application. Although some labels for registered toxicant formulations allow for broadcast application, this practice is strongly discouraged as it is not a cost-effective or safe technique. Broadcast application often end up treating areas not currently supporting a vole population, thus wasting the often expensive product with no return on investment). Additionally, treated bait disseminated via broadcast application often gets hung up in the above-ground vegetative cover and never reaches the soil surface where meadow voles encounter it. Alternatively, where vegetation is lacking, broadcast treated bait will lay on the exposed soil surface, increasing the potential for non-target consumption. Baits preferably should be placed in covered bait stations or placed by hand directly into vole holes at the rates shown in Table 25. Two bait placements per tree for plantings up to 100 trees/A is desirable. In plantings with over 100 trees/A, one placement per tree is sufficient. For best results, baits not enclosed in a bait station or feeding tube should not be disseminated just before or just after a rain or when the soil is frozen more than an inch deep.

The proper use of bait containment devices greatly increases the effectiveness of bait applications, decreases baiting time considerably, and reduces the likelihood of non-target exposure. Split rubber tires provide excellent bait covers, and bait placed in shallow plastic cups under the tires will extend the life expectancy of bait. Covers placed under trees 2-3 months

ahead of baiting will attract voles and increase the likelihood (by 50-80%) of them finding baits later. If evidence of activity is not present (e.g., no trails, holes, or runways) under a cover, move it to another area under the same tree rather than waste bait. Bait covers may interfere with or be destroyed by mowing or cultivation activity, so proper marking is suggested. Please note that bait stations located within an herbicide strip generally are ineffective; covers should be placed in vegetated areas adjacent to the herbicide strip. At least 40, but no more than 80, covers will provide good contact with the population.

ZINC PHOSPHIDE BAITS

Accurate pre-treatment monitoring is necessary to identify areas within the orchard where problems exist so as to increase the success of zinc phosphide (ZP) applications. Zinc phosphide concentrate (63%) is registered and available to certified applicators in the apple industry for dormant season treatment and offers distinct advantages over prepared grain baits for the control of woodland voles and meadow voles. Although commercially available ZP-treated grain baits can provide adequate control of most vole situations, site-specific baits treated with concentrate at the appropriate dose and application rate (as indicated on the label) generally are more effective; voles are more likely to accept something with which they already have familiarity rather than a new material being introduced into their environment. Hand-placed bait, at the rate of 2-3 lbs/A under covers or in holes and runs, will provide a significant initial reduction of both vole species. If populations are high, a second application of an anticoagulant may be required. Because of problems of reduced bait acceptance among the residual vole population, zinc phosphide is not recommended for use as the "mop up" bait; another toxicant should be used in a second application. Producers should not get into the habit of applying toxicant baits as a prophylactic once-a-year treatment throughout the orchard unless regular population monitoring justifies that such treatment actually is warranted. Applying baits where vole populations do not exist or are not threatening production is a wasteful expense, increases the likelihood for non-target lethal exposures, and may create bait shyness or avoidance among voles.

ANTICOAGULANT BAITS

Several days of continuous feeding are required for voles to receive a lethal dose of anticoagulants, such as diphacinone (Ramik) or chlorophacinone (Rozol). For this reason, the rate per acre should not be reduced below suggested levels for hand placement treatment (Table 25). If populations are high, voles may consume all the bait before a lethal dose has been administered. A second application should not be made within 14 days of the first treatment. Voles that receive a lethal dose from the first treatment will die within 20 days; animals that were exposed to a sublethal-dose should receive a second treatment 20-30 days after first treatment.

Woodland voles versus meadow voles: The anticoagulant chlorophacinone is more effective against woodland voles than meadow voles. Zinc phosphide is more effective against meadow voles than chlorophacinone. Consistent use of either bait against a mixed population of both vole species will shift the population to the species less impacted by that bait. Therefore, adopting a program of rotating hand-placed baits—zinc phosphide in the first baiting and chlorophacinone in the second baiting—may be the most effective way to control both species. This treatment regimen will be more successful against residual meadow vole populations where zinc phosphide baits may be detected from prior exposure after the first treatment. If only woodland voles are present, two applications of chlorophacinone may be more effective than a zinc phosphide and chlorophacinone follow- up approach.

Table 25. Rodenticides for the Control of Woodland and Meadow Voles in Orchards

Hand-placed:	Rozol[1] (Chlorophacinone) lb/A	Ramik-Brown[2] (Diphacinone) lb/A	Zinc Phosphide lb/A
Woodland vole	10	10	2-3
Meadow vole	10	-	2-3

[1] If populations are high, a second application may be required 1-2 months later. An anticoagulant should be used for second application. Zinc phosphide loses effectiveness when used repeatedly.
[2] Applications made at 20-40 day intervals.

Deer Management

Deer can cause serious problems in fruit orchards, particularly where the orchard is surrounded by forested habitat. Deer prefer to feed on leaf and fruit buds and young shoots, and bucks rub their antlers on larger limbs and trunks of young trees. Young trees, particularly spur types, may be seriously stunted and misshapen. Although "horning" damage occurs most often in late summer and early fall, plantings should be examined often, as damage may occur at other times of the year; feeding damage can occur at any time. It is difficult to change the feeding habits of deer once they become established; therefore, it is important to monitor for problems as they occur and apply controls before serious damage begins. The best approach to deer damage management is an integrated pest management strategy, one that incorporates fencing, repellents, modification of adjoining habitats, and population management. New research (see Hildreth, A.M., S.E. Hygnstrom, and

K.C. VerCauteren. 2013. Deer-activated bioacoustic frightening device deters white-tailed deer. Human-Wildlife Interactions 7(1):107-113) has found playback, triggered by a remote motion detecting device, of the recorded distress call of a deer was effective in deterring deer. However, on large acreages, many such detection and auditory projection devices may be needed to provide adequate protection, which calls into question the cost-effectiveness of this approach.

VEGETATION MANAGEMENT

Several strategies related to the manipulation of native vegetation adjacent to a production block have been suggested as means to reduce deer damage. Planting of "decoy crops" (i.e., strips of highly desirable or preferred foods of deer) outside the production area has been suggested as a means to draw deer away from the block and into these plots. Although these equivalents to a food plot for deer often are heavily utilized by deer and may provide temporary relief from damage, these plots often attract and maintain a higher than normal deer density in the immediate area of the orchard, as deer are drawn in by the attractiveness and ready availability of desirable foods. If the plots are not large enough and well-stocked to retain the level of attractiveness, deer will shift back to other food resources in the immediate vicinity of the plot as supply dwindles. With a higher than normal density of deer attracted to the area by these plots, damage actually can increase once food runs out and deer make this shift back to the production block.

Adoption of a different form of vegetation management may provide more effective deer damage reduction, that being the creation of wide strips of open space between the production block and the forest edge. Although deer undoubtedly spend time out in open fields, they are much more tentative and alert when doing so. They much prefer being able to move directly from the forest into a production block than having to cross open exposed ground. Growers should evaluate the economic feasibility and consequences of maximizing the amount of open space between their production area and the surrounding habitat.

DOGS

Trained dogs confined within an orchard by invisible fencing successfully have reduced the presence of deer (as well as woodchucks and rabbits) in the orchard. The purchase, care, and maintenance of electronic collars worn by dogs, invisible fencing, and training of dogs often can be considerably less expensive than the typical electrified fencing for deer. However, not all dogs are equally attentive and effective; dogs also need to be spaced apart so that they are out of a direct line of sight from each other and will remain focused on their vigilance duties and not on each other.

PERMITS

Permits are required to reduce deer populations outside the normal fall hunting season. “Kill permits” (that allow Out of Season Take) may be obtained from the Virginia Department of Wildlife Resources or the West Virginia Department of Natural Resources. Bonus tags also are available, which growers then distribute to licensed hunters who offer to help increase the “in-season” harvest of deer and thereby reduce local herd density. Although helpful, population management alone rarely will solve a depredation problem.

FENCING

Fencing has been shown to be the most reliable method to manage deer. Recent evaluations of several high-tensile, high-voltage low-impedance electric fences indicated that a 7-wire vertical design of at least 8 feet in height proved to be a cost-effective option for reducing deer damage. Because deer often will try to crawl under a wire fence rather than jump it, attention should be given to eliminate gaps beneath the lower strands. Proper wire spacing, sufficiently high voltage, and proper baiting of the fence are essential to keep animals at bay. Electric fencing can be less expensive than other permanent fence designs, but it requires frequent inspection to insure that proper wire spacing and voltage are maintained.

The only deer-proof fence is a 10 ft. non-electric woven wire fence. Woven wire is available in 48 and 75 in. heights. Sections of woven wire can be stacked one above the other or strands of high-tensile smooth wire can be added above the woven wire to create a 10-foot fence height. Although less maintenance is required for this fence design, growers still must be vigilant in periodically checking for damage (i.e., blow-downs of adjacent trees or branches or post failure).

Some growers may find that a light-weight high-tensile electric deer fence is a cost effective option for use around small plantings (<10 acres) of young stock where deer pressure is not severe. Such fences utilize wooden corner posts without bracing and 4 or 5 16-gauge high-tensile Class 3 zinc-galvanized smooth wires. Alternatively, use of polytape electric fencing may be less expensive, offers greater visibility and higher detection by deer, but has a shorter life expectancy. Growers must “do their homework” to find the proper fencing system that works and is cost-effective for their operation. Although voltage, height, and wire spacing are key determinants of a fence’s success, visibility equally is important. Any fence that is erected within or immediately along the edge of the bordering woods will have noticeably lower success than one built out in the open and away from the wood’s edge. Jumping a fence is most common where deer cannot see the fence until the last minute as they approach on a run.

For more information about fences contact your horticultural specialist or consult the Natural Resources, Agriculture, and Engineering Service (NREAS) publication entitled "High Tensile Wire Fencing" (NREAS Publication #11).

CHEMICAL REPELLENTS

Taste and odor repellents may provide some relief when other naturally occurring foods are abundant and available to deer, but efficacy of repellents will decline noticeably when natural food supplies become diminished or deer density increases. The length of time a repellent remains effective will also be influenced by rainfall, which can wash off these topical treatments. Deer activity and weather should be monitored carefully so that applications are properly timed.

Currently, numerous active ingredients and formulations are registered for use on deer, including the following: ammonium soaps of higher fatty acids, capsaicin, putrescent egg solids, denatonium benzoate, concentrated coyote and/or fox urine, and thiram. Many of the repellent products currently registered for use against deer are restricted to dormant season applications or plants not intended for human consumption. Repellents that are based only of food additives (e.g., garlic, pepper, fish oils) are exempt from registration, so many companies have begun adding these ingredients to existing products; in some cases, producers may see some marginal improvement in efficacy with such “enhanced” products, but results vary widely. In terms of effectiveness, repellents that contain putrescent egg solids, either alone or in combination with other ingredients, typically have demonstrated higher success, but, over large acreages, they become less effective and generally uneconomical for commercial operations. Historically, the simple process of hanging “hotel-sized” soap bars from the lower branches of trees (2-3 bars/tree) proved to be an effective repellent strategy in rural or secluded orchards; however, as residential development has further encroached upon orchards, odors associated with that increase in human activity led to decreased response by deer and diminished usefulness of soap in most areas (i.e., deer have acclimated to the odors of humans and no longer perceive them as a signal of potential threat).

Rabbit Management

Rabbits can cause serious damage by chewing bark off tree trunks, particularly on young trees. Trees over 5 years old seldom are damaged, unless deep snow allows rabbits the reach higher on the bole where thinner bark could be accessed. Unmown or fallowed fields that adjoin newly planted orchards provide optimal cover and food for rabbits, and may lead to potential problems, especially during late fall and winter when rabbit conflicts tend to be more common. Removal of brush piles and heavy weed growth adjacent to the production area, and especially along fences, will reduce rabbit populations in the area. Encouraging hunters to visit the site during the regulated season can help with managing high populations.

Tree guards made of plastic, wire mesh, and other stout materials may reduce damage to trees caused by rabbits but, where accumulated snow builds up, rabbits can gain access above short guards. Rabbits may be fenced from small nursery areas, but tree guards generally are more economical and effective in larger orchards. Chemical repellents (many similar to those discussed under deer control) applied to trunks above the tree guard may offer additional protection.

Woodchuck Control

Woodchucks are particularly damaging to roots, trunks, and scaffold limbs of young and newly planted trees. In addition, open burrows are a hazard to workers and machinery. A number of control methods are available. Trapping or shooting may be effective, but require constant vigilance, which may not be practical on a large scale. The most practical and cost-effective method of control is to fumigate adult males and females in the underground burrow early in the spring, before the first litter can be born.

Sodium nitrate cartridges (commonly referred to as a “smoke bomb”) may be used as a fumigant. They are stable, require no special permits, and work effectively if administered properly and with good timing (try to place in burrows before the year’s young are born). There is a slight fire risk, so ambient conditions must be monitored. Sodium nitrate cartridges must not be used under a building or other structure.

Bird Control

Although birds often provide useful service in helping to keep troublesome insects in check, flocking birds sometimes can become problematic in orchards, especially when they peck and damage maturing fruits. The unmistakable triangular shaped piercings that result where the bird’s bill was jammed into the fruit are characteristic of such damage; the gouge left behind varies depending upon the size and dimensions of bill of the particular species of bird, the state of maturity of the fruit, and the intensity with which the thrust had been made. In most commercial operations, use of bird netting likely will not prove to be a cost-effective strategy for dealing with damage, due to the cost of materials, the labor needed to place the netting and its impact on routine maintenance and harvest operations. Currently only methyl anthranilate is registered for use on birds, but producers should check label restrictions carefully to see what limitations may apply to their operation. In many operations, periodic harassment to prevent birds from beginning to display the pecking behavior may be warranted. However, because

birds acclimate to visual and auditory cues so quickly, unless these techniques are reinforced with other, more threatening, consequences, effectiveness of harassment techniques declines rapidly due to habituation. Growers must recognize that killing birds is usually not an option; due to provisions of the Migratory Bird Treaty Act and other regulation, it is illegal to kill migratory non-game birds, unless granted a permit to do so from the U.S. Fish and Wildlife Service. Such permits typically are not granted until all other options have been exercised and found to be ineffective in limiting damage usually.

Other Species

BEARS

During periods of natural food shortage, black bears increase reliance on crops, commodities, and other human-produced foods and may view orchards as viable foraging sites. When foraging in an orchard, bears primarily utilize "drops" that are readily available and require little expenditure of energy to acquire. However, bears occasionally will climb into trees and on to trellis structures, causing substantial physical damage due to their weight (e.g., breaking branches, snapping support wires). Because the black bear is managed as a "game species," agencies have established defined open seasons during which take is allowed; harvest outside the established seasons is illegal, unless a producer has sought and acquired a "kill permit" from the wildlife agency. In most cases, though, before such a permit would be issued, the agency will require a producer to implement reasonable harassment techniques and/or reduce the amount of attractive food resources in an attempt to deter bears from the orchard. The same type of high tensile electric fencing used to deter deer often can be tweaked to also provide protection against bears; consultation with fencing technicians may prove beneficial before any fencing strategy is undertaken.

FERAL HOGS

Among orchardists in the mid-Atlantic region, the appearance of feral hogs on the landscape is a threat many may not have yet experienced. However, new populations of hogs have become established and can spread rapidly, presenting a new and serious operational concern. Whether from foraging and rooting behavior or direct physical damage to trees, the damage inflicted by hogs can be extensive and devastating in a short period of time, depending on the size of the sounder (i.e., the family or social grouping) that takes up residence in the area.

Because feral hogs are an introduced, non-native species, they have no protection under wildlife or game laws, so hogs theoretically may be taken by legal methods at any time. However, it sometimes can be difficult to distinguish true feral animals from domestic swine that recently may have escaped and still constitute the swine owner's property. Thus, in some states, population management and damage mitigation have become complicated by questions of ownership and the legalities related to the take of property — caution is urged before any hog removal action is implemented.

That said, growers confronted by the first evidence of feral hogs immediately should contact the USDA-APHIS Wildlife Services Office that serves their state and request assistance in devising an effective hog eradication plan. Trap and bait techniques currently have proven to be the most reliable and successful approach to manage hog populations, but such operations take time and persistence to achieve the desired outcome. Shooting alone often proves ineffective in that only a small number of hogs can be taken at once and those that escape quickly learn to avoid hunters in the future. Although on-going research on potential toxicants has been encouraging, registration of an approved pesticide product remains years away. At this time, keen observation and attentiveness to the first sign of hog presence is imperative to stay ahead of the threat.

TREE SQUIRRELS AND CHIPMUNKS

Squirrels and chipmunks occasionally are implicated for damaging fruit trees, which takes the form of bark stripping (in early spring) or clipping developing stone fruits (especially peaches). These types of damage occur only seasonally and for short periods of time. Bark stripping normally is exhibited by gray squirrels and consists of the animal gnawing into the cambium layer of the bark as means to create a tag that then is grasped and pulled, causing long linear strips of bark to be peeled away from the trunk. These peeled strips then are collected and used in nest construction. In other cases, squirrels have been observed creating small tears in the bark as means of creating an opening that allows sap to exude from the wound, which squirrels then lick as a source of nutrition.

In the case of chipmunks, individuals will climb up into the tree and work their way along branches, stopping to snip off the small developing fruits as they are encountered and allowing them to fall to the ground. This behavior is seen most often in peach trees, when fruits are approximately 1.5-2 inches in diameter. Although chipmunks sometimes are seen later back on the ground collecting these culled fruits, they often are left untouched on the ground. To date, a satisfying explanation for this behavior is not available, although some believe is may be related to a need to wear and/or sharpen the animal's incisor teeth, which grow continuously.

Although several capsaicin-based repellent registrations exist (for foliar, non-consumable application only), this approach is unlikely to provide a cost-effective remedy.

ORCHARD NUTRITIONAL PROGRAMS

Determination of Nutritional Needs

Orchardists must make an annual judgment regarding the nutritional status of their trees. They must decide whether to continue with the past year's program or to modify it in some manner that will improve the growth of their trees or the quantity and quality of the fruit produced.

Nutritional requirements can be determined by leaf analysis, soil analysis, and observation of tree performance. All three should be used. Soil analysis is of value in determining the acidity of the soil and the lime required to adjust the pH to 6.5. Leaf analysis is the best tool available for the determination of fertilizer needs of established plantings. Leaf analysis is useful in diagnosing an existing nutritional problem, but more importantly it can be used to detect approaching excesses or shortages, and corrections can be made before symptoms occur. Leaf analysis has proven to be an excellent guide for the economical use of fertilizers. A test every 3 years may be sufficient if trees are making good growth. However, when growth is poor, annual tests may be advisable. Orchard observations that should be taken into account when planning a fertility program include shoot growth, leaf color, crop size, and crop quality (color, corking, storage behavior).

The nutrients that are most commonly supplied to Virginia and West Virginia orchards are nitrogen, calcium, and boron (Table 26).

NITROGEN

Young, non-bearing apple trees will benefit from a ground application plus several foliar applications of nitrogen per season. Apply 20 to 40 pounds of actual nitrogen per acre to the soil about a month before bloom. To each pesticide spray through mid-July add 4 pounds of urea per 100 gallons on a dilute basis (Table 24). These early-season foliar nitrogen applications may improve fruit size, shoot growth, and flower bud formation for the following season. Avoid late-season nitrogen applications because fruit may remain green and red color development may be retarded.

On mature trees, nitrogen needs are generally met by late-winter or early-spring soil applications. Where trees are not growing too vigorously, urea at the rate of 4 pounds per 100 gallons on a dilute basis can be added to each spray from petal fall through mid-June.

CALCIUM

To obtain high quality fruit with good market acceptance, growers must maintain adequate calcium levels in their fruit. Low fruit calcium is associated with two major problems - cork spot and bitter pit.

Cork spot shows up as a shallow depression in the fruit surface, which when peeled has brown, firm corky tissue that is harder than the flesh. This corky area will usually extend into the flesh. Cork spot can also be internal in Yorks. The problem is associated with early-season water stress, irregular cropping, excessive tree vigor and poor nutrition. The disorder is initiated by midseason and does not develop after harvest.

Bitter pit is characterized by numerous small sunken pits of collapsed tissue softer than the apple flesh. Most pits are just beneath the skin, mostly on the blossom end of the fruit. The problem is associated with late-season moisture stress conditions, and fruit harvested too early is more prone. Bitter pit does not usually develop until after harvest.

The maintenance of adequate levels of calcium in the fruit to minimize losses from cork spot and bitter pit requires the use of a season-long management program. This program should include soil pH levels at 6.5 or higher, the encouragement of even, annual cropping by thinning, and the avoidance of excessive pruning and fertilization that stimulate too much growth. Most importantly, calcium should be included in each cover spray throughout the season.

Cork spot may have been misdiagnosed in the past. Research from the USDA in West Virginia indicates that late summer and fall stink bug feeding injury can produce symptoms very similar to cork spot. Symptoms appear as circular discolored depressions on fruit skin with corky flesh immediately below skin that develops within a day of feeding. Corking can extend up to 1/4 inch into the flesh. Feeding punctures may be only visible with magnification and may occur anywhere on fruit, single or multiple damage sites. If multiple damage sites, they are often clustered. Damage takes place from mid-July until harvest.

CALCIUM SPRAYS

Rate: Calcium can be applied in cover sprays at the rate of 2 to 8 pounds of calcium chloride per acre (for a total of 15 to 50 pounds per acre per year) (Table 26). At 15-19 pounds per acre per year, some cork spot and bitter pit control will be achieved, but storage life will not be enhanced. The standard rate to apply in blocks where these disorders are chronic is 20-29 pounds per acre per year. The 30-39 pound rates will give fairly good control of corking and bitter pitting most years. The 40-50 pound rates may increase storage life in addition to providing good control of cork spot and bitter pit. The higher rates can cause foliage burn and should not be reapplied unless at least 1/2 inch of rain has fallen since the last application.

Timing: All cover sprays.

Gallons Per Acre: No restrictions. Applications of as little as 20 gal per acre have been effective.

Compatibility: At the rates recommended, calcium chloride and/or Solubor may be mixed with spray oil (Superior 70 sec), with WP formulations, or with EC formulations of the more common fruit pesticides. Do not premix calcium chloride with Solubor in a small volume of water before adding to the tank, when both materials are to be applied together. ALWAYS DISSOLVE CALCIUM CHLORIDE IN A PAIL OF WATER and add this last, when the spray tank is nearly full, to insure that the calcium chloride is completely dissolved before spraying begins.

Additives: Surfactants are not needed when calcium chloride is applied with regular cover sprays.

Temperature: Spray on days when the temperature will not exceed 90°F.

Leaf Injury: Some leaf injury may occur from calcium sprays made after wet, cool springs or during hot, dry summers. When injury is noticed, reduce calcium chloride to one-half rate in the next spray.

Corrosion: Calcium chloride can corrode equipment (by keeping it wet). Be sure all parts of the sprayer and the tractor are rinsed thoroughly with water following each use.

BORON

Boron is frequently deficient in Virginia and West Virginia apple orchards. The first symptom of a boron deficiency is usually internal cork. Scattered areas of brown corky tissue appear in the flesh of the fruit, often in the core area. If the deficiency becomes severe, the fruit may be misshapen with sunken corky areas.

Boron may be supplied as a foliar spray or in a soil application. Foliar sprays are the easiest method of application; however soil applications have been shown to raise calcium levels in leaf samples and have been associated with yield increases when a boron deficiency exists.

Rate: Generally, boron levels can be maintained with a single application of 3 to 4 pounds per acre of Solubor at petal fall or first cover (Table 26). Rates of application to the soil are generally 1.5-2.5 pounds of actual boron per acre per year. Soil and leaf analyses should be used to determine optimum rates and methods of application.

Precaution: Do not premix boron with calcium chloride in a small volume of water because of boron precipitation.

Toxicity: Peaches are very sensitive to excess boron; therefore, boron should not be applied unless it is certain that a deficiency exists. Pears can be sprayed with Solubor at the same rate as apples. Excessive boron can kill young apple and pear trees.

Table 26. Recommended Rates and Materials for Nutrient Sprays

Material	Rate of Application (lb per acre)	Timing
Urea	6 to 12	After bloom but not later than second cover on bearing trees.
Calcium chloride	2 to 8	All cover sprays.
Solubor or	3 to 4	Petal fall and first cover.
Soil applied B	1.5-7.5 actual B	Before bloom.

To insure proper vegetative growth and good fruit quality, it is best to apply solubor at full bloom plus soil applications made every year to every 3 years at the rates listed below for three different boron fertilizers. It is important not to apply too much boron because it can cause abnormal fruit maturation and injure trees. Rates of boron application to the soil should be adjusted for tree age.

Tree age (years)	Pound per acre per year			Pounds per acre per 3 years		
	Borate 46	Borate 65	Borax	Borate 46	Borate 65	Borax
1 - 3	0	0	0	0	0	0
4 - 6	1.3	0.8	1.7	4	2.5	5
7 - 9	2.6	1.7	3.0	8	5	9
10 - 12	3.3	2.5	4.0	10	7.5	12
13 - 15	5.0	3.3	6.3	15	10	19
16 +	8.0	6.0	10.3	25	18	31

Magnesium. Sometimes soil and leaf levels of magnesium are low. Depending on the situation there are several ways to improve magnesium nutrition.

a. When soil tests indicate low pH and a need for lime, the type of lime applied should be based on soil calcium and magnesium levels. Where calcium levels are rated as Medium or higher (M + to VH), and magnesium is rated as Medium or lower (M – to L -), choose a high-magnesium limestone or dolomitic lime. Regardless of soil calcium levels, when magnesium is rated as Medium or higher (M + to VH), use calcitic limestone.

b. If soil or leaf analyses indicate that potassium and magnesium are both low, use potassium magnesium sulfate as the source of potassium.

c. If leaf analysis indicates that only magnesium is low, apply 2 to 3 sprays of Epsom Salts (15 lbs per 100 gallons dilute equivalent) at petal fall, 1 to 2 weeks after petal fall, and 2 to 3 weeks after petal fall.

Manganese. Sometimes, especially in peach orchards, manganese deficiency appears as intervienal chlorosis, where leaf tissue between the veins becomes yellow or light green. Symptoms appear first on mid-shoot and older leaves. When leaf symptoms or leaf analysis indicates a need for manganese apply a spray of manganese sulfate (4 lbs per 100 gallons dilute equivalent) 1 to 2 weeks after petal fall or whenever the symptoms appear. Symptoms usually disappear within a few weeks of application.

NEMATODE MANAGEMENT

Dr. James Kotcon, West Virginia University, Morgantown, West Virginia

Nematode management in fruit orchards begins before planting and must continue each year throughout the life of the orchard. Once a nematode problem becomes serious, it is often difficult to reestablish control. Seriously affected trees may never recover full productivity.

Identifying Nematode Problems: The Critical First Step

Nematode damage is often difficult to detect. Common symptoms, such as poor yields, unthrifty growth, and increased tree mortality, may not immediately suggest nematode damage and may not be obvious until after extensive losses occur. Dagger nematode transmits tomato ringspot virus which causes stem pitting in peaches and union necrosis and decline in apples. The presence of damaging levels of nematodes can be detected only by proper laboratory techniques. Routine sampling of soil and roots on a regular basis, and especially before planting young trees or whenever nematode damage is suspected, is recommended.

Nematode samples must be collected properly, delivered promptly, and handled correctly in order for a reliable diagnosis to be made. Nematodes in a soil or root sample can be killed by warm temperatures, freezing, or drying. **Samples must be collected so that they are representative of the area being collected**. Faulty sample collection or handling can result in a misleading diagnosis and expensive nematode management mistakes.

WHEN, WHERE, AND HOW TO SAMPLE

When. Soil and root samples can be taken and reliably processed as needed, whenever the soil is not frozen. For best results, collect samples in fall or early spring before planting a site. For established orchards, collect samples during late summer or early fall. Keep samples cool and submit them to the Nematode Laboratory as soon as possible.

Where. A sample should consist of 10 or more subsamples representative of the area being sampled. When sampling individual trees, collect subsamples from around the dripline and toward the trunk. From problem areas, soil and root samples should be collected from symptomatic plants at the margin of the affected area. Since plant parasitic nematodes feed only on living plant tissues, dead or dying trees should be avoided.

For larger orchard blocks, collect a subsample from inside the drip line of at least 20 trees throughout the block. Blocks should be no larger than five acres. Collect separate samples for areas with different soil types, different cropping histories, or different management objectives.

How. Subsamples should be taken with a soil sampling tube. A trowel or narrow-bladed shovel may also be used. Take subsamples at a 2- to 12-inch depth, collecting as many feeder roots as possible. Combine at least 10-20 subsamples from the area being sampled in a clean pail or bag, mix thoroughly, and place 1 to 2 pints in a plastic bag to make the sample.

Caution! Put samples in an ice chest or refrigerate until submission. Do not allow samples to dry as the nematodes will die before the sample arrives in the laboratory. Temperatures above 95^{o}F will also kill many nematodes.

SUBMIT SAMPLES TO THE NEMATODE LAB PROMPTLY!

Submit with the samples a letter or a nematode assay report form which includes the following information:

a. date sample was collected

b. crop from which sample was collected

c. crop to be planted (if different from above)

d. names and addresses of the grower and the person submitting the sample

e. description of plant symptoms

f. a brief history of the affected area

g. previous pesticide usage and other relevant comments

Contact your county extension agent for appropriate forms, sample bags, and instructions.

Predictive assays will be processed for a cost of $11.00 per sample by Virginia Tech. There is no charge for diagnostic assays. Send samples to: Nematode Assay Lab, 115 Price Hall, Virginia Tech, Blacksburg, VA 24061-0331. In West Virginia, send diagnostic samples to Nematology Lab, 401 Brooks Hall, P.O. Box 6057, Morgantown, WV 26506.

Recommended Nematode Management Practices in Orchards

Tree fruit orchards planted on new sites and receiving good care usually remain vigorous and productive for 20 years or more. Failure to control nematode diseases can substantially reduce orchard vigor, productivity, and life span. No single practice will eliminate nematode problems from any particular site. Rather, all of the practices listed below should be followed to maintain healthy productive trees.

NEW AND REPLANT ORCHARD SITES

New orchard sites are generally preferred for orchard establishment, especially for stone fruits. Nematode problems are not encountered frequently although it is a good idea to collect soil samples to be sure. If high nematode densities occur, treatment is recommended.

Orchard replant problems are more common than problems on new sites. Many different factors, including nematodes, contribute to orchard replant problems and the relative importance of any one factor varies from site to site. The potential for damage on replant sites, as well as new sites with serious nematode infestations, can be reduced by:

1. thorough removal of all tree root residues to reduce population density of nematodes and other soil-borne pathogens,
2. subsoiling and deep plowing to rework the soil profile and improve internal drainage,
3. rotating to field crops for at least two years to reduce pathogen populations, help eradicate weeds, and increase soil organic matter,
4. liming and fertilizing to adjust soil pH and nutrient levels for optimum tree growth and fruit production,
5. if needed, improving air and water drainage through the site, and
6. submitting a follow-up soil sample in the fall before tree planting to determine nematode population densities and the need for soil fumigation.

Soil fumigation is recommended if nematode densities exceed damaging levels, if the site has a history of other soil-borne diseases, and/or if highly susceptible cultivars are to be planted. The success of soil fumigant treatments depends on soil type, temperature, and moisture. Do not apply soil fumigants when soil temperature at a 12-inch depth is below 50oF or to wet saturated soils because the fumigant cannot volatilize and disperse adequately through the soil profile. Higher fumigant rates should be applied in heavier clay soils, soils with high organic matter, or where other soil-borne pathogens and weeds must be controlled. Many nematode problems can be controlled by treating a 12 to 14 foot band over the row. Where more serious problems occur or re-infestation from untreated areas is likely, a broadcast treatment to the entire area is recommended. The nematicides listed (see Table 27) are divided between nematicidal fumigants, broad-spectrum fumigants, and nonfumigant nematicides. Nematicidal fumigants act primarily against nematodes. Where control of other soil-borne disease and weeds is required, broad-spectrum soil fumigants should be used. In rocky ground or where fumigation is difficult, nonfumigant nematicides provide some nematode control, but do not control weeds or other diseases. Many fumigants now require buffer zones, **consult the label.**

POST-PLANT NEMATODE CONTROL

After planting, nematode control options are limited to nonfumigant nematicides. They should generally be applied in a band from one foot beyond the dripline of the tree to the trunk. Broadcast applications are also registered. Application through drip irrigation systems are registered for some products.

Since these nematicides are not fumigants, they must dissolve in the soil water and contact the nematode before control will occur. Therefore, soil incorporation is needed for effective control. Mechanical incorporation to a depth of 2 to 4 inches or sprinkler irrigation with 1 to 2 inches of water should be applied immediately after nematicide application. Several new materials may be applied to bearing or non-bearing trees. Annual applications of non-fumigant nematicides may be needed to achieve good control. Some materials for certified organic and biological production (azadirachtin, soaps, and several bacteria and fungi), have been labeled in recent years, however, efficacy data are very limited.

SPOT TREATMENT

Spot treatment of replant sites offers promise for nematode and disease control. Several pieces of equipment are currently available depending on the material to be used. After removing dead or diseased trees and as many roots as possible, make a shallow basin (10 by 10 feet) over the planting site and apply 0.8 lb metam sodium (e.g. 3/4 qt of Vapam HL) per 100 square feet while filling the basin with enough water to penetrate the entire root zone, up to six feet if possible. Alternatively, use 31 fl oz Telone C-17 per tree injected at least 18 inches into the soil.

Caution: Pesticide registrations may change. Always read and follow directions on the label.

Table 27. Nematicidal pesticides for use in deciduous fruit orchards

Active ingredient	Trade Name	Rate per treated acre[a]
1,3 dichloropropene[b]	Telone II	27-35 gal
	Telone EC	9-24 gal
Broad Spectrum Fumigants (for control of nematodes, other soil-borne diseases, and weeds)		
dichloropropene + chloropicrin	allyl isothiocyanate[c] Dominus	10-40 gal
1, 3 dichloropropene + chloropicrin	Telone C-17	32-42 gal
	Telone C-35	39-50 gal
metam-sodium[c]	Vapam HL	50-75 gal
dazomet+ 98%	Basamid	222-450 lb
Nonfumigant Nematicides: Nonbearing trees		
spirotetramat	Movento	6-9 oz[d] (foliar spray)
fluopyram	Velum Prime	6.8 oz[f]
fluazaindolizine	Salibro	30.7-61.4 oz[g]
fluensulfone	Nimitz	2-4 pt[h]
oxamyl (foliar spray)	Vydate L	3.5-7 pt[i]
oxamyl (pre-plant, soil incorporated)	Vydate L	2 gal[j]
Bearing trees		
Spirotetramat	Movento	6-9 oz[d] (foliar spray)

[a]Use the higher rates in heavier soils, soils with high organic matter content, or where deeper penetration of fumigants is desired.
[b]Telone EC is labeled in Virginia and Maryland for preplant application through drip irrigation lines at 9-24 gal/A.
[c] For use in Virginia, for organic or conventional growers, labeled for lesion, ring and root knot nematodes. Shank injection or via irrigation, apply at least 10 days before planting.
[d] Metam sodium is available in a variety of formulations such as Nemasol (3.18 lb/gal), or as Nemasol 42% or Sectagon 42 (4.26 lb/gal). Adjust rates according to label directions.)
[e] For use on stone fruits (peach, plum, nectarine, cherry, etc.). Consult the label for rates and application directions.
[f] 500 ml/ha, Apply via micro-sprinkler, drip or trickle irrigation. Maximum of two applications (13.7 oz.) per year.
[g] For use on non-bearing stone fruits (peach, plum, nectarine, cherry, etc.).
[h] Apply via irrigation in 1-2 applications when nematodes are active. Do not exceed a total of 7 pt. per year
[i] Apply 2 to 4 pints per 100 gallons of water as a foliar spray. Start when trees reach full leaf and apply at 2 to 3-week intervals up to four applications per season. Treatment will also control some insects. For use on nonbearing apple, cherry, peach, or pear.
[j] Apply within 24 hours of planting and thoroughly incorporate to a depth of 4-8 inches immediately after application.
[k] For organic or conventional growers. Apply 3-4 applications 7-10 days apart via irrigation.

Orchard Site Bio-Renovation Program

Dr. Paul Steiner, University of Maryland, College Park Maryland (Deceased)

Few registered chemicals for soil fumigation remain for treating old orchard sites to reduce plant parasitic nematode populations and various soil-borne fungi. Simply leaving the land fallow for several years is often not enough to return the site to its full productive potential. If broad leaf weeds are not excluded during the fallow period, the site may continue to harbor the tomato ringspot virus. Most grain, corn and forage crops that might be grown in the interim between orchard contribute little to the reduction of many parasitic nematode species that attack fruit trees and can be at high levels in old orchard soils. Finally, old orchard soils often have persistent residues of herbicides, are low in organic matter, have problems with soil compaction and internal drainage.

Given the high cost of establishing a modern, high density orchard and our limited ability to treat the soil effectively after the trees are planted, it is important to prepare the soil for these intensively cropped sites carefully. All of the elements of the pre-plant site conditioning program outlined here are based on research in the mid-Atlantic region over the last decade. What is new is that these elements have now been combined into a cohesive two-year program aimed at establishing a soil ecosystem that will support the long term productivity needed in fruit orchards.

FALL, THREE YEARS BEFORE PLANTING

Remove old trees and roots. Rip soil thoroughly to expose additional roots and large rocks for removal. Submit sold samples from top 18 inches for pH and basic fertility determinations.

Apply lime to adjust soil pH to 6.5 and incorporate by deep plowing. If more than 1,500 pounds of total oxides per acre are required, apply half before plowing and incorporate the remaining half after plowing by disking.

Plant barley, oats or rye as cover crop to reduce winter erosion.

TWO YEARS BEFORE PLANTING

Mid-April to Early May

Broadcast 50 pounds of actual nitrogen per acre along with the required amounts of phosphorus and potassium needed for forage crops based on soil test results and incorporate these materials as the winter cover crop is plowed or disked under.

Plant Sudex (sorghum x sudan grass hybrid variety of *Sorghum bicolor*) at 20-25 pounds of seed per acre. *Note*: Sudex is the crop of choice because it produces a large amount of biomass quickly and the roots will penetrate four to six feet deep. This additional organic matter should also help reduce the availability of toxic herbicide residues in the previous orchard soil.

Mid-July through Late-August

Mow down Sudex in mid- to late-July and add an additional 75-100 pounds per acre of ammonium sulfate to support regrowth of the Sudex crop and to begin the nutritional plan for the following rapeseed crop. In mid-August, an additional mowing with a flail mower may be necessary to reduce the bulk of plant residue before plowing it down thoroughly.

Incorporate 50-75 pounds of ammonium sulfate per acre by disking. *Note*: The additional sulfur added during this season may acidify the soil slightly, but the additional availability of sulfur should increase the amount of toxic materials produced in the following rapeseed crop.

In late August, approximately two weeks after plowing down the Sudex plant residues, plant rapeseed (var. 'Dwarf Essex') at 8 to 10 pounds of seed per acre. *Note*: In addition to adding more organic matter to the soil, rapeseed produces chemicals that are toxic to plant-parasitic nematodes. Test show that two successive plantings of rapeseed will reduce nematode populations equivalent to an application of Telone-II.

ONE YEAR BEFORE PLANTING

Mid- to Late-April

Mow rapeseed using a flail mower and plow down the residue immediately. Never mow down more area than can be plowed under within two hours. *Note*: Mowing injures the plants and initiates a process releasing nematicidal chemicals into the soil. Failure to incorporate mowed plant materiel into the soil quickly, allows much of these available toxicants to escape by volatilization.

Two weeks after plowing down the first rapeseed crop, broadcast 50-75 pounds of ammonium sulfate and plant a second crop of 'Dwarf Essex' rapeseed at 8 to 10 pounds of seed per acre.

August-September

Collect and submit soil samples in early August for pH and basic fertility levels so that results can be available by early September.

In mid-August, mow down the second rapeseed crop and plow down the residue immediately as done previously.

In early September, approximately two weeks after plowing down the second rapeseed crop, broadcast any lime needed to readjust the soil pH to 6.5 along with 15 to 20 pounds of actual nitrogen (do not use ammonium sulfate) per acre along with other nutrients needed for fruit crop production and plow or disc these materials in deeply.

Plant 20 pounds of *certified* Kentucky-31 tall fescue seed and 10 pounds of winter oats per acre. *Note*: Use only certified Kentucky-31 seed for uniformity and maximum performance and then only seed lots that are "endophyte-infested". Bargain seed lots marked K-31 often are not true to variety and endophyte free seed may not suppress nematode populations as intended.

SPRING, YEAR OF PLANTING

Two weeks prior to planting trees, apply glyphosate (Roundup) herbicide as a directed spray to kill the K-31 sod cover in four foot wide strips marking the planting rows. Where possible locate the new tree rows in the row spaces from the previous orchard. Leave the killed sod in place and plant trees through the sod with a tree planter where possible or a suitable auger if necessary. *Note*: Killed sod does not compete with the new trees, traps more rain than bare ground and reduces soil loss through erosion. In addition, by not disturbing the soil, fewer weed seeds are exposed for germination.

TABLE 28. NUMBER OF DAYS FROM LAST SPRAY TO HARVEST** AND RESTRICTED ENTRY INTERVALS (hours)

		Time limit in days for use before harvest						
Common name	**Trade name**	**Apple**	**Pear**	**Cherry**	**Nectarine**	**Peach**	**Plum**	**REI(h)**
abamectin	Agri-Mek, Abba	28	28	21	21	21	21	12
abamectin + cyantraniliprole	Minecto Pro	28	28	21	21	21	21	12
abamectin + thiamethoxam	Agri-Flex	35	35	-	-	-	-	12
acequinocyl	Kanemite	14	14	-	-	-	-	12
acetamiprid	Assail	7	7	7	7	7	7	12
afidopyropen	Versys	7	7	7	7	7	7	12
aminovinylglycine	ReTain	7	7	7	7	7	7	12
azadirachtin	Aza-Direct, Neemix	0	0	0	0	0	0	4
azoxystrobin	Abound	-	-	0	0	0	0	4
Bacillus subtilis	SerenadeMax	0	0	0	0	0	0	4
Bacillus thuringiensis	Various	0	0	0	0	0	0	4
6-benzyladenine	Various	86	86	-	-	-	-	12
beta-cyfluthrin	Baythroid XL	7	7	7	7	7	7	12
bentazon	Broadloom	365	365	365	365	365	365	48
benzovindiflupyr	Aprovia	30	30	-	-	-	-	12
bifenazate	Acramite, Banter	7	7	3	3	3	3	12
bifenthrin	Bifenture	-	14	-	-	-	-	12
bifenthrin	Brigade	14	14	-	14	14	-	12
buprofezin	Centaur	14	14	14	14	14	14	12
captan		(H)	-	0	0	0	0	(L)
carbaryl	Sevin	3	3	3	3	3	3	12
carfentrazone	Aim	3	3	3	3	3	3	12
carfentrazone + sulfentrazone	Zeus Prime XC	14	-	-	-	-	-	-

See footnotes at end of table, p 175.

TABLE 28. NUMBER OF DAYS FROM LAST SPRAY TO HARVEST** AND RESTRICTED ENTRY INTERVALS (hours) (cont.)

		Time limit in days for use before harvest						
Common name	**Trade name**	**Apple**	**Pear**	**Cherry**	**Nectarine**	**Peach**	**Plum**	**REI(h)**
chlorantraniliprole	Altacor eVo	5	5	10	10	10	10	4
clethodim	Select	365	365	365	365	365	365	24
clofentezine	Apollo	45	21	21	21	21	-	12
clopyralid	Stinger	30	-	30	30	30	30	12
clothianidin	Belay	7	7	-	-	21	-	12
CM granulovirus	Cyd-X, Madex, Virosoft	0	0	0	0	0	0	4
cyclaniliprole	Verdepryn	7	7	7	7	7	7	4
cyantraniliprole	Exirel	3	3	3	3	3	3	12
cyflufenamid	Torino	14	14	6	-	-	-	4
cyflumetofen	Nealta	7	7	-	-	-	-	12
cyfluthrin	Tombstone	7	7	7	7	7	7	12
cyprodinil	Vangard	0	0	2	2	2	2	12
diazinon		21	21	21	21	21	21	96
dichlobenil	Casoron	0	0	0	-	-	-	12
difenconazole + cyprodinil	Inspire Super	14	14	2 (G)	2	2	2	12
diflubenzuron	Dimilin	-	14	-	-	-	-	12
dinotefuran	Scorpion, Venom	-	-	-	3	3	-	12
diuron	Karmex	(L)	(L)	-	-	(L)	-	12
dodine	Syllit	7 (B)	-	0	-	15	-	48
emamectin benzoate	Proclaim	14	14	-	-	-	-	48
esfenvalerate	Asana, Adjourn	21	28	14	14	14	14	12
ethephon	Ethrel, Cepha	4	-	-	-	-	-	48
etoxazole	Zeal	14	14	7	7	7	7	12
fenazaquin	Magister	7	7	3	3	3	3	12
fenbutatin oxide	Vendex	14	14	14	14	14	14	48
fenbuconazole	Indar	14	-	0	0	0	0	12
fenhexamid	Elevate	-	-	0	0	0	0	4
fenpropathrin	Danitol	14	14	3	3	3	3	24
fenpyroximate	Portal	14	14	7	7	7	7	14
flonicamid	Beleaf	21	21	14	14	14	14	12
fluazifop-P	Fusilade DX	365	365	14	14	14	14	12
fluazinam	Omega	28	-	-	-	-	-	48
flumioxazin	Chateau	60	60	60	60	60	60	12
fluopyram + tebuconazole	Luna Experience	-	-	0	0	0	0	12
flupyradifurone	Sivanto	14	14	14	14	14	14	4
fluroxypyr	Starane Ultra	14	14	-	-	-	-	24
flutriafol	Topguard	14	14	-	-	-	-	12
flutianil	Gatten	14	0	3	0	0	0	12
fluxapyroxad	Sercadis	0	0	0	0	0	0	12
fluxapyroxad + pyraclostrobin	Merivon	0	0	0	0	0	0	12

See footnotes at end of table, p 175.

TABLE 28. NUMBER OF DAYS FROM LAST SPRAY TO HARVEST** AND RESTRICTED ENTRY INTERVALS (hours) (cont.)

		Time limit in days for use before harvest						
Common name	**Trade name**	**Apple**	**Pear**	**Cherry**	**Nectarine**	**Peach**	**Plum**	**REI(h)**
fosetyl-Al	Aliette	365	365	365	365	365	365	12
gamma-cyhalothrin	Proaxis, Declave	21	21	14	14	14	14	24
gibberellins A_4 A_7	ProVide	-	-	-	-	-	-	12
glufosinate	Rely	14	14	14	14	14	14	12
glyphosate	several	1	1	17	17	17	17	4-12(L)
halosulfuron	Sandea	14	14	-	-	-	-	12
hexythiazox	Savey, Onager	28	28	28	28	28	-	12
imidacloprid	Admire Pro, Alias	7	7	7	0	0	7	12
imidacloprid + beta-cyfluthrin	Leverage	7	7	7	7	7	7	12
indaziflam	Alion	14	14	14	14	14	14	12
indoxacarb	Avaunt eVo	14	28	14	14	14	14	12
inpyrfluxam	Excalia	B	-	-	-	-	-	12
iprodione	Rovral	-	-	(B)	(B)	(B)	(B)	24
kaolin	Surround	0	0	0	0	0	0	4
kasugamycin	Kasumin	90	90	-	-	-	-	12
kresoxim-methyl	Sovran	30	30	-	-	-	-	12
lambda-cyhalothrin	Warrior, Lambda-Cy, Silencer	21	21	14	14	14	14	24
lambda-cyhalothrin + chlorantraniliprole	Besiege	21	21	14	14	14	14	24
lambda-cyhalothrin + thiamethoxam	Endigo	35	35	14	14	14	14	24
malathion	various	-	-	3(K)	7	7	-	12 (cherry) 24 (nectarine, peach)
mancozeb	various	(L)	(L)	-	-	-	-	24
mefanoxam	Ridomil Gold	(Q)	-	(L)	(L)	(L)	(L)	12
mefanoxam	Ridomil 5G	365	365	365	365	365	365	12
mefentrifluconazole	Ceyva	0	0	0	0	0	0	12
metconazole	Quash	-	-	14	14	14	14	12
methomyl	Lannate	14	-	-	1 (J)	4	-	48-96 (L)
methoxyfenozide	Intrepid	14	14	-	7	7	7	4
metiram	Polyram	(L)	-	-	-	-	-	24
myclobutanil	Rally, Nova	14	-	0	0	0	0	24
naphthalene acetic acid	NAA	(F)	-	-	-	-	-	
naphthylacetamide	Amid-Thin	(F)	-	-	-	-	-	
norflurazon	Solicam	60	60	60	60	60	60	24
novaluron	Rimon	14	-	-	-	-	-	12
OFM sprayable pheromone	CheckMate OFM-F	0	0	0	0	0	0	0
oryzalin	Surflan	0	0	0	0	0	0	12
oxamyl	Vydate	14	14	-	-	-	-	48
oxyfluorfen	Goal	(A)	(A)	(A)	(A)	(A)	(A)	24
oxytetracycline	Mycoshield, FireLine	60	60	-	21	21	-	12

See footnotes at end of table, p 175.

TABLE 28. NUMBER OF DAYS FROM LAST SPRAY TO HARVEST** AND RESTRICTED ENTRY INTERVALS (hours) (cont.)

		Time limit in days for use before harvest						
Common name	**Trade name**	**Apple**	**Pear**	**Cherry**	**Nectarine**	**Peach**	**Plum**	**REI(h)**
paraquat	various, Gramoxone	0	0	28	28	14	28	12
permethrin	Perm-UP, Pounce	(B)	(C)	3	14	14	-	12
pendimenthalin	Prowl H2O	60	60	60	60	60	60	24
phosmet	Imidan	7	7	7 (D)	14	14	7	96
prohexadione-calcium	Apogee	45	-	-	-	-	-	12
pronamide	Kerb	0	0	0	0	0	0	24
propargite	Omite	(P)	(P)	-	-	-	-	48
propiconazole	Orbit, Tilt, PropiMax	-	-	-	0 (R)	0 (R)	0 (R)	24
pyraclostrobin	Cabrio	-	-	0	-	-	-	12
pyraclostrobin + boscalid	Pristine	0	0	0	0	0	0	12
pyridaben	Nexter	25	7	300	7	7	7	12
pyrimethanil	Scala	72	72	-	2	2	2	12
pyrimethanil + fluopyram	Luna Tranquility	72	-	-	-	-	-	
pyriproxyfen	Esteem	45	45	14	14	14	14	12
Reynoutria sachalinensis	Regalia	0	0	0	0	0	0	12
rimsulfuron	Matrix FNV	14	14	14	14	14	14	4
sethoxydim	Poast	14	14	25	25	25	(P)	12
simazine	Princep	150	0	0	-	0	0	12
spinetoram	Delegate	7	7	7	1	1	7	4
spinosad	Entrust	7	-	7	1	1	7	4
spirodiclofen	Envidor	7	7	7	7	7	7	12
spirotetramat	Movento	7	7	7	7	7	7	24
stylet oil	JMS Stylet-Oil	0	0	(L)	(L)	(L)	(L)	4
streptomycin	Agri-mycin 17	50	30	-	-	-	-	12
sulfoxaflor	Closer	7	7	7	7	7	7	12
sulfur		0	0	0	0	0	0	4
tebuconazole	Elite, Orius	-	-	0	0	0	-	12
tebuconazole	Tebuzol	75	75	0	0	0	0	5 days
terbacil	Sinbar	60	-	-	-	60	-	12
thiamethoxam	Actara	(M)	(M)	14	14	14	14	12
thiamethoxam + chlorantraniliprole	Voliam Flexi	35	35	14	14	14	14	12
thiophanate-methyl	Topsin M	0	1	1	1	1	1	12
thiram		-	-	-	-	7	1	24
tolfenpyrad	Apta	14	14	14	14	14	14	12
2,4-D	various (E)	14	14	40	40	40	40	48
triadimefon	Triadimefon	45 (N)	45 (N)	-	-	-	-	12
trifloxystrobin	Flint, Gem (O)	14	14	1	1	1	1	12
trifloxystrobin + fluopyram	Luna Sensation	14	14	1	1	1	1	12
triflumizole	Procure	14	14	-	-	-	-	12

See footnotes at end of table, p 175.

TABLE 28. NUMBER OF DAYS FROM LAST SPRAY TO HARVEST** AND RESTRICTED ENTRY INTERVALS (hours) (cont.)

		Time limit in days for use before harvest						
Common name	**Trade name**	**Apple**	**Pear**	**Cherry**	**Nectarine**	**Peach**	**Plum**	**REI(h)**
zeta-cypermethrin	Mustang Maxx	14	14	14	14	14	14	12
Ziram		14	14	14	14	14	-	48
zeta-cypermethrin + avermectin	Gladiator	28	28	21	21	21	21	12

(A) Dormant use only.
(B) Apply no later than petal fall.
(C) Prebloom application.
(D) Do not use as a foliar spray on sweet cherries.
(E) Check herbicide label to determine which species can be treated with a specific formulation of 2,4 - D.
(F) Apply no later than 2 1/2 weeks after bloom for thinning. As a stop-drop spray, do not apply NAA within 2 days of harvest.
(G) Tart cherry only; do not use on sweet cherry.
(H) See label. Re-entry interval may be more restrictive than days-to-harvest limitations.
(J) SLN 24(c) label for Virginia.
(K) Malathion 57 EC (5E) is the only formulation registered on cherry.
(L) See label.
(M) 35 days if over 2.75 oz/A; 14 days for rates up to 2.75 oz/A.
(N) Maximum 24 oz per acre per season.
(O) Flint for pome fruits, Gem for stone fruits.
(P) Non-bearing trees only.
(Q) Apply before growth starts in spring and in the fall after harvest.
(R) Apply a maximum of 2 sprays during the period beginning 3 weeks before harvest through the day of harvest (0 day PHI). Do not apply to prunes.
** Days to harvest can vary according to the formulation and percentage of active ingredient used in some cases. Be sure to read the label carefully before applying any pesticide. Use this chart only as a guide.

Table 29. Degree Day Table for Codling Moth, Based on 50°F Minimum and 88°F Maximum Thresholds[a]

Daily Maximum Temp (°F)	Daily Minimum Temperature (°F)																				
	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70
52	0	0	0	0	0	0	0	0	0	1	1	2	-	-	-	-	-	-	-	-	-
54	0	0	0	0	1	1	1	1	1	1	2	3	4	-	-	-	-	-	-	-	-
56	1	1	1	1	1	2	2	2	2	2	3	4	5	6	-	-	-	-	-	-	-
58	1	2	2	2	2	2	3	3	3	3	4	5	6	7	8	-	-	-	-	-	-
60	2	2	2	2	2	3	3	4	4	4	5	6	7	8	9	10	-	-	-	-	-
62	3	3	3	3	3	4	4	4	5	5	6	7	8	9	10	11	12	-	-	-	-
64	4	4	4	4	4	5	5	5	5	6	7	8	9	10	11	12	13	14	-	-	-
66	5	5	5	5	5	6	6	6	6	6	8	9	10	11	12	13	14	15	16	-	-
68	6	6	6	6	6	6	7	7	7	7	9	10	11	12	13	14	15	16	17	18	-
70	6	6	6	6	6	7	7	8	8	8	10	11	12	13	14	15	16	17	18	19	20
72	7	7	7	7	7	8	8	8	9	9	11	12	13	14	15	16	17	18	19	20	21
74	8	8	8	8	8	9	9	9	9	10	12	13	14	15	16	17	18	19	20	21	22
76	9	9	9	9	9	10	10	10	10	10	13	14	15	16	17	18	19	20	21	22	23
78	10	10	10	10	10	11	11	11	11	11	14	15	16	17	18	19	20	21	22	23	24
80	10	11	11	11	11	11	12	12	12	12	15	16	17	18	19	20	21	22	23	24	25
82	11	11	12	12	12	12	12	13	13	13	16	17	18	19	20	21	22	23	24	25	26
84	12	12	12	13	13	13	13	13	14	14	17	18	19	20	21	22	23	24	25	26	27
86	13	13	13	13	14	14	14	14	14	15	18	19	20	21	22	23	24	25	26	27	28
88	14	14	14	14	14	15	15	15	15	15	19	20	21	22	23	24	25	26	27	28	29

[a] Degree days determined using a sine wave function [Baskerville and Emin (1969) Ecology 50: 514-517]. To convert Fahrenheit degree days to Centigrade divide table values by 1.8

Table 30. Degree Day Table for Tufted Apple Bud Moth and Oriental Fruit Moth, Based on 45°F Minimum and 91°F Maximum Thresholds[a]

Daily Maximum Temp (°F)	Daily Minimum Temperature (°F)																				
	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70
46	0	0	0	0	0	0	0	0	1	-	-	-	-	-	-	-	-	-	-	-	-
48	0	0	0	0	1	1	1	1	2	3	-	-	-	-	-	-	-	-	-	-	-
50	1	1	1	1	1	2	2	2	3	4	5	-	-	-	-	-	-	-	-	-	-
52	2	2	2	2	2	2	3	3	4	5	6	7	-	-	-	-	-	-	-	-	-
54	2	3	3	3	3	3	3	4	5	6	7	8	9	-	-	-	-	-	-	-	-
56	3	3	4	4	4	4	4	4	6	7	8	9	10	11	-	-	-	-	-	-	-
58	4	4	4	5	5	5	5	5	7	8	9	10	11	12	13	-	-	-	-	-	-
60	5	5	5	5	6	6	6	6	8	9	10	11	12	13	14	15	-	-	-	-	-
62	6	6	6	6	6	7	7	7	9	10	11	12	13	14	15	16	17	-	-	-	-
64	6	6	7	7	7	7	8	8	10	11	12	13	14	15	16	17	18	19	-	-	-
66	7	7	8	8	8	8	9	9	11	12	13	14	15	16	17	18	19	20	21	-	-
68	8	8	9	9	9	9	10	9	12	13	14	15	16	17	18	19	20	21	22	23	-
70	9	9	10	9	10	10	11	10	13	14	15	16	17	18	19	20	21	22	23	24	25
72	10	10	11	10	10	11	12	11	14	15	16	17	18	19	20	21	22	23	24	25	26
74	11	11	12	11	11	11	12	12	15	16	17	18	19	20	21	22	23	24	25	26	27
76	11	12	12	12	12	12	13	13	16	17	18	19	20	21	22	23	24	25	26	27	28
78	12	12	13	13	13	13	14	13	17	18	19	20	21	22	23	24	25	26	27	28	29
80	13	13	14	14	14	14	15	14	18	19	20	21	22	23	24	25	26	27	28	29	30
82	14	14	15	14	15	15	16	15	19	20	21	22	23	24	25	26	27	28	29	30	31
84	15	15	16	15	15	16	17	16	20	21	22	23	24	25	26	27	28	29	30	31	32
86	15	16	16	16	16	16	17	17	21	22	23	24	25	26	27	28	29	30	31	32	33
88	16	16	17	17	17	17	17	18	22	23	24	25	26	27	28	29	30	31	32	33	34
90	17	17	17	18	18	18	18	18	23	24	25	26	27	28	29	30	31	32	33	34	35
91	17	18	18	18	18	18	19	19	24	25	26	27	28	29	30	31	32	33	34	35	36

[a] Degree days determined using a sine wave function [Baskerville and Emin (1969) Ecology 50: 514-517]. To convert Fahrenheit degree days to Centigrade divide table values by 1.8

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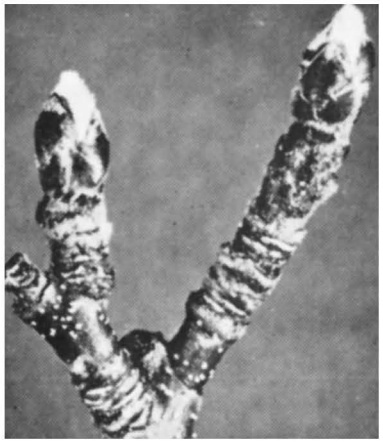
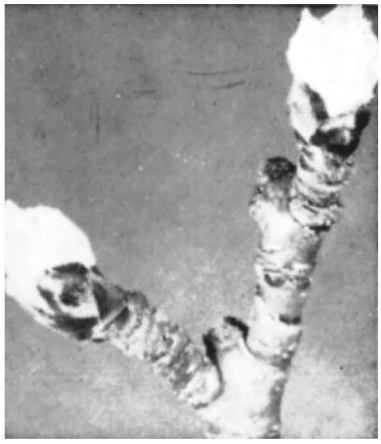
STAGES OF APPLE BUD DEVELOPMENT

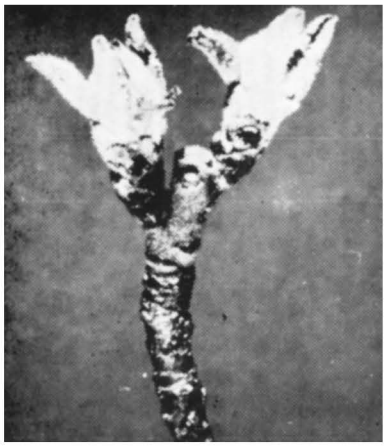
Dormant



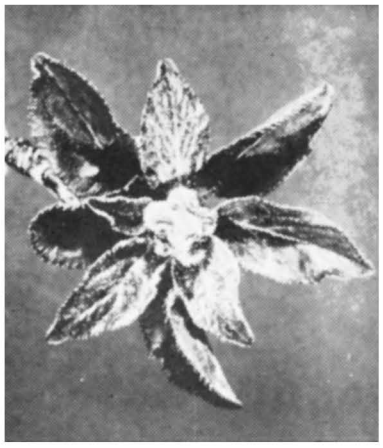
Silver-tip



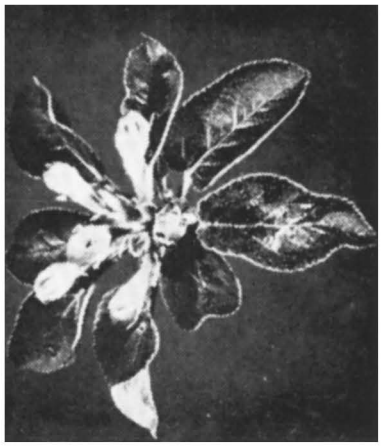
Green-tip



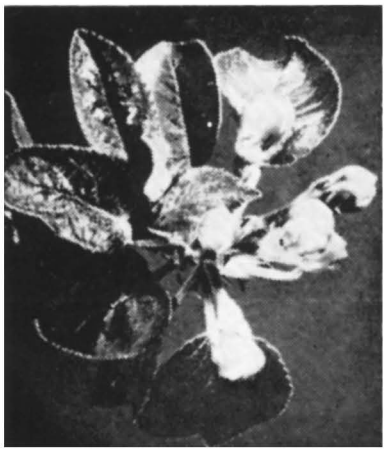
Delayed-dormant (1/2-in. green)



Tight-cluster

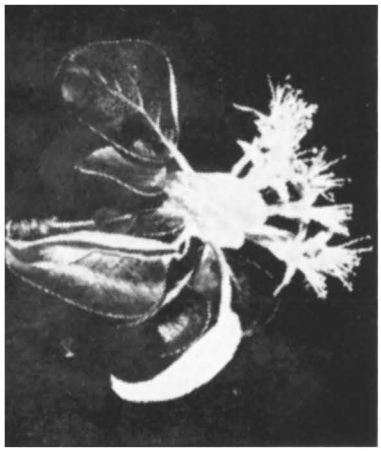


Open-cluster



Pink

Full-bloom



Petal-fall

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