Look, Ma! No Weeds: Early Season Weed Control

Part 2: Blind cultivation

Get weeds before they become established and the battle is nearly won.

By Klaas and Mary-Howell Martens
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Lely finger weeder

Missed one?

Part 1: The basics of effective tillage techniques
Knowing just when to use just the right tool for just the right weed is critical to early season weed control.

Part 2: Blind cultivation
Get weeds before they become established and the battle is nearly won.

Part 3: In-row cultivation
It's as much about the technique—and being able to adapt to fickle weather—as it is about the tools.

Farm-at-a-Glance

The goal of blind cultivation is to remove the initial flushes of weeds when they are very small and most sensitive to disturbance. Blind cultivation takes advantage of the difference in size and sprouting depth between crop and weed seeds. Most weed seeds are smaller than crop seeds, and they germinate shallower in the soil. Annual weeds are most sensitive to disturbance from after germination to emergence. At these early stages, breaking contact between the tiny roots and the soil will kill most weed seedlings.

Blind cultivation works best when the soil is loose and in good physical condition and the crop is actively growing. By stirring and shaking the top inch of soil, early season weeding or blind cultivation creates a loose dry layer of soil that is too dry and airy for weed seeds to germinate or grow in. This layer also serves as a dry mulch that conserves soil moisture. The crop seeds are safely below this layer and are not hurt by a shallow weeding before emergence.

Field preparation stimulates many weed seeds to germinate. These annual weed seeds quickly sprout and emerge before or with the crop. At this point, a rapid and brutal race ensues which will quickly determine which type of plant will have dominance in the field. We must work decisively to give our intended crop the advantage and to reduce the competition. If our blind cultivation eliminates most of the first flush of tiny weeds, the crop will rapidly begin to suppress subsequent germinating weed seeds. Therefore, our goal in blind cultivation is to give the crop the greatest possible initial size advantage over the weeds before we

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The Martens' Farm

Location: about 60 miles southeast of Rochester, NY, on the western shore of Seneca Lake
Important people: Klaas and Mary-Howell Martens, Peter, Elizabeth, and Daniel. Plus Robert Hall (employee/asst farm manager)
Years farming: We've farmed this farm together since 1991. Klaas has farmed all his life.
Total acreage: 1500
Tillable acres: 1300
Soil type: Honeoye Lima silt loam
Crops: corn, soybeans, spelt, wheat, barley, oats, triticale, red kidney beans, sweet corn, snap beans, cabbage, edamame soybeans
Livestock: sheep, pigs, chickens for our own use
Regenerative farm practices: diverse long term crop rotations that incorporate legumes and small grains, under seeding all small grains with red clover, actively increasing soil organic matter
Marketing: corn & small grains are sold to Lakeview Organic Grain LLC, our organic feed business. Soybeans, red kidney beans, and spelt sold to brokers and processors. Some spelt is sold as kosher organic spelt. Sweet corn, snap beans and edamame are sold to processors who freeze them under brand name labels. Cabbage is made into sauerkraut and packed under the Cascadian Farms label. Some of the oats, wheat and barley are being grown from Foundation Seed to produce Certified Organic Certified Seed.

come in with the row cultivator. If we can establish a favorable crop/weed size differential, the crop will then achieve dominance and we will then be almost assured a clean crop, or at least one where row cultivation will be much easier, faster, and more effective.

We have a short window of about two to three days, depending on weed species, when the first flush of germinating weeds are at their most susceptible. This window starts the day you can see the white hair roots when you scratch the soil surface with a stick or knife and continues until about a day after the weeds have emerged, depending on the weather. At this point you don't see any weeds from a truck window or tractor seat, but if you kneel down on the ground, there is a light reddish-green haze over the soil. Sometimes you can just see tiny weeds growing in soil cracks.

The success of the first blind cultivation is extremely important because it must give the crop an initial head start. The intention, of course, is to remove the weeds without harming the crop. The first pass usually takes place just before the crop emerges. At that stage the crop is able to survive a fairly aggressive weeding and weeds are usually small enough to be easily destroyed. Crop susceptibility to weeder damage is very low until the tip of the plant shoot is near the soil surface. The potential for crop damage rises rapidly as the crop emerges and until after the first leaves extend.

The crop can suffer some of the same types of damage by the weeders as the weeds do, and because of that, we have to be aware of what the weeders are doing. If the crop has emerged but is too small, it can be buried too deeply to re-emerge and may be suffocated. The crop can also be broken or plucked out. Soybean hypocotyls, for instance, are very fragile in the crook stage. If the weather is cool during this time, they are much more brittle. Usually the crop and the weed points of greatest susceptibility don't coincide. However, sometimes when our timing is less than ideal, it is important to assess how much crop damage is occurring and to get a sense for how much damage can be tolerated.

If we do the first pass too early, the crop may need a second weeding before the crop is large enough to withstand the action of the weeder; too late, and the weeds will be already resistant to the weeders, and/or the crop may be at a stage where it is too sensitive to survive an effective aggressive weeding. It is always best if we can hit this 'sweet spot', with the crop, weeds, weather and equipment at the ideal point for control!

The timing of the second blind cultivation is critical to eliminate the 'second flush' of weeds that emerged after the first weeding. The second pass must occur before weeds are big enough to become tolerant to the weeder action. We try to wait until the crop is as large as possible so the machine can be adjusted to a more aggressive setting, reaching more of the weeds. This is often a rather delicate balance, tempered by weather and labor. But when we can hit the second weeding right, the crop is off to a good start and we have several weeks of a breather before we have to come in to row-cultivate.

We need to have the tools available that can take out the weeds without doing excessive damage to the crop in all the different situations that we may have to deal with. This is why, on our farm, we have several different blind cultivation tools with varying configurations. This isn't an exact science, and there are some days when we switch between two or three tools before we are satisfied that we have chosen the best one for the conditions.

An experienced operator with a clear understanding of his soil, the weeds species, the crop stage, and the influence of the weather can do a great job with less-than-ideal equipment. The fanciest or most expensive equipment will not ensure good weed

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control. Instead, success is determined by the skill of observation and the agility to make the right decisions at the right time. When the relative stages of the crops and the weeds don't occur as we want, or when the weather prevents weeding at the right time, having the right equipment and the skills and experience to make the right adjustments can help make the difference between success and a weedy field.

There are a number of tools used for blind cultivation. They fall into two main categories – the various types of harrows and the rotary hoe.

Tine weeders

Tine weeders, or flexible harrows, are the most widely used tools for blind cultivation. Examples of tine weeders are the Kovar coil tine harrow, the Einboeck tine weeder and the Lely finger weeder. The action of a tine weeder is determined by tine shape, tine size, tine spacing, tine length, type of toolbar, and the suspension of the units. Tine weeders are effective in a wide range of crops and conditions. They perform well in stony soil and can pass over moderately large stones without being damaged. The variety of available tines and adjustments make doing a good job of weeding possible under difficult soil conditions and when weather prevents proper timing of operations.

Most tine harrows are either drawn by a toolbar and suspended from chains or attached to 'U' shaped pieces, or "wishbones", that can self-level laterally and be leveled from front to rear with a hydraulic top link that tips the toolbar back and forth.

The tine harrow wishbone can self-level laterally and be leveled from front to rear with a hydraulic top link that tips the toolbar back and forth.

It is important to operate tine weeders so that all the tines penetrate equally and the units are level. In the more rigidly mounted models, this can be accomplished by adjusting the length of the top link until all the tines are running evenly. Using a hydraulically adjustable top link makes fine tuning the weeders very easy. With the chain suspended models, this adjustment is more difficult to achieve, especially in hard or crusted soil. The front tines often have to work harder than the others to break the soil. This tends to lift the rear tines or to spring the front tines back farther than the ones at the back of the implement. To compensate, we need to raise the toolbar so that the front chains pull up at the front of the unit, leveling it and forcing the rear teeth deeper into the soil. This is much easier to do on three-point hitch mounted machines than in trailing models. Adding a little weight to the rear of the tine units may also help make them run level.

If chain-mounted weeder units begin to hop, rock, or lunge while weeding, the tines can't move properly in the soil. The springs may all bend back and then snap out of the soil together causing the whole weeder unit to jump. This action repeats in a cycle that

makes the whole unit jump up or twist around in a regular rhythm. When this happens, the unit moves, instead of the teeth. Reducing speed usually stops this erratic motion. The most common cause of this problem is hard or crusted soil with too much speed for the conditions. Sometimes units running in wheel tracks will jump while the rest of the units are working fine. This is due to the compaction in the wheel tracks. To address this problem, the operator must slow down or use rigidly mounted weeder units.

Straight-tine weeders freely move forward, backward, and side to side, producing a rotating action. They move soil sideways and level the land by filling low spots and knocking down ridges. This action covers weeds more than it uproots them. Small seedlings are easily killed by this tool, and even most large weeds are covered with soil. The sideways movement of the tines can damage young soybean plants by knocking off leaves and breaking stems and can also bury small corn seedlings. Corn that is buried between emergence and the 2 leaf stage can push back out of loose soil if rain doesn't come too soon after weeding. If it rains before the buried corn seedlings push back out, they can be sealed in the ground and die.

Some farmers operate weeders at an angle to the rows on the first pass and then with the rows when they make the second pass. The cross hatch pattern that results covers the field very thoroughly. This approach works well in large wide fields but is more difficult to use in long narrow strips.

It is important to check how much additional soil is pulled over the rows, especially when weeding a field that is soft. It is possible for the weeder to bury the yet-to-emerged crop much deeper than it had originally been planted. With small seeds or seed with low vigor, this could hurt the stand quite severely. This can be especially true if a hard rain after weeding causes crusting. If this happens, it is important to weed the field again to break the crust and help the crop emerge. A rotary hoe or bent-tine weeder may be better than a straight-tine weeder for helping a crop emerge through a crust. These tools are more gentle and tend to lift the soil at the surface from over the buried seedlings rather than pushing it across the top of them.

The straight-tine weeder is excellent on any large seeded crop that has not yet emerged. It's aggressive action is very effective on weeds and does very little crop damage when used pre-emergence. Once the crop has emerged, it becomes much more vulnerable. Crops are softer and less likely to break off in hot weather and, if possible, should be weeded in the afternoon during the hottest part of the day. Corn becomes more vulnerable to damage when the leaves begin to unroll. Soybeans are most sensitive after emergence but while still crooked.

In soft, loose, uncompacted soil, it is possible to operate a weeder at a much higher ground speed than when the soil is hard. The straight-tine weeder does not perform as well in crusted or hard tight soil. In crusted soil, it helps to add some weights to the back of the units to make them go in better. John Saeli, an organic farmer in Geneva, New York, has added a hitch to the back of his units so that they can be turned around and pulled backward in hard soil. The tines are worn on an angle from being pulled in the normal direction so that the sharpened points cut through the crusted soil quite effectively when pulled in reverse. A second pass immediately after the first will often improve weed control in hard soil. Driving at an angle to the rows may also help. Kreher Farms, in Clarence, New York, has had good success in crusted soil by row cultivating with a Danish tine cultivator first to break the hard crust and following a day or so latter with a weeder.

It is very important to weed early if a crust begins to form to prevent it from becoming hard. Once a soil crusts, it must be broken up as soon as possible to stop it from getting worse. A

crust will continue hardening and become thicker if it isn't broken up. It is important to get air back into a crusted soil as quickly as possible.

In a wet season, it is better to bury weeds than to uproot them. Seedlings re-root easily when they lay on top of damp soil. Weeders with straight tines that level the field and can move soil sideways will cover weeds more than uproot them. Rain after a weeding is very likely to seal the surface enough to prevent even shallowly buried weeds from coming back up. When soil is hard or crusted, some extra weight on the back of the weeder sections may help. Transferring some weight from the toolbar to the units by changing to the newer self leveling supports may help.

Forty-five degree bent-tine weeders are very good for loosening tight or crusted soil. The 45° tines are more effective at uprooting weeds than they are for covering them. The longer tines are better able to follow the surface of the soil so that they loosen the soil evenly. These tines will give the same action in low spots that they do in high spots. Because of this, there is much less soil leveling in the action of these weeders than with the straight tine units. The 45° teeth loosen soil uniformly but do not move much soil sideways. For this reason, these tines are usually less damaging to emerged soybeans than the straight tines. They are less likely to bury small crops deeply but more likely to pull plants out.

Peter Martens showing the possible angle adjustments on a Kovar coil tine harrow with 45 degree teeth.

The angle of the tines on the 45° units is adjustable from a very flat swept back orientation to an aggressive angle where the teeth are pointed forward so that they pull themselves in. These units will penetrate a hard soil much better than straight tines, especially when the teeth are set into their most aggressive position. We have found that the close spacing and the stiffness of the tines on the Einboek machine can be overly aggressive with some soils and crops, especially when the weeders are equipped with the shorter (390 mm), stiffer, and larger-diameter tines. The Kovar machine has widely spaced, long flexible tines (25-inch) that sometimes deflect sideways away from ridges, leaving narrow strips on each side of the rows unweeded. This has not been a problem as long as the cultivator is adjusted properly, because the cultivator cleans up these strips of missed weeds if they occur.

Eighty-five degree bent-tine weeders will penetrate deeper than other weeders. An example of such a weeder is the Lely finger weeder. The angle of the teeth, rather than down pressure or the weight of the units, causes the 85° teeth to pull into the soil. This type of tooth can lift and break up a heavy crust despite the small light teeth. These weeders are exceptionally well suited for tap-rooted crops. The hooked tine goes in deep but does not pull out soybeans, kidney beans or other crops with a straight tap root. Instead, weeding seems to stimulate the crops' growth.

While the 85° tine is very gentle on beans, it can do serious damage to crops with branching root systems, such as corn and small grains. Corn produces axillary roots that branch off from the stem. The 85° bent tines will penetrate deep enough in soft soil to get under the branched roots and pull out the small corn seedlings. If an 85° tine weeder is to be used in this type of crop, it must be watched carefully and adjusted to stay above the branches of the crop roots. The crop should be examined carefully for damage after going a few yards, and the operator needs to be aware of areas in the field with softer soil where the tines can go deeper to be sure that the crop roots are not being damaged.

In warm, dry weather with good sun and/or wind, the newer weeders with longer bent tines work better to uproot weeds, lay them on top and dry them out. The 45° tooth works well with corn and beans, while the 85° tooth weeders are better on beans or other tap-root forming crops. The branching roots of corn are damaged and pulled out by the aggressively hooked teeth of the Lely type weeders, while the straight tap roots of beans are unaffected.

The 85° tines primarily break the connection between the soil and the weed roots. They are particularly effective at uprooting weeds because they penetrate so deeply. They are the most effective weeders for quackgrass because the tines can pull up quack roots very efficiently. In fields with a lot of quackgrass, these weeders may plug with roots and so may need to be cleaned out by hand or sometimes by shaking the weeder up and down by the lift arms. This should be done outside of the field over a ditch or in a driveway to insure that the roots can't reestablish themselves. This also prevents the tangled weed piles from plugging cultivators later in the season.

Rotary hoes

Rotary hoes are best used from before weed emergence to very early post emergence. Weeds must be very small or not yet emerged for good control. It's very important to keep hoe tips in good repair as they lose their effectiveness quickly with very little wear. "Hoe-bits" are replacement tips that can be welded onto the worn tips; these actually make the hoe more effective than it was originally. Rotary hoes generally work by uprooting and desiccating (drying out) tiny weed seedlings. They are very gentle on the crop and can be used when more aggressive weeders cause too much crop damage. Best results with a rotary hoe come right after a light rain when the soil is just lightly crusted and breaks apart easily into 'chips'. It's important to maintain high speed when using a rotary hoe.

Rotary hoe: When we add new wheels, we put them over the rows first because early in-row weed control is most important.

The height of the tool bar together with the strength of the 'down pressure springs' on a

rotary hoe determine the
ground pressure of the hoe wheels. This adjustment is usually controlled by setting the position of the tractor lift arms. In tight or crusted soil, it may be necessary to add some weights to the tool bar to achieve enough down pressure to do a good job. If the tractor has a quick hitch, this adds enough weight to hold the tool bar in the right position under most conditions. Rotary hoes generally need to be set to be level with the ground. In extremely hard soil, extending the top link to tip the machine back may increase the ground pressure slightly, but this should only be done if none of the other adjustments are sufficient to make the machine penetrate correctly.

Ground speed with a rotary hoe should usually be between 8 and 12 mph, and the hoe tips should penetrate deep enough to go through any crust that has formed. In soft soil, the hoe tips may penetrate as deep as 1.5 to 2 inches without excessive harm to most crops. A very shallowly planted crop, however, can be damaged by a rotary hoe that is set too deeply. Some farmers have improved the weed control by adding a second set of hoe wheels behind the first set so that the crop is actually hoed twice with each pass, or by going over the field twice.

Rotary hoes work primarily by uprooting weeds and/or by loosening the soil from the tiny roots of the weed seedlings. Stony soils can present a serious problem to rotary hoes. Large stones can bend and damage the delicate parts of these machines. Smaller stones, especially those 2- to 3-inches in diameter, can get stuck between the hoe points, bending them or stopping the wheels from rotating. If this happens directly over a row and is not immediately detected, it can tear out a long section of a row in a very short time.

Other harrows

Spike-tooth harrows have been used as weeders for many years. They were probably the first tools to be used by farmers as weeders.

German farmers used spike-tooth harrows extensively to control weeds in small grains fields before the coming of herbicides. American corn farmers throughout the United States used spike-tooth harrows as weeders in the early part of the twentieth century. George Washington Carver promoted their use widely in the American South by taking some of the machines from town to town to demonstrate how effective they were. Spike-tooth harrows fell out of use around World War II with the advent of chemical weed killers.

Spike-tooth harrows are very effective weeders. They can both uproot and bury weeds. The angle of the spikes can usually be adjusted with a handle from straight up and down to angled back at a flat angle to the soil. Rocks are a big problem with spike-tooth harrows. Rocks can easily get caught in the harrow and take out a row of crop, or they can roll under the harrow and lift the teeth out of the ground so that the weeds aren't controlled.

Spike-tooth harrows can sometimes be overly aggressive and damage the crop especially in cool weather when plants are brittle. Spike-tooth harrows work best on very hot afternoons when the corn is soft and flexible. Tine weeders have largely replaced spike-tooth harrows because they are effective and have better crop safety.

Spring-tooth harrows are extremely aggressive, but they are sometimes used for weeding. Because of their potential to do crop damage, spring-tooth harrows are generally only used in emergencies where the crop will otherwise be lost. If a field is so infested with big, grassy weeds or crusted so badly that no other tools can loosen it, a spring-tooth harrow may be able to save it. This is a drastic measure but it often works as a miracle rescue if done carefully.

A drag (springtooth harrow) with worn teeth set just as shallow as possible while still having all the teeth in the soil should be used. Often, the drag is drawn across the rows rather than with them. The tractor needs to be run slowly, and the driver should be prepared for a scary sight when they look back. Corn treated like this often perks up and starts to grow rapidly after being dragged. The stand loss from the dragging is usually high. But in cases where nothing else will work, there is really nothing to lose by trying this tool, because the stand would be worthless anyway if nothing is done.

Chain-link harrows are more commonly used on pastures, but they can do a good job of weeding. If plugging is not a problem and no other tools are available, a chain-link harrow can do a good job of controlling weeds before crop emergence. A chain link harrow would not be a good choice for post-emergence use because of crop damage. NF

Part 3: In-row cultivation >>

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