

ORGANIC SOYBEAN WEED CONTROL

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Pssst, how would you like to make some real money farming? How does \$22.50/bu for organic soybeans sound? Let's see, with a possible yield of 50 bu/acre per acre, that would bring \$1125 per acre, and if I put most of my farm in soybeans this year, then . . .

Organic soybeans, the glamour crop for the organic 90's. Or is it? Words like these have been circulating throughout the organic community for the past few years, luring many with the promise of finally finding a crop that could turn a reliable easy profit. However, as with everything else in farming, there is no such thing as an easy profit.

Weed control presents THE primary challenge to organically growing any field crop, including soybeans. Preventing the weeds from getting out of control sometimes seems like an insurmountable task, particularly during the transition period. Once land becomes fully organic, weed pressure does dramatically decrease and the weed species change, but the challenge of keeping up with the weeds never ends.

CULTURAL WEED CONTROL

When most people think of weed control, they think of cultivators, rotary hoes and tillage implements. However, before any machinery is considered, weed control must begin with cultural methods. It is a

great deal easier to prevent weed problems than to kill them. Failing to optimize cultural weed control measures puts much greater pressure on one's mechanical weed control ability and timing. Heavy reliance on chemicals and powerful machinery in modern agriculture has made us forget that farmers really do have much control over the initial weed population in a field.

Sanitation

It is possible to prevent many new weeds from being introduced onto the farm and to prevent existing weeds from producing large quantities of seed. The use of clean seed, mowing weeds around the edges of fields or after harvest to prevent weeds from going to seed, and thoroughly composting manure before application can greatly reduce the introduction of weed seeds and difficult weed species. It is even possible to selectively hand eradicate isolated outbreaks of new weeds, effectively avoiding future infestations. A field where weed control failed in previous years is not a good choice for organic soybeans.

Clean seed not only means crop seed that is free of weed seeds. Crop seed that is contaminated with viral or fungal disease pathogens or that has a low germination rate can result in slow or impaired plant growth which will make weed control measures more difficult. Without the option of using chemical seed treatments, it is essential to use healthy, vigorous seed. Seed inoculation with the appropriate strain of Rhizobium bacteria will insure that nitrogen fixation begins quickly and uniformly.

Soil Fertility and Condition

Dave Mattocks of the Fertrell Co. in Pennsylvania states that the presence of weeds can be a clear indicator that chemical components are out of balance in the soil. He credits magnesium as the element that is commonly the regulator of weed population size and strength. Many prevalent weed species in soybean fields throughout the United States, such as foxtail and summer annual grasses, thrive in hard compacted soils, most often soils that are also low in calcium and high in magnesium. For this reason, weed control can be usually improved by calcium amendments. Mattocks thinks that a ratio of calcium:magnesium of 8:1 to 10:1 is optimal for weed control and crop plant growth. When the soil calcium:magnesium balance strays from these optimal ratios, with either excessively high calcium or magnesium, weed problems will often result though different weed species will be favored with either extreme. Using a regular soil test testing regime to carefully develop an appropriate fertility improvement plan is critical. Not all organically acceptable fertility materials may actually benefit the soil. While most people realize that lime can be a beneficial source of calcium, it is less well known that inexpensive and readily available dolomitic lime, which is high in magnesium, can actually accentuate some weed problems in soils with already adequate or high magnesium. On such soils, substituting gypsum as a lime source may be a better choice. Gypsum, which is calcium sulfate, has the unique ability to supply calcium while slightly lowering the pH of the soil.

Mattocks credits micronutrient availability as one other important factor in weed growth patterns. Where there is a deficiency in key micronutrients

such as zinc and sulfur, certain weeds like thistle and dandelion tend to develop deep taproots making them much harder to control with mechanical cultivation. Additionally, certain other weed species thrive under nutrient-poor conditions. Micronutrient deficiencies will limit the vigor of the crop plants, making the soybeans less competitive. Adjusting the soil pH to achieve the proper cation balance is a simple way to make micronutrients more available.

Crop competition and weed control can be increased by improving soil drainage, aeration and the regular addition of organic material. A high organic matter level, combined with a proper calcium:magnesium balance and good aeration stimulates soil microbiological activity. These organisms destroy weed seeds, release vital nutrients for crop growth, increase soil aggregate stability, and decrease soil compaction.

John Myer of Romulus, NY, who has successfully been growing soybeans organically for many years, usually applies no additional fertilizer to his soybean fields, relying on fertility from the decomposition of organic material left from the previous crop, the cover crop, or from residual fertility left from prior applications of compost and organic fertilizer materials.

Crop Rotation

It is indeed a temptation to plant as many acres of soybeans as possible on your land, but where does that leave you for next year? Well planned crop rotation is essential to break weed and insect cycles. Continuous monoculture of any species, including well-managed organic soybeans, effectively selects for a population of weeds that is very well adapted to

those conditions. Every year that such an environment is created, all of those adapted weeds that escape control measures will produce thousands or even millions of seeds. In a proper crop rotation, the environment changes each year, denying the weed seeds the previous year's favorable conditions.

Not all organic soybean growers agree that soybeans must never follow soybeans on the same field. Some New York growers have actually seen higher yields and better soil tilth on soybean fields in the second year of soybeans, but lack of well-planned rotation should be avoided especially if white mold, soybean mosaic virus or other pathogens were present the first year. Chuck Welter of Ottoson, Iowa has been growing soybeans organically since 1982. He describes himself as a market-driven farmer and does plant soybeans for 2-3 years on a given field, but then his attention to mechanical weed control must be meticulous.

Farmers do agree that the easiest way to grow organic soybeans with low weed pressure is to plant on a field that has been in hay or grass for a number of years. While this may be the easiest choice for weed control, it obviously could greatly limit the number of acres of soybeans a farmer can grow in any given year. It also would dictate that hay be an important part of the farm rotation. Jim VanVleet from Lodi, NY has seen reduced soybean weed problems on land that has been idle for a number of years, but with land that had large applications of animal manure in the past, he has seen major outbreaks of red root pigweed and other adapted weeds. Since soybeans, alfalfa and clover are legumes and have the ability to fix nitrogen, growing soybeans after alfalfa or clover or on land that has

had heavy manure applications may actually waste nitrogen that could be better used by a non-leguminous heavy nitrogen feeder. There are many factors to weigh in planning a good crop rotation and it should be done on a whole farm, long range basis.

Some crops produce substances that kill or inhibit weed growth. This phenomenon is called allelopathy. This effect can be clearly seen when oats are sown with a new planting of alfalfa, allelopathy from the oats will prevent the alfalfa from being choked with weeds in the first year. John Myer credits the allelopathic effect for controlling weeds in his soybeans when he plants them after growing wheat that was underseeded with clover. This rotation also gives him an opportunity to selectively chisel plow portions of a field with particularly high perennial weed populations during the summer preceding growing soybeans. In 1997, Klaas Martens of Penn Yan, NY had two soybean fields side by side. One had been in buckwheat the previous year, one had been in spelt. Buckwheat is well known for its weed suppressive ability and it was very apparent throughout the season that the weed pressure was much less in the buckwheat field. Therefore, planting buckwheat or other such allelopathic crops intentionally on particularly weedy fields that will be put into soybeans the following year can be an effective cleanup technique. Other allelopathic crops include sunflower, sorghum, rye, oats, wheat, and sorghum-sudan grass hybrids.

Bernard Rademacher, a German scientist writing in the 1930's and 1940's (Imp. Bur. Pastures and Forage Crops, Herbage Pub. Serv. Bulletin, 1940, 27:68-112) stated that "If each crop is grown after its most suitable predecessor, the competition of weeds is checked

through its vigor alone. Moreover, the danger of plant disease is diminished through suitable cropping, and therewith the formation of poor and patchy stands, which encourage weed growth, is to a large extent eliminated. Finally, good cropping promotes soil (biological) activity that the life of weed seeds is shortened.” There is still much to be learned from agricultural research done in pre-chemical days that has been largely forgotten by modern agriculture!

Variety Selection

Variety selection in soybeans seems largely market driven. Fortunately, the tofu variety of choice, Vinton 81, is much more competitive than many modern commercial soybean varieties that have been bred for modern conditions that rely on heavy herbicide and salt fertilizer use. In an ideal situation, careful selection of vigorous or spreading crop varieties can shade the soil surface, thereby preventing weeds from 'breaking through' the canopy and growing above the crop. Where varieties of lesser vigor are used, a farmer may choose to drill a high population rather than to plant in wider rows, though this practice limits many types of mechanical weed control options. Plant population needs to be matched to the variety. A high population of a competitive variety can result in lodging, and therefore yield loss.

MECHANICAL WEED CONTROL

Despite careful cultural weed control, it is amazing how large a population of weed seedlings can be found growing in a recently planted field of soybeans. It takes little imagination to predict what will happen to the soybeans if the weeds are not controlled mechanically.

Most soybean farmers are happy to talk about their favorite weed control tools. Some swear by the rotary hoe, others by a Danish tine cultivator, a coil tine harrow or a flame weeder. Best control frequently comes from a combination of tools and techniques. A common mistake that many farmers inadvertently make is to farm by the previous year's variables. The tools, timing and techniques that worked so well last year will not necessarily work this year! Each year presents new growing conditions and new learning opportunities. Every implement seems to have field conditions and weed species where it is most effective. In most cases, timing and soil moisture conditions are absolutely critical for weed control success. Learning to match the correct machine to the conditions is essential.

Chuck Welter stresses the importance of creating a favorable crop/weed size differential. If the crop is at least 2” ahead of weed growth, Welter figures he is in control. Obviously, an even larger the crop/weed size differential will make for easier weed control. Delaying mechanical control measures until the weeds are clearly visible and competitive will probably result in failure. Rain at the wrong time, poor timing of weed control techniques, slow crop growth or excessive weed pressure can alter the differential and quickly allow the weeds to gain the upper hand.

It is important to know your enemy. ‘Weed’ is not a generic term. All weed species have their weaknesses and their strengths, usually occurring at distinct stages of their life cycle or due to specific growth patterns. Some weed control strategies, such as disking a field infested with quackgrass, may even increase the prevalence of certain species of weeds

under specific conditions. Grassy weeds often require different control measures than do broad leaved weeds. Correctly identifying the species of weeds causing major problems in your fields is critical to understanding what control measures will work best.

It is also important to consider again the temptation to plant as many acres of soybeans as possible. If the number of soybean acres exceeds what a farmer can cover in a timely manner with the machinery available, then weed control may get out of control rapidly. It is often possible to harvest more bushels from a smaller acreage of well tended soybeans than from a much larger planting that was not managed properly!

Tillage

An initial tillage of fields a week or ten days before planting will allow one flush of germinating weeds to be killed during final field preparation. In heavily infested fields, late spring plowing will reduce weed pressure by burying large populations of germinating weed seeds. Both John Myer and Chuck Welter rely on working a field 2 or 3 times before planting to eliminate many germinating weeds. Myer plows the field first, after which he waits 10 days to 2 weeks hoping for a rain during that time. He then covers the field a second time with an S-tine field cultivator fitted with small S-tines and a tine harrow on back to level the field.

When tillage is done on a sunny warm day, particularly troublesome weeds having long underground rhizomes, such as quackgrass, can be dragged to the surface with a spring tooth harrow to desiccate. This old technique can effectively rid an

infested field of quackgrass if done several times. It is important to note that weather conditions dictate how effective tillage is in controlling weeds. Wet weather following tillage may result in weeds re-rooting and not being killed. Cold wet conditions may also slow weed seed germination. Weed seeds that are germinating but have not yet sprouted will probably not be damaged by tillage operations.

Planting the Crop

Few farmers realize that a well adjusted planter is one of their most valuable weed control tools. Uniform, proper placement of the crop seed will result in even vigorous growth. For this reason, and because the ability to cultivate is so important, most soybean farmers interviewed prefer using a corn planter set for 30" rows.

Don't assume that if a planter has shiny paint, it is doing a good job! Farmers should regularly get off the tractor and dig up the seed to check the accuracy of the planting and make adjustments if necessary. This should be done not only in good locations in the field but in lumpy, uneven or unusual areas too. Planting into wet or particularly lumpy soil should be avoided. Older corn planters with worn seed discs, gauge wheels, closing wheels or other parts can result in uneven planting. Worn parts should be replaced or improved. The planter frame and units should also be regularly inspected to insure they are not bent or warped. Retrofitting with shoes, firming points, specially designed seed tubes or eccentrically bored gauge wheel bushings will often result in more uniform seed placement than what the planter had when it was new. John Myer uses trash wheels in front of the gauge wheels to sweep away clods and

stones. He feels this makes for a more level surface and therefore more uniform planting.

Blind cultivation

After planting, a number of tools can be used for 'blind cultivation' before the crop emerges. In blind cultivation, the entire field is tilled shallowly with the implement, paying little attention to where the rows are. The larger seeded soybean seeds germinate below the level of the cultivation and are not damaged. The point of blind cultivation is to achieve the biggest possible crop/weed size differential from the start.

At the time when conventional farmers would be out spraying their fields, Klaas Martens is 'blind cultivating' with a 45' Kovar coil tine harrow. This implement actually covers the fields faster than a sprayer would and is very economical to operate. One evening recently in 1998, Martens covered 47 acres in less than 2 hours with the Kovar harrow. A second blind cultivation with a Lely weeder or rotary hoe can follow a week later after the crop has emerged. John Myer relies primarily on the rotary hoe for his blind tillage operations, the first time about 3-4 days after planting and again 5 days later. Speed is a key factor in successful rotary hoe operation. A rotary hoe needs a high horsepower tractor capable of moving at least 8-12 mph to be effective. Surprisingly this does little damage to the young crop seedlings, but destroys the weeds effectively. The Lely weeder works by shaking the soil loose, killing small weeds but not harming the larger, deeper rooted soybeans. Blind cultivation is the easiest and best opportunity to destroy the weeds that would be growing within the rows and presenting direct competition to the crop.

In New York, it is not uncommon to find inexpensive old, worn rotary hoes at auctions. Are they a good deal? As seen in the picture, worn rotary hoe teeth are frequently short, rounded and much less aggressive than new teeth. Such a rotary hoe will barely penetrate the ground, resulting in less dirt moved and few weeds killed. A rotary hoe can be an expensive machine to maintain. It is not essential to replace all the worn rotary hoe teeth. Since weeds growing between the rows will be controlled by later cultivation, Klaas Martens economizes by installing new rotary hoe wheels only directly over each row and leaving older wheels between the rows. Hoe bits can be welded to worn rotary hoe teeth to extend the life of the machine. John Myer maintains two rotary hoe teeth arrangements, one with regular teeth and one with larger spoons, which are more aggressive on hard crusty soils.

Weed species vary in their vulnerability to cultivation. Broad leafed weeds with their growing point above ground are easily killed when their tops are broken, while grasses with growing points below the soil surface need to be uprooted and desiccated. Most weeds are most sensitive to desiccation when they are in the 'white hair' stage early in germination. Perennial weed species with deep roots and large reserves are not well controlled by blind cultivation and must be controlled by other methods.

Between Row Cultivation

When the soybean rows are clearly visible and the plants are in the third trifoliate stage or later, it is time for between row cultivation. Earlier cultivation may be necessary if a good crop/weed size differential has not been achieved, but cultivation

will go much slower to prevent the crop plants from being buried and must be less aggressive. Some farmers find that cultivating soybeans at least once will control most weeds for the rest of the season if all other weed control methods are working adequately. In New York, usually a second cultivation is necessary to eliminate the weeds that were stimulated to grow by the first cultivation and to further aerate the soil.

Cultivators are not all created equal. There are rear mounted and front or belly mounted models, and there are numerous types of cultivator teeth, shanks and points. There are 3 main types of cultivator shanks - the Danish tine, the C-shank, and the trip-shank. The Danish or S-tine teeth will allow the greatest operating speed, they are not easily damaged by rocks, they will handle the most crop residue without plugging and are relatively inexpensive, but they do not penetrate as well in hard soil and large rooted weeds may slip around the flexible teeth, thereby avoiding damage. Of different types of cultivator teeth, the operator has the least control over the action of the flexible Danish tine teeth. C-shank cultivator teeth are more rigid and do give the operator more control. These may be the best for hard or rocky soil and for heavy infestations of quackgrass and other weeds with underground rhizomes. C-shank teeth are slightly more adjustable than the Danish tine teeth. Trip-shank teeth are the most rigid and allow for the slowest progress, but they give the operator superior weed control and adjustment ability. These are also the most expensive, large rocks can break the trip-shanks, and it takes a more experienced operator make the necessary adjustments to get the full benefit of trip-shank teeth. A ridge till cultivator may also be of

benefit, but none of the soybean growers interviewed had used this machine.

There are many different types and widths of points that can be put on the different cultivator teeth. Danish tine cultivator teeth offer the least opportunities to vary point type, while trip-shank teeth offer the greatest choice. The most versatile type of points are probably half sweeps next to the row and full sweeps between the row. Each type of point works best under specific conditions and on certain weed species. For example, a type of point called a 'beet knife' is particularly effective on nutsedge. Narrow spikes may sometimes be used to advantage to aerate waterlogged soil.

Klaas Martens uses a tractor equipped with both a front and a rear mounted cultivator. He uses trip-shanks on the front cultivator with half sweeps next to the row to get good weed control within and immediately next to the row. The rear mounted cultivator, which has C-shank teeth with full sweeps, cover the between-row area. While this combination is slower than a single Danish tine cultivator, it gives excellent control of most types of weeds even under an unfavorable crop/weed size differential.

John Myer begins his cultivation when the soybeans are approximately 7" tall. He uses a rear mounted Danish tine cultivator with 5 shanks between each row. They are fitted with 2 1/2" duck feet points set 7 1/2" from the row on center. If the ground is hard or if he has a quackgrass problem, he will use 1" spikes instead that are angled back to dig deeper. If he must cultivate when the soybeans are shorter than 7", he will use half worn teeth immediately next to the row.

Adjusting the cultivator to best fit the conditions is a fine art. Relatively little adjustment is possible with Danish tines other than varying speed and depth and by changing the type of the points. With C-shanks, it is possible to change the angle to the soil and to the row slightly, but because they are springs, this adjustment changes in the soil as the cultivator moves. This is not a major problem when the cultivator is set deep and working between the rows, but it limits the success of controlling weeds within the rows. Trip-shanks allow wide adjustment of the angle of the points both to the row and to the soil. Depth of the point is also easily adjusted. Because trip-shanks are rigid, the adjustments remain constant while cultivating. For example, by twisting the shank toward the row, a much greater amount of soil will be pushed into the row. Conversely, by twisting the shank away from the row, the soil thrown into the row is reduced. Changing the angle of the point to the soil can adjust for hard or soft soil. Under the right soil conditions, setting the points at an extreme angle to the soil can create a bulldozer effect, squeezing the crop row tightly with soil and thereby killing many weeds growing between the soybean plants and burying the rest. Another logical but often overlooked point in successful cultivation was suggested by Cliff Peterson, a neighbor of Klaas Martens who remembers cultivating with horses when he was a boy. He says for the second cultivation in a field, be sure to drive the opposite direction on each row. It is important to remember the pattern of the first cultivation, and reverse the direction for the second cultivation. This can get weeds that were not fully removed in the first cultivation, and can compensate for gaps in cultivator coverage.

Jim VanVleet has one further caution about mechanical weed control. Trying too hard to get every last weed in a field is probably unnecessary and can waste time, labor, and may actually do damage to the soybean crop. Tractor operations in a soybean field after canopy closing will usually crush and tear crop plants excessively and will probably be unnecessary as shade from the soybean leaves will kill weeds trapped under the canopy. It is important to keep the whole crop in perspective, not spending too much time making first few fields immaculate.

IS IT WORTH IT?

Organic soybean weed control is probably sounding like a large investment of planning, work and equipment. However, consider that an annual investment of \$30-50/A is common for chemical weed control. It is also important to consider that chemical weed control regularly fails due to poor weather conditions, herbicide-resistant weed species, and selection of especially tough weed populations. Soybean herbicides can cause severe crop damage or may even kill a crop of soybeans under certain weather conditions. Carryover herbicides or unexpected synergism between herbicides can also result in severe damage. Chemical companies are constantly producing new materials and combinations to combat the problem of inadequate soybean weed control. No one interviewed for this article had yet met a weed that was resistant to being cut off, buried or ripped out!

When organic weed control is not good, the neighbors are quick to laugh and say it was “because he didn’t spray”. But when chemically farmed fields are overrun by weeds, burned by herbicide, or grow

poorly, the neighbors tend to sympathetically say it was “because he used the wrong chemical”.

However, these days, it is the organic soybean growers who are ultimately quietly laughing as they look out over clean, vigorous soybean fields, knowing that come harvest, they will be pocketing a check for 2-3 times what the neighbor’s chemically farmed soybeans will bring while saving all the money that others are spending on chemicals.

Is it worth it? It certainly is!