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# Library research, some strategies for weed management in organic farming

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**ABSTRACT:** organic farmers struggling to develop effective and economical weed management practices are not alone. Weed control in organically managed special attention to preventing weed problems before they start. Cover crops planted and mechanical controls of weeds in the vine row are key components of an organic weed management program. Typically combinations of methods are used in organic situations. Drip irrigation, Manually pulling weeds, Boiling water, Vinegar, Mechanically tilling around plants, Besides tilling, other mechanical weed control methods also exist Ploughing, Crop rotation, Weed mat, A weed mat is an artificial mulch, fibrous cloth material, bark or newspaper laid on top of the soil preventing weeds from growing to the surface. Therefore; weed management in organic farming, using no application of chemical weed control capability and their density in the long term.

***Keywords*:** weeds, Organic management, control

## INTRODUCTION

The concept of thresholds has many applications in weed science, depending on the response being measured. The most common adjectives used to describe thresholds are damage, economic, period, and action. Damage threshold is the term used to define the weed population at which a negative crop yield response is detected. An economic threshold is the weed population at which the cost of control is equal to the crop value increase from control of the weeds present. Economic threshold may be used to describe short-term effects of weed interference occurring in a single growing season, or multiple-season effects including some cost associated with seed produced by uncontrolled plants. The term period threshold implies that there are times during the crop cycle in which weeds are more or less damaging than at others. Motivations for production of organic crops and consumption of organic foods include economic, food safety and environmental concerns. Certified organic soybeans in Iowa in 1999 averaged a 250% premium price over conventional soybeans, for example. Some of the environmental concerns include the desire to reduce the 240 million pounds of herbicides applied each year in the Midwest; and concerns over weed resistance to herbicides and transfer of herbicide-resistant genes to wild plants that occurs with increasing reliance on herbicide-resistant crops.

Effective weed management depends on thoroughly understanding the biology and growth habit of the species in question. Is it an annual, winter annual, or perennial? At what soil temperatures does it germinate? Is it a strong or weak competitor? Does it propagate by seed production only? How long will the seeds remain viable in the soil? Does the weed favour growing in any specific soil condition? The interactions are complex. A practice that controls one weed may not work on another, or may actually cause it to increase. In most cases, a combination of a number of cultural and preventative practices will be required to effectively deal with the problem.

To plan an effective weed management program in organic systems, you should consider historical pest problems, soil management, crop rotation, machinery, markets, weather, and time and labor. Adjusting weed control strategies based on these factors and observing and avoiding potential threats will help you stay ahead of weed problems.

***DISCUSSION***

In organic agriculture, weed control involves using a combination of cultivation techniques such that the crop is always more mature than the weeds. The younger the weeds, the more effectively they can be suppressed. They are most sensitive to damage from machines or heat from the time that they sprout until the 2-4 leaf stage. Effective weed control must take place in the early stages of development. When beginners hear about "organic weed control," they may initially labor under a misapprehension. So let me reassure you: it's not just about pulling weeds by hand (although occasionally, it does come to that). On the contrary, this article introduces you to smart ways of dealing with weeds. Cultivation generally kills a constant proportion of established weed seedlings (Mohler, 2001). High levels of weed control in organically-managed fields thus requires a low density of germinable seeds in the weed seed bank, and consequently a low initial density of weed seedlings. Seed banks in agricultural systems may be managed by maintaining low densities of weeds, by enhancing the competitive advantage of the crop, by increasing seed mortality, and by manipulation of the soil environment to reduce the probability of weed establishment (Gallandt 2006. Cover cropping practices may be useful in this regard, contributing soil disturbance events that preempt weed growth and stimulate germination of additional weeds, and establishing a competitive environment that can reduce seed production of surviving weeds. Moreover, cover crops often offer flexible management opportunities that can prevent weed seed rain. They also contribute residues that reduce weed establishment in subsequent crops. A further advantage of cover cropping practices is their potential beneficial contribution to soil quality.

Most organic farmers rely on multiple tactics for their weed management. Ecological weed management seeks to promote weed suppression, as opposed to weed elimination, by enhancing crop competition and phytotoxic effects on weeds. Specific methods include the following techniques:

- Plant competitive crops to maintain suppression of weeds. There is a strong correlation between biomass, tillering (multiple stems) and weed competitiveness. Barley, for example, has a more extensive tillering system and is more competitive than wheat. Small grains are more competitive than corn or soybeans with their single main stem.
- Reduce weed seed set through allelopathic effects. Allelopathic crops, such as rye and oats, exude a chemical that mitigates small weed seed germination. Many organic farmers opt to “fallow” a field to a rye for an entire season if weeds have presented a persistent problem in the past.
- Maintain soil fertility through crop rotations, cover crops, intercross, and biologically based fertilizers to assist in enhancing the competitiveness of the crop plant.
- Improve advantage of crops over weeds through compost applications. It has been reported that humic and fulvic acids present in compost may mitigate weed seed germination. Small-seeded weeds may also be more susceptible to pathogens associated with high organic matter in compost.

***Cover crops***

Cover crops may contribute multiple benefits to organic farming systems that aim to function with greater biodiversity, notably linking management to improve soil quality with multiple direct and indirect stresses that may reduce weed problems (Bàrberi 2002; Gallandt 2004). While the beneficial contributions of cover crops are frequently discussed, without strategic implementation, cover cropping may actually exacerbate existing weed problems. A long period of a perennial cover crop will, for example, preserve the seedbank of relatively persistent species. If the growth of a cover crop is not terminated prior to weed reproduction, the cover crop can contribute significant seed rain. Thus, deployment of cover crops should be guided by the timing of unique disturbance events to avoid “crediting” the seed bank while maximizing opportunities for “debiting” the seedbank (Forcella 2003). For example, post-harvest management should aim to keep seeds on the soil surface to encourage predation (Westerman et al., 2006), and timing of tillage events, i.e., summer fallowing, should aim to maximize germination losses. Single-season cover cropping practices including three or more unique soil disturbance events resulted in a marked reduction in the germinable weed seedbank. Despite their apparent competitive ability, and likely benefits to soil quality, full season cover crops lacking soil disturbance may result in considerable weed seed rain and therefore an increasing weed problem in subsequent years. While we do not discourage growers from considering these full-season cover crops, they must be monitored carefully so that they are terminated prior to production of viable weed seed.

***Mulch***

A thick layer of mulch keeps light from reaching weeds. "Without adequate light, the plants don't produce enough chlorophyll to enable further growth. Most of these plants sicken and die before you even notice them," writes Miranda Smith in Rodale's Chemical Free Yard & Garden. "The few plants that do manage to stick their leaves into the light will be shallowly rooted and very easy to pull."Organic mulches—straw, grass clippings, leaves, shredded bark—nourish the soil as they decompose. They are fairly effective weed barriers. For even better weed protection, use several sheets of newspaper, Kraft paper (the paper used to make grocery bags) or cardboard under these mulches. In a 1992-93 study at the University of

Vermont, a 6-inch layer of shredded newspaper applied at the beginning of one season allowed no more than 8 weeds per square yard to sprout for two summers. Without renewing the mulch layer, the newspaper controlled weeds for two seasons. Kraft paper and cardboard allow even less light to reach weeds and are even more impenetrable.

***Hoeing***

Annual weeds die when you sever the stems from the roots just below the soil surface. With a sharp hoe, you cut the weeds easily. Forget about the square-headed traditional garden hoe for this job—go for an oscillating or a swan neck hoe instead. To hoe your garden without cultivating a backache, hold the hoe as you would a broom—that is, with your thumbs pointing up. Skim the sharp sides of the hoe blade through the top inch of the soil.

***Solarization***

can let the sun help you get rid of persistent weeds, if you're willing to leave the bed fallow for six weeks in the summer. Get started in late spring or early summer by pulling, hoeing or raking out as many weeds as you can from the garden bed. Then, moisten the soil and cover it with clear plastic, weighting or burying the edges. Leave the plastic in place for 6 weeks. When you remove the plastic, the sun will have cooked weeds that would otherwise have sprouted.

***Spraying organic herbicides for natural weed control***

There are an increasing number of effective organic herbicides on the market, and most of them work by burning off the waxy cuticle that protects the plants' cells from losing water. This means you see nearly immediate results. The nice thing about organic herbicides is that they only kill things that get their foliage coated with it, so if you have bulbs underground, or tree roots nearby, you're still safe, unlike with some traditional chemical herbicides. The bad thing is that if you aren't careful, it's easy to spray your prized perennials with it, too. This is true for chemical herbicides as well. Temperature and sunlight have both been suggested as factors affecting organic herbicide efficacy. In several field studies, we have observed that organic herbicides work better when temperatures are above 75F. Weed Pharm (acetic acid) is the exception, working well at temperatures as low as 55F. Sunlight has also been suggested as an important factor for effective weed control. Anecdotal reports indicate that control is better in full sunlight. However, in a greenhouse test using shade cloth to block 70% of the light, it was found that weed control with Weed Zap improved in shaded conditions. The greenhouse temperature was around 80F. It may be that under warm temperatures, sunlight is less of a factor. Organic herbicides are expensive at this time and may not be affordable for commercial crop production. Because these materials lack residual activity, repeat applications will be needed to control perennial weeds or new flushes of weed seedlings. Finally, approval by one's organic certifier should also be checked in advance as use of such alternative herbicides is not cleared by all agencies.

***Flaming***

Flamers can be used for weed control in the vine row, with propane-fueled models being most common. Fire causes the cell sap of plants to expand, rupturing the cell walls; this process occurs in most plant tissues at about 130°F. Weeds must have less than two true leaves for greatest efficiency of the burner. Grasses are harder to kill by flaming because the growing point is below the ground. After flaming, weeds that have been killed change from a glossy to a matte finish. This occurs very rapidly in most cases. Foliage that retains a thumb print when pressure is applied between your thumb and finger has been adequately flamed. Typically, flaming can be done at 3 to 5 mph through fields, although this depends on the heat output of the unit being used. Repeated flaming can likewise be used to suppress perennial weeds such as field bindweed. Care must be taken to avoid igniting dry vegetation, which could injure the vines, or start a wildfire.

***Weeder geese***

Geese can often be used to manage grass weeds in vineyards. Geese prefer grass species and will eat other weeds and crops only after the grasses are gone and they become hungry. If confined, they will even dig up and eat johnsongrass and bermudagrass rhizomes, which they have a particular preference for. Both of these weeds can be especially troublesome in vineyards. Generally, about 4 geese per acre are needed. They require water for drinking, and some form of protection from predators (dogs, coyotes, etc.). Young geese are preferred, as they eat larger quantities of food, although having at least one older goose, helps to protect the younger birds. Consult the following Website for further information on geese: http://www.metzerfarms.com/weeder.htm. Other animals sometimes used in organic vineyards include sheep and goats. Sheep will effectively remove all weeds down to ground level. Goats are browsers and must be carefully managed to avoid damage to the vines. Both sheep and goats are generally used during the time when grapes are dormant and the chance of grazing damage is minimal.

***Middles Management***

Similar to many conventionally managed vineyards, weeds in the middles of organic vineyards are commonly managed with cover crops and/or mowing. Consider planting a cover crop in the area between vine rows. Resident vegetation does not usually grow uniformly enough to compete well with newly invading weeds. In addition, resident vegetation includes weed species that continually colonize the vine row. An annual cover crop

that reseeds itself will compete against weeds and reduce the potential for problems in the future. If there is a potential for frost and the cover crop is tall, mow once before bloom to minimize frost damage; the cover crop will regrow and flower later in the season. However, the cover crop will be most competitive if mowing can be avoided. After most species in the cover crop have produced seed, mow or roll it using a ringroller. The ringroller will allow more seed production and also create a surface mulch that will prevent emergence of weed seeds.

***Composting to Reduce Weed Seeds and Plant Pathogens***

A key feature of organic farming systems is the utilization of organic residues as soil mulches and amendments in an integrated system to maintain and improve soil quality. Organic residues used for these purposes may be produced on the farm, or they may be imported from off-farm sources. Often, fresh organic residues produced in place are used in these practices, such as when cover crops are plowed down as a green manure to build soil organic matter and improve soil fertility, or rolled as a mulch in organic no-till systems to suppress weeds, reduce soil erosion, and conserve soil moisture. Organic residues may also be processed before being used to attain desirable qualities, such as when animal manures are composted to reduce volume and improve stability. Regardless of the circumstances, organic residues that are handled incorrectly can introduce otherwise avoidable problems to the farming system. For example, raw cattle manure may contain viable weed seeds and may spread an otherwise isolated weed infestation more broadly across the farm or, if the manure is imported from outside the farm, introduce a weed problem that previously didn't exist. Similarly, plant residues may be infected with pathogens that can infest subsequent crops. This article provides a brief description of the composting process, discusses the use of composting to reduce weed seeds and plant pathogens**,** and identifies issues that can lead to the failure of composting to reduce weed seeds and plant pathogens.

Many of the tactics below are commonly used by the organic growers in New England, and may have application to other regions and larger scale of production. Here are 10 steps toward successful non chemical weed control:

1) LOWER WEED PRESSURE by managing your weed seed bank to reduce the need for cultivation and hand hoeing.

- Thoroughly compost animal manures to kill off weed seeds, or avoid using manure altogether.
- Keep weeds from going to seed: cultivate solely for that purpose, or handful, if necessary.
- Reduce weed influx by keeping alleys and field edges mowed or harrowed.
- Power wash tillage equipment after use in fields with a noxious weed problem.

2) DIVERSIFY ROTATIONS to keep a particular weed from proliferating.

- Try to alternate crops with different tillage requirements or time of planting.
- Include small grains or sod crops in the rotation if possible, to vary the habitat for weeds.

3) USE COVER CROPS because they compete with weeds while providing other benefits.

- Select species for rapid growth that can starve weeds of light and nutrients. In the northeast, overwintering hairy vetch plus rye or hairy vetch plus oats mixtures are popular as a spring cover crop. Buckwheat, sorghum-Sudangrass, or Japanese millet work well in the heat of summer. Ryegrasses, oats or other small grains provide fall cover and winter erosion control.
- Sow at high rates, drill the seed and even irrigate if necessary to assure thick stands and rapid establishment of cover crops.
- Regular incorporation of cover crops (green manuring) enhances soil tilth, making cultivation easier. Since frequent cultivation can harm soil structure, it is important to compensate by adding clean organic residues whenever practical.

4) FEED THE CROP, NOT THE WEEDS by manipulating fertilizer placement and timing.

- Avoid pre-plant broadcasting of soluble nutrients that may be more readily utilized by fast-growing weeds than slow-growing crops, and may even stimulate weed germination.
- Apply fertilizer near the rows where it is more likely to be captured by the crop.
- When using expensive bagged organic fertilizers, band at low rates at planting or sidedress; rely on mid-season release of nutrients from compost and/or green manures for primary fertility.

5) PICK THE RIGHT TOOL FOR THE JOB. Cultivation is critical to weed control on organic farms, and doing it right requires a variety of tools that can be matched to the weed, crop and soil situation. Over the season, different tools are needed as the crops and/or weeds get larger.

- Blind, "over-the top" cultivation controls very small weeds, just germinated or emerged, before and sometimes after planting. The entire surface of the field is worked very shallow using flex-tine cultivators (e.g. Lely weeder), or rotary hoes.
- Shallow between-row cultivators such as basket-weeders, beet-hoes, or small sharp sweeps are used to cut off and uproot small weeds after the crop is up. These can get very close to the crop when it's small, without moving much soil into the row, and may be the only tools used on delicate crops like leafy greens.

- As vigorous crops grow, soil can be thrown into the row to bury in-row weeds using rolling cultivators (e.g. Lilliston), spyder wheels (e.g. Bezzerides), large sweeps or hilling disks. Some of these tools can be angled to pull soil away from the row when plants are small and later turned around to throw soil back on the row during subsequent cultivations.

6) COMBINE TOOLS to cover the different zones in the field.

- Between-row, in-row, and wheel-track weeds must all be attacked.
- Watch out for narrow strips that are missed because they pass between too-few tools.
- Front-mounted or belly-mounted tools plus rear-mounted toolbars facilitate combinations that can assure complete coverage.

7) SET UP FOR SPEED to minimize cultivation time and expense.

- Perfectly straight rows and alert tractor drivers are essential
- Uniform row spacing across comparable crops enhances the utility of a cultivation set-up.
- Consider multiple-row units; gauge wheels are helpful on wide units or if fields aren't level.
- With frequently-used tractor-mounted cultivators, get them set just right and leave them on all season to avoid repeated mounting and adjustment.

8) TIMING IS EVERYTHING: get the weeds while they're small, before the field looks weedy.

- Very shallow cultivation of "white thread" weeds can minimize bringing up more weed seeds.
- Keep an eye on the weather and try not to get beat by the rain; if you do, be ready with the heavy artillery - more aggressive tools for bigger weeds, when you can get in.

9) CONSIDER STALE SEED BEDS OR STALE ROWS using flame-weeders.

- Prepare soil for planting, then use a flamer to kill very small weeds without disturbing the soil.
- One or two flamings are used, just before and/or after planting, but prior to crop emergence.
- Single burners flame just the crop row, multiple burner units cover a whole bed.
- Backpack, push-type and tractor-mount units are in use.

10) EXPERIMENT to fine-tune your weed management tactics.

- Start on a small scale with tools and techniques that are new to your farm.
- Identify your problem weeds and compare different combinations of rotations, cover crops, and cultivation tools for their effectiveness in providing control.
- Keep an eye our for new tools, or new ways to use old tools.
- Leave a "control" row or section untreated, so you can see the effectiveness of your tactics.

The goal of biological control is not eradication, but the use of living agents to suppress vigor and spread of weeds. Such agents can be insects, bacteria, fungi, or grazing animals such as sheep, goats, cattle or horses. Grazing produces results similar to mowing, and bacteria and fungi are seldom available for noxious weed management. Biological control is most commonly thought of as 'insect biocontrol'.

USDA-APHIS (United States Department of Agriculture-Animal and Plant Health Inspection Service), is the federal agency responsible for authorizing the screening and importation of biocontrol insects. APHIS conducts intensive multi-year screening programs assuring an insect agent's host specificity (feeds only on target weed species, not other plants) prior to approval for release.

***Biological Control***

Biological weed control through insect/plant interactions is an important component of the County's weed management program. Insect agents, proven to be effective, are utilized in cases where eradication is impractical due to the vastness or inaccessibility of an infestation, and where other methods of management are not feasible. Insect agents typically require 3-5 years for establishment and can limit the spread and density of target weed species by feeding on leaves, stems, roots and/or seed heads. One must realize that eradication of a weed cannot be attained through insect biocontrol. The most effective scenario is a weed infestation reduced to a 'tolerable level', a level where the insect agents are significantly limiting distribution and abundance of the target weed species and the weed density is no longer considered detrimental to the desired plant community. Some biocontrol insects proven to be successful are:

- Bindweed mites - field bindweed
- Flea beetles - leafy spurge
- Mecinus janthinus - dalmatian toadflax
- Larinus minutus and Cyphocleonus achates - diffuse knapweed

In integrated weed management, farmers employ a diversity of weed-killing techniques, including tillage, cultural practices, and methods for depleting the weed seed bank, rather than depending solely on the spraying of Roundup or another single tool.


In automated weed control, sensor and computer technologies aboard a tractor would identify the species of every weed in a field, and then apply one of several weed-fighting tools to each plant based on its biology.But diversification isn't the same as true integration, cautions University of Nebraska-Lincoln weed ecologist, Steve Young. Why? Because most integrated weed management practices still manage every weed the same, regardless of location or season, and they're usually deployed one at a time rather than together. Young is now hoping to change that by developing a fundamentally different approach to weed control.In the automated systems he envisions, sensor and computer technologies onboard a tractor would first categorize each plant in a farmer's field as either weed or crop, and then go on to identify the species of weed. Once those identifications were made, one of several weed fighting tools located on the tractor could be applied to individual plants based on their biology. If the system identified a weed that's resistant to Roundup, for example, it could be sprayed with a different herbicide. Or an onboard cutting or flaming tool could be used to kill the plant instead. In other words, the system could target different weed-killers to specific weeds, Young says—similar to how variable rates of nitrogen are applied in different sections of fields today based on variations in crop nitrogen status."This is all about trying to get more precise with our weed control practices," Young says, and in fact he began developing his ideas while working as a postdoc at the Center for Precision Agricultural Systems at Washington State University. His advisor, Fran Pierce, was "really into automation," he says, and it got Young thinking about ways to apply automation and robotics in weed science, as well. Young has since been studying the micro-rates of chemicals and mechanical treatments needed to kill single plants. "If we can figure out these parameters, then they'll be ready for the engineering part of it," he says. As with other precision agriculture technologies, there could be many benefits. Applying micro-doses of herbicide to the leaves of single plants would eliminate spray drift and the leaching of chemicals into groundwater. Weeds would also be less likely to evolve resistance to herbicides, because less chemical would be required overall and only targeted weeds would receive the dose.Young is not advocating the system as yet another "silver bullet," but as an entirely new approach in cropping systems where multiple weed-fighting strategies are available for use at the same time. "It's revolutionary because all the tools for controlling weeds are put on a level playing field; none is regarded or relied on more than another," he says. "And because the tools are interchangeable, this system can be used in conventional, organic, or any other cropping system.

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