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Weed Management in Organic Cropping Systems

When managing weeds in organic systems, producers use many of the same techniques used in conventional systems, but they rely much more on nonchemical control strategies. The primary weed control strategies for organic systems are cultural and mechanical, focusing on prevention, crop rotation, crop competition, and cultivation.

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.

Key Points

- Understand weed biology.
- Rotate crops and alter planting dates to disrupt weed life cycles.
- Encourage competitive crop production with sound agronomic practices.
- Use mulches and cover crops to help suppress weeds.
- Timely tillage and cultivation is critical for weed control.
- Chemical weed control is generally not allowed in organic production systems.

PREVENTION

Prevention focuses on keeping new weeds out and preventing the further spread of weed seed or perennial plant parts. Stopping the addition or introduction of weed seed to the soil can be particularly critical for successful weed management.

Understanding weed biology is an important component in developing a preventive approach. Weed species have strengths and weaknesses that make them vulnerable or resilient at different stages in their life cycle. Therefore, proper identification and knowledge of weed life cycle and reproduction and spread are important factors for developing management strategies. For example, disking or field cultivating a creeping perennial such as quackgrass or hedge bindweed in the spring may make the problem worse by spreading underground rhizomes or other vegetative structures.

Some preventive tactics can be classified as *sanitation*: removing or destroying weeds in fields or near fields before they flower and release weed seed. Weed seeds can live for a number of years, depending on the species and whether the seed is exposed or buried beneath the soil surface. If necessary, weeds may need to be removed from the field by hand before they produce seed. Weeds can also be introduced into fields through manure, compost, hay, straw, animal feed, contaminated crop seed, or other materials. Whenever you plant, apply, or drive something in a field, make an effort to learn whether weed seeds are present and weigh the benefits against potential risks.

CULTURAL WEED CONTROL

Any tactic that makes the crop more competitive against weeds is considered cultural management. Some cultural practices—in particular, crop rotation and altering planting dates—can be critical components of weed management in organic production systems.

Organic growers should plan rotations so that weed species favored in one year or season will not be favored in another year or cropping sequence. This generally means mixing summer annual crops with fall-seeded species or even perennials that allow different weed management strategies.

The planting date will influence the type and number of weeds present. Delaying planting of spring-seeded crops is common among organic producers. This planting delay may sacrifice some yield potential, but higher soil temperatures will help the crop emerge more quickly and weeds that emerge earlier in the season can be killed before planting the crop to reduce the potential weed seedbank.

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A *stale seedbed* is a technique sometimes used in vegetable production systems that can also be used in agronomic crops. In this technique, a seedbed is tilled several weeks before planting. The weeds are allowed to emerge and then they are killed, while still small, by shallow cultivation, flame weeding, or other nonselective methods. Depending on the length of time before planting, one or more flushes of weeds may emerge and be killed between seedbed preparation and planting. The success of a stale seedbed depends on the weed spectrum and the time of planting. Delayed or later-planted crops are generally more successful. Late-emerging weeds will still be a potential problem.

Crop competition is another important component of cultural weed control and an effective way to control weed growth. Tactics that allow the crop to establish quickly and dominate will help reduce the impact of weeds. Use high-quality, vigorous seed, adapted varieties, uniform proper placement of the crop seed, optimal soil fertility, and plant populations that lead to vigorous crop growth and canopy closure. A vigorous growing crop is less likely to be adversely affected by weeds.

MULCHES AND COVER CROPS

Because soil open to sunlight helps weeds grow and complete, mulches are used to help manage weeds in some organic production systems. The mulch provides a physical barrier on the soil surface and must block nearly all light reaching the surface so that the weeds which emerge beneath the mulch do not have sufficient light to survive. Plastic mulches are acceptable in some organic programs, but are generally not practical for lower-valued, large-scale field crops. Mulches of organic material, such as straw, newspaper, or killed cover crop residue left on the surface, can also effectively block sunlight and are more commonly used in organic row crop production systems.

Cover cropping can help manage weeds in several ways. Cover crops can provide an opportunity for crop rotation and rapid turnover of weed seedbanks. In addition, cover crops can provide some weed control by competing with weeds for light, moisture, nutrients, and space. This can be particularly helpful for suppressing winter annual weed growth or certain cool-season perennials. Cover crops and their residues also can act as mulches or physical barriers by smothering weeds, suppressing weed seed germination and growth, and lowering soil temperatures. In general, the larger the cover crop and greater the biomass or dry matter production, the greater the impact on weeds. Cover crops also may contain allelopathic compounds, which are released from living or decaying plant tissue, that chemically interfere with weed growth. However, these qualities can vary depending on the type and quantity of cover crop and environmental conditions during the growing season. Despite these potential benefits, physical and chemical effects from cover crops may not provide adequate weed control. Use mechanical control tactics and cultural controls to complement cover crops for weed management.

MECHANICAL WEED CONTROL

Mechanical weed control is critical for managing weeds in organic systems. In organic row crops, such as corn or soybeans, mechanical cultivation is generally necessary for adequate weed control. Mechanical weed control includes the use of preplant tillage such as plowing, disking, and field cultivating. These types of primary and secondary tillage can help reduce the rate and spread of certain perennial weeds and can also kill emerged weed seedlings and bury weed seeds below the germination zone.

Most organic corn and soybean producers prepare a conventionally tilled seedbed before planting their spring crop. Cultivation should generally begin a few days after planting. To control very small weed seedlings that are just beneath the soil surface or barely emerged, implements such as a rotary hoe, chain-link harrow, or tine weeder are dragged over the field. These implements will displace small seedling weeds and expose them to the drying effects of the wind and sun.

Rotary hoes, tine weeders, or similar implements are the best method for controlling weeds in the crop row. Operate a rotary hoe at 10 to 12 miles per hour with enough drag to stir the soil and displace the small seedlings. Continue to use a rotary hoe or similar implement about every 5 to 7 days as long as the weeds are germinating or until the crop is too big. Do not rotary hoe soybeans in the “hook” stage (when the stem is exposed and the cotyledons have not yet opened above the ground). Also, use rotary hoes or similar implements in the afternoon, when turgor pressure is less and soybeans and corn are more flexible. In general, up to three rotary hoeings may be performed within 2 to 3 weeks after planting.

Crop rows planted 30 inches or more apart allow for row cultivation. Once soybeans have two to three trifoliate leaves and corn is beyond the two-leaf stage (V2) and 8 to 10 inches tall, use a row cultivator to control small weed seedlings. Shallow cultivation at 1 to 2 inches deep will avoid harming crop roots. Continue to cultivate at 7- to 10-day intervals until the corn is too tall and the soybean canopy closes the rows. Organic corn and soybeans generally require one to three cultivations depending on weed species, severity, and rainfall. Cultivation works best when performed during the heat of the day in bright sunlight; weeds quickly desiccate and die under these conditions. Rainfall shortly after cultivation or wet cloddy soils at or following cultivation may allow weeds to recover and survive. Hand-pulling escaped weeds will help ensure maximum crop yield and prevent weed seed production, which can affect future weed problems.

Mowing may also play a critical role in managing weeds in forage crops or noncrop areas. Repeated mowing reduces weed competitive ability, depletes carbohydrate reserves in the roots, and prevents seed production. Some weeds, mowed when they are young, are readily consumed by livestock. Mowing can kill or suppress annual and biennial weeds. Mowing can also suppress perennials and help restrict their

spread. A single mowing will not satisfactorily control most weeds; however, mowing three or four times per year over several years can greatly reduce and occasionally eliminate certain weeds, including Canada thistle. Also, mow along fences and borders to help prevent the introduction of new weed seeds. Regular mowing helps prevent weeds from establishing, spreading, and competing with desirable forage crops.

HERBICIDES

Chemical weed control is generally not allowed in organic crop production systems. The USDA National Organic Program (NOP) rule does allow certain nonsynthetic soap-based herbicides for use in farmstead maintenance (roadways, ditches, right-of-ways, building perimeters) and in ornamental crops. In addition, several products that contain natural or nonsynthetic ingredients are classified as Allowed or Regulated by the Organic Materials Review Institute (OMRI). Regulated substances are listed with a restriction on the USDA National List or in the NOP rule. The OMRI listing does not imply product approval by any federal or state government agency. It is the user's responsibility to determine the compliance of a particular product.

Corn gluten meal is sold as a preemergence herbicide in some production systems. However, because of the volume of product necessary and the associated cost, corn gluten meal is generally not practical for agronomic crop production systems. In addition, the need for and use of corn gluten for weed control must be explained in the Organic System Plan and it must not be derived from genetically engineered sources. To learn more about corn gluten, visit the corn gluten meal research Web page at Iowa State University (www.gluten.iastate.edu).

The nonsynthetic postemergence herbicides contain plant-based ingredients, including eugenol (clove oil), garlic, and citric acid, and act as nonselective contact-type herbicides. They will injure or kill all vegetation they come in contact with. The need for the use of herbicides derived from plant or animal sources should be explained in your Organic System Plan, and you must obtain permission from your organic certifying agencies to use these materials. Acetic acid or vinegar is an ingredient in a number of products, but we believe it is not currently approved as an herbicide for organic crop production systems. Additional products and ingredients are currently under review.

Nonsynthetic adjuvants (such as surfactants and wetting agents) are allowed unless explicitly prohibited. All synthetic adjuvants are prohibited, which includes most adjuvant products on the market. However, a number of plant-based adjuvants are available. These are often derivatives of pine resin (Nu-Film P), yucca (Natural Wet), or other plant-based substances. Some products contain acidifying agents and other ingredients touted to enhance pesticide or nutrient uptake. Check with your organic certifier to find out if these additives are allowed.

The following table contains some herbicides listed by OMRI at the time of printing. Some of these products already include surfactant-type adjuvants in their formulation. Penn State does not assure the effectiveness or allowance of any of these products.

Table 1. Herbicides listed by the Organic Materials Review Institute (OMRI) for use in organic production as of May 2004. All products listed are classified as Regulated.

Product	Active ingredients	Manufacturer
Alldown	Citric acid plus garlic plus acetic acid	Summerset Products www.sumrset.com 952-820-0363
Corn gluten meal	Corn gluten meal	Numerous—for more information see. www.iastate.edu/~isurf/tech/cgmwebsite.html
Ground force	Citric acid plus garlic plus acetic acid	Abby Laboratories www.abbylabs.com
Herbicidal soap	Various salts of fatty acids	Several brands—may be synthetic and used for nonfood crops only
Matran II	Clove oil	EcoSmart Technologies, Inc. www.ecoipm.com 888-326-7233
Xpress	Thyme and clove oil	Bio HumaNetics www.biohumanetics.com 800-961-1220

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