Virginia Cooperative Extension

PUBLICATION 442-456

Equipment Considerations for No-till Soybean Seeding

Robert "Bobby" Grisso, Extension Engineer, Biological Systems Engineering, Virginia Tech
David Holshouser, Extension Soybean Specialist, Tidewater Agricultural Research and Extension Center, Virginia Tech
Robert Pitman, Superintendent, Eastern Virginia Agricultural Research and Extension Center, Virginia Tech

No-till planters and drills must be able to cut and handle residue, penetrate the soil to the proper seeding depth, and establish good seed-to-soil contact. Many different soil conditions can be present at the time of planting in the Mid-Atlantic region. Moist soils covered with residue, which may also be wet, can dominate during late fall and early spring and occasionally in the summer. Although this provides for an ideal seed germination environment, such conditions can make it difficult to cut through residue. In contrast, hard and dry conditions may also prevail. This is especially common when no-tilling soybean into wheat stubble during the hot, dry months of June and July. Although cutting residue is easier during dry conditions, it is more difficult to penetrate the hard, dry soils. Proper timing, equipment selection and adjustments, and management can overcome these difficult issues.

Condition of the Field and Residue

Two of the keys for success with no-till equipment are proper handling of the previous crop residue and weed control. If these issues are not considered, then the ability of the planter or drill to perform its functions is greatly limited. The residue has to be uniformly spread behind the combine if the opening devices are going to cut through the material and plant at a uniform depth. It is very difficult for the planter/drill to cut the residue if the combine has left a narrow swath of thick residue and chaff. Ensure that the combine is equipped with a straw chopper and chaff spreader to distribute residue and chaff over the entire cut area.

For example, if a 30-foot platform header is cutting high-yielding small grain and dumps the material into a 5-6 foot swath, then this swath contains 5 to 6 times more material than the other cut area. The residue may vary from less than 30% coverage to more than 1-inch thick and can affect planting depth. This mat of material is an ideal place for disease and pest problems to accumulate and increases problems relating to cutting residue and penetrating the soil. This mat can create a lot of variability that makes it difficult to adjust the planter/drill for proper operation and this limits successful emergence and early crop growth.

Experience has shown that the residue is best handled by the planter/drill when the residue remains attached to the soil and standing. When the residue is shredded and chopped, it has a tendency to mat and not dry out as quickly as standing residue. The loose residue may not flow through the planter/drill as well and has potential to plug the opening devices.

The other key is weed control. In double-cropped soybeans, one of the reasons to convert to narrow rows is that crop canopy closure, which shades the weeds and gives the soybean more of a competitive advantage is faster. Due to the closure time, 7.5-inch rows may have an advantage over 15- or 30-inch rows. However, if the weeds have a head start, this advantage can be lost. If standing weeds exist, you are asking the planter/drill to cut and move this extra material through the system, plus the crop has lost valuable resources of nutrients and water.

Coulters and Seed Furrow Openers

Probably the primary difference between conventional planter/drill systems and those designed for conservation tillage systems is weight. Since the openers and soil engaging devices must penetrate much firmer soils and cut the residue, the conservation planter/drill systems are built heavier and have the ability to carry much

www.ext.vt.edu

VirginiaTech
Invent the Future

Produced by Communications and Marketing, College of Agriculture and Life Sciences,
Virginia Polytechnic Institute and State University, 2009

more weight than conventional systems. For adequate coulter penetration, weight may have to be added to the carrier. Some planter/drills use a weight transfer linkage to transfer some of the tractor weight to the coulters to ensure penetration. Because coulters are usually mounted several feet in front of the seed opening/placement device (in the case of coulter caddies even further), many use wide-fluted coulters, a pivoting hitch or a steering mechanism to keep the seed openers tracking in the coulter slots.

Wide-fluted coulters (2-3 inches wide) perform the most tillage and open a wide slot in the residue. They allow faster soil warm-up (which may be a disadvantage in some double-cropping situations) and prepare an area for good soil-to-seed contact. However, because of the close spacing, fluted coulters require more weight for penetration, disturb more soil surface, and bury more residue. In wet soil conditions, fluted coulters may loosen too much soil, which could prohibit good seed-to-soil contact. The loose, wet soil may stick to the seed openers and press wheels resulting in non-uniform depth control and clogging.

Narrow-fluted coulters (1/2 to 1 inch wide, see Figure 1) or narrow bubble coulters, ripple coulters and turbo-rippled coulters do not require as much weight for penetration and do not throw as much soil out of the seed furrow as the wide-fluted coulters. Turbo-ripple coulters have more cutting action over the ripped coulters of the same width. Ripple coulters with a smooth edge or smooth coulters are preferred for residue cutting. They can be sharpened to maintain the cutting surface. Operate all coulters close to seeding depth (Figure 2) to avoid excessive soil throwing at high operating speeds and to limit the formation of air pockets below the seeding depth. Use the largest diameter coulters available. When operated properly, they have the best angle for cutting residue and require less weight for penetration.

Most no-till planters/drill are equipped with independent seeding units that should allow at least 6 inches of vertical movement. This will allow smooth transit over non-uniform surface and adjust for root stubs and other obstacles. These units are sometimes staggered which helps with the unit function (more side-to-side space) as well as more space for the residue to flow through the system. These units should be equipped with heavy down-pressure springs and sufficient weight to ensure penetration of both the coulters and seed furrow openers into untilled soil. Usually these springs are adjustable and multiple springs can be added until sufficient pressure is achieved.

Some no-till planters/drills are not equipped with coulters (Figures 2-A and D). These planters/drills use the seed furrow openers to cut and place the seed. Several planter/drill systems have a staggered double disk

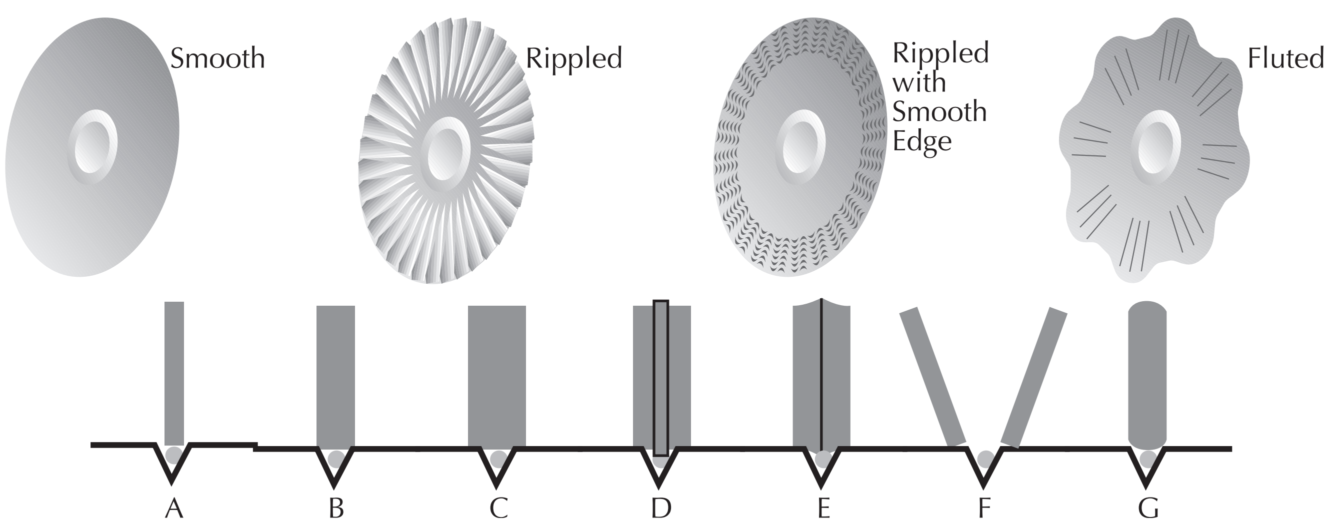

Figure 1. Top figure shows common coulter styles and the bottom figure shows various types of press wheels. Press wheels (bottom figure) are defined as: A) 1- inch wide wheel presses directly on the seed in the bottom of the seed furrow, B) 2-inch wide wheel presses on the seed and gauges planting depth by riding on the sides of the seed furrow, C) wide press wheel gauges planting depth but does not press directly on the seed, D) wide press wheel with two ribs applies pressure on the side of the seed furrow to press soil on the seed while gauging the depth, E) wide press wheel with one center rib applies pressure on the seed furrow to press while gauging the depth, F) a pair of angled press wheels gauge depth while closing the seed furrow and establishing seed-to-soil contact, G) narrow steel press wheel applies pressure directly on the seed but does not flex to "shed" soil in sticky conditions.

seed furrow opener without a coulter (Figures 2-C and E). The leading disk (usually 1/2 to 1 inch in front) cuts the residue and the second aids in opening the seed furrow. Some manufacturers use a single, large disk set at a slight angle. These units require less weight for penetration and provide minimal soil disturbance.

Some no-till drills use offset double-disk openers (Figure 2. C & E)and the leading edge of the double disks is subject to significant wear. Single disk openers are also subject to similar wear. Essentially, the leading edge of one disk takes the abrasion and wear of cutting straw or stalks and penetration into the soil. The leading and trailing disk are typically two different parts and cannot be interchanged. As the double disk openers wear, check the gap between them. If a gap opens between the double disk they will push residue into the furrow and have less ability to cut the residue. Adjustment washers are found in the double disk opener assembly, which allow some adjustment to compensate for wear.

More on Weight and Down Pressure

Individual openers should have sufficient down pressure and independent depth control so as to allow enough movement up and down to ensure that all rows are operating at the same depth. Depending on coulter width, opener design and field conditions, up to 500 pounds per row may be necessary for adequate penetration. Down-pressure springs on independent row units must transfer enough weight from the drill frame so that all meter wheels, seed openers, and all depth control devices and seed pressure wheels are making firm contact with the soil.

Drills, depending on the opener spacing, have four times the number of row units for a given width of operation compared to a row-crop planter of similar width (30-inch spacing). Thus, the total weight of a no-till drill or narrow-row planter should be 2-4 times the weight of a conventional planter. In some cases, when sufficient drill weight is lacking, the springs may physically lift the meter drive mechanism off the ground. Some manufacturers use a spring-loaded drive mechanism to keep the drive firmly in contact with the soil, but this still requires adequate total drill weight for proper operation.

Having enough weight becomes more of a problem with drills than with planters simply because of the number of rows per unit width. For instance, a six-row planter on 30-inch row spacing may require more than 3,000 pounds of weight just for cutting the residue and

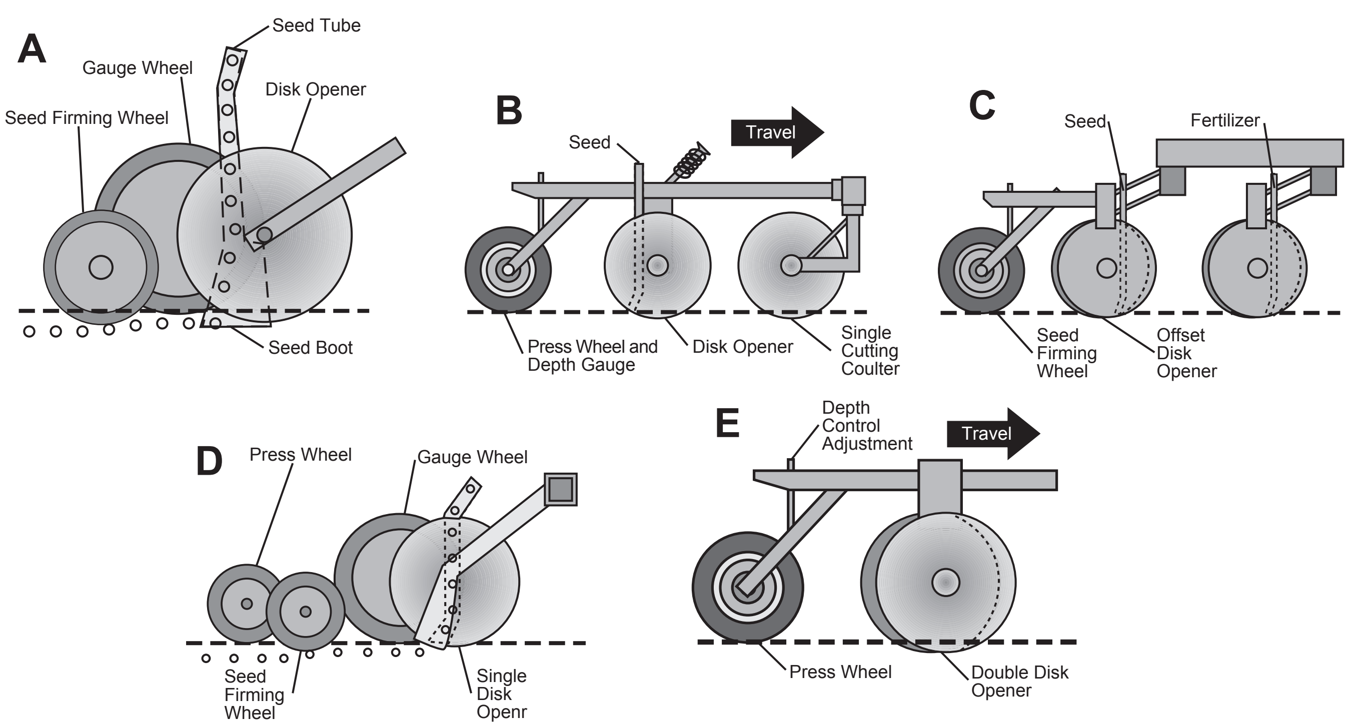

Figure 2. Diagram of typical seeding mechanisms: A) Single disk opener, B) single disk opener with add-on coulter unit, C) offset double disk openers with fertilizer opener mounted midway between seed openers, D) depth control is maintained by mounting the gauge wheel beside the seed opener disk, E) depth control is maintained by mounting the press wheel on the furrow opener frame member.

penetrating the soil (six rows times 500 pounds per row), whereas, a drill of the same width on 7.5-inch row spacing has 24 openers and may require more than 12,000 pounds for proper penetration. This additional weight could cause structural problems with the drill/planter frame. Added weight also can cause potential compaction in wet conditions or on turn rows.

Sufficient weight must remain on the press wheels to ensure firming of the seed into the soil. Wet soil is easily compacted and care must be taken not to over pack the soil, making it difficult for seedling roots to penetrate the soil. In dry soil conditions, extra closing force may be needed. The key is to evaluate seed-to-soil contact, not the top of the seed-vee. As long as the contact is there, something as simple as a harrow that acts to close the top of the vee and pull light residue cover back over the vee may be all that is needed. This is a common practice on drills that use a narrow press wheel.

Figure 3. Seed metering for seed singulation on a grain drill. Meter device is shown with gear and chain drive. (see figure 4 for location)

Seed Meter Devices

When comparing planter/drill systems, evaluate the differences they may have on germination and plant stand consistency. The conventional seed meter devices for drills often result in poorly spaced stands with many gaps. To compensate for this stand variability, many operators will over-seed their stands by 10-20%. The interest in the drills with singulation devices similar to row-crop meter devices (Figure 3) is due to the possibility to improve stands, reduce seed cost (from not over-seeding), and reduce variability seen in conventional flute-meter devices.

About 10 years ago, some research was conducted on conventional fluted-meter devices to evaluate them for variable rate seeding. Fluted-meters have a cup on a rotating shaft and then an opening gate. The device performed very poorly for this test and showed that changing shaft speed or forward speed or gate opening greatly hindered the accuracy of population and spacing of the seed. As the seeds increased in size, the variability was even greater. The drill meter devices were usually not considered for singulation accuracy because the small grains can usually compensate for the inconsistency. This may not be the case for soybeans. Some accuracy and spacing uniformity can be gained with very specific travel speeds and fixed population but this degrades quickly if travel speed is not consistent. Another problem that contributed to the lack of spacing uniformity was the distance from the meter to the seed furrow. The seed bounce and travel in the seed delivery tube greatly influenced the spacing uniformity.

Figure 4. Precision seeding system with seed meters close to the ground. a) marks the metering device.

Figure 5. Planter equipped with extra planter boxes to plant 15-inch rows.

With these inherent problems of conventional fluted-meter devices, manufacturers have designed a spiral cup, belted meters, and meter devices that singulate out the individual seeds (potential to plant corn). Designers also moved the meter device closer to the ground (Figure 4) to reduce the travel distance to the seed placement. The new meter device on the "Precision Seeding System" has these singulation features and has a narrow profile that allows a 7.5-inch spacing.

Manufacturers have also adapted row-crop planters (Figure 5) for narrow row (15 inch spacing) to give producers the seed singulation and spacing accuracy as well as a machine that could be used for both drilled and row-crops. Several manufacturers have configured row-crop planters so that they are easy to convert from 15 to 30 inch row spacing.

Since the meter devices of some systems are close to the ground, they are difficult to calibrate and check the seed population. Most recommend a static test and rotating the meter drive wheel. While this can be a reflection of the accuracy and uniformity of the individual units, it may not give accurate measurements for field conditions. Be prepared to spend some time in the field observing the seed spacing and calculating seeding population by digging into several seed furrows.

Press Wheels and Depth Control

Depth control of most no-till planter/drill systems comes in two methods: 1) gauging the depth from a gauge wheel adjacent to the seed furrow device (Figures 2-A and D), or 2) press wheel behind the seed furrow openers (Figures 2-B, C and E). In either case, keep adequate pressure on the gauge or press wheel to force the openers into the soil to the proper depth. A harrow behind a drill ensures seed coverage and redistributes residue for effective conservation measures. Regardless of the depth control, wide-flat press wheels (Figure 1-C) are unacceptable for no-till since they will ride on the firm soil adjacent to the seed furrow and will not firm the seed into soil. A wide press wheel equipped with a rib that runs on the sides of the seed furrow or a rib that runs directly over the furrow to press the seed is adequate for good seed-to-soil contact.

Another option is to use a pair of angled press wheels (Figure 1-F) behind the opener to gauge planting depth and close the seed furrow at the same time. When using angled press wheels, ensure that pressure is not placed on the seed furrow to the point that a ribbon of soil moves the seed up. On some models, increasing press wheel pressure will decrease the pressure applied on the seed openers. Adjust the angle or spacing such that the angle of the press wheels meet at the seed depth.

The disadvantage of any system using the press wheel for depth control is its distance from the seed opener. As the distance increases, there is a greater possibility that irregular terrain will influence both depth control and the press wheel's ability to provide good seed-to-soil contact.

Setting planters and drills for the season

When the weather and time is right for planting, producers should be in the field planting, not getting equipment ready and making last minute repairs. Any repairs should have been made at the end of planting season last year when problems were fresh in their minds.

In the shop… Read the owner's manual for suggested maintenance and lubricate as directed. Check the operation of the seed metering devices and replace worn parts. Adjust the seed metering devices using this year's seed to match seed size and shape. Check, adjust, and lubricate chains, sprockets, bearings, and fittings. Replace worn ones. Adjust or replace the seed-furrow opener disks and other ground engaging components. Properly inflate all tires, including those on the tractor.

In the field before planting season… Set the toolbar and the hitch point at the proper height to match soil conditions. Level the planter from front-to-rear, slightly tail down to help with seed-to-soil contact. Blind plant (or use some old seed) a short distance to check operation: check residue cutting and handling, check penetration to desired seeding depth, evaluate seed-to-soil contact, and evaluate closing the seed-vee. Adjust down pressure springs to improve residue cutting and seedbed penetration. Add weight as needed for the down pressure springs to work against and to keep the drive wheels in firm contact with the ground to avoid slippage.

General Operation

Since the planter/drill system must handle and cut the residue, allow the residue to dry and become crisp before planting. These conditions aid in the cutting and handling of the residue. The weight of the drill and pressure from the down-pressure springs are essential for cutting residue, penetrating the soil and preventing seed openers from bouncing over residue. Most drill manufacturers suggest operating speeds between 6 to 10 mph. However, in soils with rocks and clods, slower speeds may be warranted to reduce system bounce and residue/soil throwing, and to allow more time to cut the residue. While high speeds hinders accurate metering from fluted-meter devices, a higher operating speed assists in residue flow, especially for planter/drill equipped with a coulter caddie and/or a harrow.

In the field during planting season, especially when changing fields… Check residue cutting and handling. Leave more residue over the row as the weather warms up to reduce seedbed drying. Check planting depth and seed-to-soil contact. Back off on pressure in wet soils that are easily compacted. Slow down to improve seed placement uniformity. Check seed spacing for proper population. Adjust harrows on drills to redistribute residue and help close the seed-vee.

Check seed depth… Drill depth control surveys from the midwest indicated a strong tendency to plant much deeper than intended. Only 20% of the producers were at or near the intended depth, and 68% of the fields were planted too deep. Excessive depth delayed germination and reduced stands. These same surveys found that producers are much more accurate with population rate than with planting depth. The maximum seeding depth should be found in areas of minimum crop residues and the depth wheels should be able to hold the planter units up in soft soil conditions.

Check for seeds on the ground... The depth control, closure and seed-to-soil contact device should be adjusted if seeds are found on the soil surface.

Varying soil and residue conditions across the field... If depth control is insufficient due to soft soil conditions (sandy soils) or residue amounts are changing, check to see if the manufacturer offers some additional down-pressure spring kits that activate more spring pressure as conditions dictate and less when the down pressure is not needed.

Check for hairpinning... When operating a planter/drill system in heavy residue, straw may be pushed in the seed furrow (hairpinning), reducing seed-to-soil contact, and slowing or reducing germination. Make sure the cutting angle on the coulter is correct and the cutting edge is sharp. Depending on the conditions, a smooth coulter may provide more needed cutting of residue than the tillage from a fluted coulter. The hairpin effect is minimized when seeding units operate on a firm soil, and when residue is dry and crisp. Simply waiting a little later in the day, when residue is drier, may greatly improve the operation of the planter/drill system.

Summary

Successful planting/drilling with no-till equipment depends on specially designed systems that can uniformly place seed through heavy residue and into firm, moist soil. No-till equipment is available to achieve these results for good yields.

Acknowledgments

The authors would like to express their appreciation for the review and comments made by Rexford Cotten, Extension Agent, Agriculture, City of Suffolk; Bobby Clark, Extension Agent, Crop and Soil Science, Shenandoah County; Dan Brann, Small Grains Specialist, Crop and Soil Environmental Sciences, John Cundiff, Professor, Biolgical Systems Engineering, Virginia Tech; and Keith Burgess, Conservation Specialist, Monacan Soil & Water Conservation District.

References:

Conservation Tillage Systems and Management. 2000. MWPS-45, Second Edition, MidWest Plan Service, Iowa State University, Ames, IA 50011, pg 270.

Dickey, E.C. and P. Jasa 1989. Row Crop Planters: Equipment Adjustments and Performance in Conservation Tillage. NebGuide G83-684, University of Nebraska Cooperative Extension, Lincoln, NE 68583.