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Successful No-Tillage Corn Production

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No-tillage corn production has been practiced in Virginia for more than 35 years (Jones et al. 1968), yet many producers have not used no-tillage to its maximum advantage. This publication addresses where no-tillage corn can and should be adopted, and where no-tillage production needs to be modified to reduce production problems associated with continuous use.

Advantages of No-Tillage

No-tillage corn production conserves soil and water and reduces capital investment in machinery, but most important to many producers, no-tillage can improve corn yields. For example, in a 15-year study at Virginia Tech, no-tillage corn planted into a rye cover crop out-yielded conventional tillage corn by 16 percent (Moschler et al. 1972). In a three-year University of Maryland study, no-tillage corn in a small-grain/double-crop soybean stubble out-yielded conventional tillage corn by 28 bushels per acre. By reducing water runoff and soil erosion, no-tillage reduces soil loss and improves stream water quality. Adding organic matter through residue can improve soil structure and fertility. The residue cover also provides for better flotation of equipment over the field surface, allowing planting and harvesting to occur under wetter soil conditions. However, it must be noted that planting or harvesting when the soil is too wet may contribute to soil compaction.

Obtaining significant yield increases from no-tillage requires sound management decisions and attention to some unique problems.

Liming

A soil pH of 6.0 to 6.5 is needed for best results from no-tillage, because triazine herbicides require a pH in this range for best performance. This pH range is also recommended for maximizing nutrient availability to the corn crop. If continuous no-tillage is to be practiced for several years, soil samples should be collected annually from the top 4 inches of soil.

Fertilization

Apply phosphate and potash per annual soil test results. Since soils warm more slowly under crop residue, it is recommended that a starter fertilizer application of nitrogen and phosphorus through the planter be used to get corn off to a more rapid start.

Apply nitrogen based on the yield potential of the soil, using a rate of 1.0 pound to 1.15 pounds of nitrogen per acre, per bushel of expected corn yield. On loamy sands, sandy loam soils, or soils with poor drainage, it is desirable to split the nitrogen with one-third of the nitrogen applied at planting and two-thirds of the nitrogen applied when corn is 6 inches to 18 inches tall. Significant quantities of urea nitrogen can be lost through volatilization when applied on crop residue. The efficiency of liquid nitrogen can be improved by dribbling sidedress nitrogen between the rows when corn is 6 inches to 18 inches tall. Do not broadcast liquid nitrogen over corn after it is 2 inches tall, due to risk of severe foliar burn. Ammonium nitrate or urea can be broadcast over corn that is 6 inches to 18 inches tall, but the corn foliage should be dry to reduce leaf injury.

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Date of Planting

Soil temperatures at the 2-inch depth can be 20 degrees cooler under no-tillage than conventional tillage. Optimum corn germination occurs when midmorning soil temperatures reach approximately 50 degrees at the planting depth. Therefore, no-tillage corn generally should be planted about a week later than conventionally tilled corn.

No-Tillage Planters

The selection and adjustment of no-tillage planters depends on the amount and type of residue cover, the soil type, and soil moisture. Planters should cut through residue cover and provide uniform placement of the seed in the soil at the proper depth to achieve good seed contact with the soil. No-tillage planters must firm the soil around the seed to ensure good germination and quick seedling emergence. Planters equipped with double-disk seed-furrow openers are recommended for no-tillage planting. Narrow, single, or dual-press wheels may be used for firming the soil around the seed. The adjustment and operation of planters should be in accordance with the manufacturer's recommendations.

It is important to avoid excessive speeds while planting to ensure correct planter operation once it is adjusted for the field setting. If the planter cannot be set to obtain adequate soil-to-seed contact, one should assume a 10 percent to 15 percent stand loss when determining the seeding rate per acre. For a final population of 22,000 plants, approximately 26,000 seeds per acre are needed. More details on setting planters can be found in *Planter/Drill Considerations for Conservation Tillage Systems,* Virginia Cooperative Extension publication 442-457 (*http://pubs.ext.vt.edu/442/442-457/442-457.html*). Under most conditions, seeds should be planted 1 inch to 2 inches deep. When soils are cold or wet, it is advisable to plant the corn only 1 inch deep, but always ensure complete coverage of the seed.

Weed Control

Weed control in no-tillage corn is often more difficult than in conventionally tilled corn. As a general rule, herbicide effectiveness decreases with the amount of crop and weed debris on the soil surface. This debris ties up herbicides and also presents a physical barrier to the uniform distribution of the herbicide on the soil for residual activity. Consequently, selection of herbicide rates and application methods is critical. Read and follow instructions on the herbicide label. On the other hand, residue cover provides some suppression of many weed species. In addition, there is generally less incidence of large-seeded weeds in continuous no-tillage systems.

Control of Existing Vegetation at Planting

The types of weeds present and the type of cover determine the herbicide program required to control vegetation present at planting. It is necessary to consider the burndown materials and the postemergence characteristics of the other herbicides to be used in relationship to the weed infestation.

Annual grasses and broadleaf weeds can be controlled with nonselective herbicides, such as glyphosate or paraquat. In general, no alteration in the residual herbicide program is needed to supplement the nonselective herbicide in these instances, although some herbicide labels require slightly higher rates to compensate for herbicide adsorption on the cover crop or other plant material.

When planting in perennial grass sods, a single paraquat application may not be sufficient to give satisfactory control. Control of orchardgrass and fescue requires use of the highest labeled rates of atrazine in addition to paraquat. The use of atrazine plus simazine combinations in perennial sods is not recommended because, unlike atrazine, simazine does not have postemergence activity and will not aid in burndown of these grass sods. In very vigorous orchardgrass or fescue sods, two applications of paraquat are sometimes required to achieve complete control.

The use of glyphosate should be considered for control of existing perennial broadleaf and grass weeds at planting. Care must be taken to allow these weeds to reach the minimum growth stages listed on the label before application is made. Often, this delays corn planting to the point that alternative crops or tillage methods should be considered as a means of control. The use of glyphosate should also be considered when heavy infestations of annual weeds are present and have advanced to the stage at which paraquat will give only partial control.

Control of Annual Grasses

Fall panicum and other annual grasses can be major problems in no-tillage corn production. Simazine has good activity on annual grasses, and a combination of atrazine and simazine will give good control, especially of late-season flushes of these annual grasses. Chloroacetamide herbicides, including metolachlor, alachlor, and acetochlor, also provide good residual control of annual grasses and suppression of yellow nutsedge. These herbicides can be used in combination with atrazine, or in combination with atrazine and simazine. Carefully consult the label and *Pest Management Guide: Field Crops, 2009,* Virginia Cooperative Extension publication 456-016 (*http://pubs.ext.vt.edu/456/456-016/456-016.html*), for rotation crop restrictions following atrazine and simazine applications.

Control of Triazine-Resistant Pigweed

Triazine-resistant pigweed is a major problem in a large part of our no-tillage corn acreage. The weed has no susceptibility to the triazine herbicides. Residual chloroacetamide herbicides afford fair-to-good control of this weed with optimum activation rainfall. If there is not sufficient rainfall for activation or if very heavy rainfall occurs early in the season, pigweed control with these compounds will be inadequate, and a postemergence herbicide application will be required. Excellent pre-emergence residual control of pigweed can be obtained when flumetsulam, mesotrione, or pendimethalin are included in the pre-emergence herbicide application. These compounds are available in prepackaged mixes. One product used extensively in Virginia no-till corn, Lumax, contains atrazine and metolachlor for general residual weed control, plus mesotrione for residual control of pigweed. Information on composition of the prepackaged mixes is contained in *Pest Management Guide: Field Crops, 2009,* Virginia Cooperative Extension publication 456-016.

Control of Perennial Broadleaf Weeds

In the absence of tillage, herbaceous perennial broadleaf weeds can become very troublesome in no-till corn plantings. These species must be controlled with systemic herbicides at growth stages when translocation towards underground perennial plant structures is maximized. Generally, these perennials have not emerged at the time of planting, and making applications before planting are ineffective. Many postemergence corn herbicides have excellent activity on perennial broadleaf weeds, and growers should carefully consult the label and the herbicide efficacy tables in *Pest Management Guide: Field Crops, 2009*, Virginia Cooperative Extension publication 456-016, to match their specific infestation to the most effective treatments. In most cases, the use of glyphosate-resistant corn hybrids represents the most effective overall method for perennial broadleaf weed control in no-till corn. Growers should also consider control of these perennials in rotational crops. Where soybeans are part of the rotation, perennial broadleaf weed control should be considered in glyphosate-resistant soybeans, because the soybean canopy is extremely effective in aiding the control of these species.

Control of Perennial Grasses

There are several excellent postemergence methods for perennial grass control in no-till corn. Johnsongrass can be controlled with nicosulfuron or with glyphosate in a glyphosate-resistant corn hybrid. Because of potential maize dwarf mosaic virus transmission to corn from dying johnsongrass following these applications, maize dwarf mosaic virus-tolerant corn hybrids must be used where postemergence johnsongrass herbicide programs will be employed. Bermudagrass control in no-till corn requires the use of glyphosate in glyphosate-resistant corn hybrids. Several postemergence herbicides, including halosulfuron, mesotrione, and glyphosate, can be used for the control of yellow nutsedge.

Herbicide-Tolerant Corn

Corn hybrids resistant to glufosinate and glyphosate herbicides are available for use and are a result of genetic engineering. There are also corn hybrids – designated as Clearfield corn – with tolerance to imidazolinone herbicides, but in these, the herbicide-tolerance trait was bred without the use of genetic engineering.

Nonselective herbicides such as glyphosate and glufosinate broaden the spectrum of weeds controlled, which is particularly important in no-till systems. In addition, as stated, the systemic activity of glyphosate also helps with the control of perennial broadleaf weeds and grasses. Glyphosate and glufosinate have no soil residual activity. This lack of soil residual affords flexibility in terms of replanting intervals for rotational crops.

Widespread and continual use of the same herbicide mode of action creates selection pressure on the population of individual weed species. Repeated use of the same herbicide mode of action is the reason for rapidly increasing instances of weed resistance to herbicides worldwide. Therefore, special attention should be given to proper herbicide rotations and combinations to avoid the development of herbicide-resistant weed populations. Repeated use of the same herbicide can also result in a shift in weed species from those easily controlled to those more tolerant of the herbicide – even in the absence of the development of resistance.

Crop Residues

Crop residue can play a very important role in a successful no-tillage program. Perennial legumes and/or grass sod, annual crops, and fall-established small grains or legumes grown as cover crops each supply different types and quantities of residue.

Perennial Sod

Residue from perennial forage or hay crops can produce some of the most favorable no-tillage planting conditions, provided the sod is relatively uniform. The soil is often in good physical condition, high in organic matter, and can supply considerable nitrogen to the corn, especially if the sod contained alfalfa or other legumes. Rotation with diverse crops typically reduces pest pressure.

Special Concerns with Sod:

Soil insects such as grubs (*Popillia japonica* Newman, *Phyllophaga* spp.), seed corn beetles (*Stenolophus lecontei* Chaudoir)**,** wireworms (*Agroites mancus* Say, *Limonius agonu*s Say), etc., can severely affect plant stands. Currently there are no corn hybrids with genetic traits to control these pests. Use of either a soil insecticide, such as Counter, or a seed-applied insecticide (Poncho or Cruiser) is recommended when planting no-till corn into sod.

Cutworm problems should always be considered for no-tillage corn, although the percentage of fields generally requiring treatment is relatively small. A burndown of existing cover crops and weeds at least two weeks prior to planting will likely decrease problems with cutworms. Insecticides such as pyrethroids (Asana XL, Baythroid XL, Mustang Max, Warrior with Zeon 1EC) or organophosphates (Lorsban 4E, Orthern 97) will control cutworms when applied with pre-emergence herbicides if cutworms are present at the time of application. Fields should be scouted in the early season and, if cutworms are present, an insecticide application may be warranted. Herculex I corn hybrids are genetically modified to produce a toxin and are labeled for control of cutworms and armyworms.

Killing sod in the fall – prior to spring corn planting – is generally more successful than trying to control sod in spring. In fact, this practice is advised whenever possible. When planting into sod, a single application of paraquat may not give adequate control of grasses such as orchardgrass and fescue. Atrazine – because it has both foliar and soil residual activity – must be included to help control these perennial grasses. Control of sod is frequently reduced when activation rainfall is not received shortly after the herbicide application. Without rainfall, only the foliar component of the atrazine is working. Two applications of paraquat, 10 to 14 days apart, can also be effective on orchardgrass and fescue. See the herbicide section of this publication and *Pest Management Guide: Field Crops, 2009,* Virginia Cooperative Extension publication 456-016, for additional information.

Small Grain Residue

Rye, barley, and wheat can be used as cover crops preceding no-tillage corn. Rye is the most desirable from a residue standpoint, because it grows more rapidly in the spring and is easily killed with herbicides. Paraquat is generally the most effective burndown herbicide for small-grain cover crops, and it should be used in combination with atrazine. Glyphosate is generally not recommended for small-grain, cover-crop burndown, because small-grain plants treated with it do not become brittle, break off, and form suitable mulch for no-till planting. Instead, small-grain plants treated with glyphosate remain upright and continue to allow loss of soil moisture for an extended amount of time after application.

Rye is the best cereal grain cover to plant for establishment of a no-tillage residue for corn. Wheat and barley can also be used but may not produce sufficient growth by corn planting time to provide good residue coverage. Cereal cover crops should not be allowed to grow beyond the boot stage before killing. If allowed to get too tall or possibly even mature prior to killing, they will take longer to form the mulch layer and can deplete the soil of valuable moisture. Also, grain that has headed serves as a host for thrips (*Thysanoptera sp*.) that can move into corn once it emerges. Rye covers should be killed before they are 30 inches tall. Sufficient residue volume is usually achieved if herbicides are applied to rye after it reaches a height of 20 inches.

Figure 1. Rye cover crop at the appropriate stage for termination

Special Concerns With Small-Grain Residue:

Armyworms are attracted to a killed small-grain cover. Pre-emergence broadcast application of a pyrethroid insecticide is generally recommended to control these pests if planting is to occur before the cover crop is completely killed. Heavy armyworm populations may require a follow-up insecticide. A control treatment for armyworms is recommended if 35 percent or more of the plants are infested and 50 percent or more defoliation is seen on the damaged plants – provided that larvae average less than 0.75 inch in length. Worms longer than 1.25 inches usually have completed their feeding.

Cutworms can often be a problem in no-tillage. Broadcast application of a pyrethroid insecticide at planting is generally recommended to control these pests if the small-grain mulch has not been completely killed. Some products are labeled for application in a T-band over the row. After the corn has emerged and passed through the two-leaf growth stage, if 10 percent or more of the young plants show fresh leaf feeding and cutworms are present, a rescue treatment should be applied. Once the corn has reached the three-leaf growth stage, a rescue treatment should be applied if 5 percent of the plants are cut and there are four or more cutworms per 100 plants. Systemic insecticides do not provide adequate control of cutworms; therefore, application of directed sprays of labeled pyrethroids or organophosphates may be needed if thresholds are reached.

Slugs thrive under high-moisture conditions with moderate temperatures – conditions that often occur with no-tillage planting of corn. They survive under crop residue and move to the corn after burndown of weeds or cover crops. Slugs are mainly nocturnal, so only the symptoms of feeding are evident during daylight. During daylight inspections, slime trails left on debris and soil provide evidence that slugs are present. Slugs feed only on green plant tissue, leaving the leaf veins undamaged, resulting in a skeletonized appearance of leaves when heavy feeding pressure occurs.

Slug damage is most severe in corn that is slow to emerge, so management practices that encourage early growth will help avoid damage. Some examples of those practices are: use of starter fertilizer; not planting until midmorning soil temperatures, measured at the planting depth, have reached 50 degrees; and the use of row cleaners or strip tillage to move residue away from the crop row. There are commercially available metaldehyde slug baits that can be applied to control slugs, however the window of activity for this bait is limited, relying upon application at the time of peak slug activity to achieve optimum control. These products can also be costly to apply.

Legume Cover Crops

Hairy vetch, Austrian winter peas, and crimson clover are nitrogen-producing winter annuals. These legumes are capable of producing up to 125 pounds of nitrogen per acre if they are planted early in the fall and are killed as late as possible in the spring. Most of the nitrogen supplied by legumes is in the top growth. To obtain 100 pounds of nitrogen per acre, approximately 3,000 pounds of legume dry matter must be produced. In most years, this may not occur until after the normal corn planting date.


Figure 2. Hairy vetch cover crop

Double-Crop Stubble

The residue present after a soybean crop that was no-tilled into small-grain stubble provides an excellent, water-conserving mulch for planting no-tillage corn.

Figure 3. No-tillage corn planting into double-crop soybean residue

Special Concerns With Small Grain/Double-Crop Stubble:

Cutworm infestations should always be monitored in no-tillage corn, especially when planting in double-crop soybean stubble, although less than 2 percent of cornfields typically have significant damage when planted into soybean stubble.

Corn Stubble

Corn can be planted no-tillage into corn stubble with success; however, there are several weeds, insects, and diseases that may be more difficult to control. The conservation of soil and moisture is better with no-tillage planting into corn stubble than with conventional tillage, but the movement of equipment over wetter soils may pose a significant surface compaction problem. Even though many producers are using corn stubble as mulch, greater yields may be obtained when the previously mentioned mulches are used. It should be kept in mind that, when planting without tillage, it is particularly important to practice crop rotation as a means of avoiding pests and pathogens, and to allow rotation of herbicides to prevent selecting for herbicide-resistant weeds.

Special Concerns With a Corn Stover Residue:

Foliar diseases can and often do cause death of leaves and may prematurely kill the plant. This reduces the photosynthetic area and thereby reduces the carbohydrate available to kernel fill. These diseases can also predispose the plant to stalk rotting and lodging.

Three leaf-blighting diseases of major concern are southern leaf blight (*Bipolaris maydis),* northern leaf blight (*Exserohilum turcicum*), and gray leaf spot (*Cercospora zeae-maydis*). These diseases overwinter in corn stubble, and their development is favored by periods of warm, wet weather. Gray leaf spot lesions are gray to tan, long (1.5 inches to 2.5 inches), narrow (0.125 inch to 0.25 inch), sharply rectangular, and they run parallel to leaf veins. The lesions develop first on the lower leaves and progress up the plant with time. Under favorable conditions (80 degrees to 90 degrees with high relative humidity and periods of dew or free water on the leaf surface), extensive leaf blighting can occur as the lesions merge. The entire leaf or leaves can be killed and the plant may be prematurely killed.

Gray leaf spot has generally been associated with the corn production areas west of the Blue Ridge, but it is not uncommon in many areas of midwestern and eastern Virginia. The use of no-tillage or reduced-tillage practices generally results in increased gray leaf spot incidence and intensity. In some situations where these tillage practices have been coupled with continuous corn production, this disease has been observed in fields as early as pretassel and resulted in significant yield losses. Commercial hybrids with resistance or tolerance to gray leaf spot are available, although none are immune.

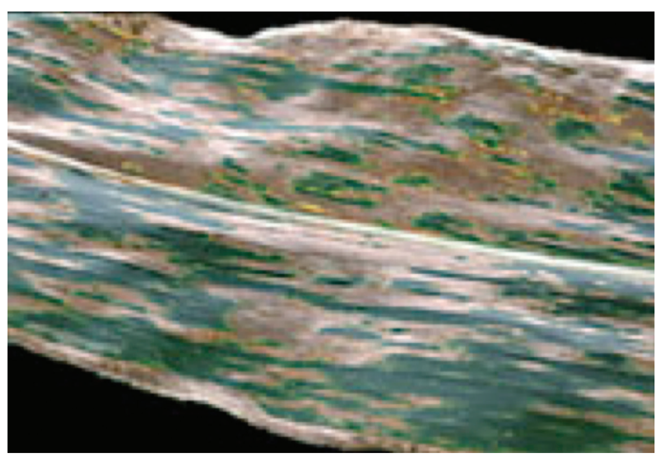

Figure 4. Gray leaf spot on corn

Northern corn leaf blight can be distinguished by long (2 inches to 6 inches), wide (1 inch to 1.5 inches), elliptical or boat-shaped lesions. The lesions are tan to gray-green, and upon close examination may show faint concentric rings of spores on the lesion surface. Generally, the lower leaves show disease first. This disease is favored by somewhat cooler weather compared to southern leaf blight and has been quite severe in the mountain counties. Under favorable conditions, the disease will spread up the plant. Heavily infected fields look dry and fired, as if they were injured by frost. The best control option for this disease is hybrids with genetic resistance.

Figure 5. Northern leaf blight on corn

Southern corn leaf blight lesions are elongated between the veins, tan, and up to 1 inch long, with limited parallel margins and buff- to brown-colored borders. Considerable blighting has occurred in some years and locations due to this disease, particularly with warm, moist weather. Resistant hybrids are available.

References

Jones J. N., J. E. Moody, G. M. Shear, W. W. Moschler, and J.H. Lillard. 1968. The no-tillage system for corn (*Zea mays* L.). *Agronomy Journal* 60:17-20.

Moschler, W. W., G. M. Shear, D. C. Martens, G. D. Jones, and R. R. Wilmouth. 1972. Comparative yield and fertilizer efficiency of no-tillage and conventionally tilled corn. *Agronomy Journal* 64:229-231.