HORTICULTURAL
MU Guide
PUBLISHED BY MU EXTENSION, UNIVERSITY OF MISSOURI-COLUMBIA muextension.missouri.edu

# Organic Vegetable Gardening Techniques

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## What is meant by organic?

Organic vegetable gardening promotes and enhances natural diversity and biological cycles on the farm. Rather than relying on synthetic fertilizers and pesticides, organic gardening is based on making the garden self-sufficient and sustainable. Producing vegetables organically is a long-term process that is carried out in stages rather than adopting a single production practice within one growing season. Adopting organic production techniques involves a transition from conventional to organic gardening. The first step in this transition is improving and maintaining soil fertility or quality. Healthy, fertile soils are the base of successful organic vegetable production.

The soil is a resource that is biologically active and dynamic, providing vegetable plants with nutrients, water and oxygen. Organic matter (decayed plant material) is an essential ingredient in fertile soils. Organic matter improves soil tilth while preventing soil compaction and crusting. Soils low in organic matter often crust or seal over after a heavy rain, which prevents water and oxygen infiltration to the root system of growing vegetables. Organic matter slows erosion of soil and provides a favorable environment for earthworms and beneficial microorganisms. Carbon dioxide from decaying organic matter brings minerals of the soil into solution, making them available to growing plants. A target level for organic matter in healthy soil is 3–5 percent.

## Sources of organic matter

**Animal manures:** Where available, animal manures are an excellent source of organic matter and nutrients for the soil. Ideally, manure should be partially broken down (aged) or composted before application. Composting manure stabilizes the nitrogen and reduces the viability of weed seeeds that may be in the manure. If fresh manure is used, it should be applied in the fall to fallow land and immediately plowed or incorporated into the soil so that there is adequate time for breakdown and ammonia release before crops are planted. Fresh manure *should not* be applied directly to growing vegetable plants and should not be applied within 120 days of harvest of any vegetable. The fertility of manures varies widely (Table 1). For example, poultry

**Table 1. Major constituents of animal manures (%).**

| Manure type | Nitrogen (N) | Phosphorus ($P_2O_5$) | Potassium ($K_2O$) | Calcium (Ca) | Organic matter (%) | Water content (%) |
|---|---|---|---|---|---|---|
| **Undried** | | | | | | |
| Cattle | 0.5 | 0.3 | 0.5 | 0.3 | 17 | 80 |
| Sheep | 0.9 | 0.5 | 0.8 | 0.2 | 30 | 65 |
| Poultry | 0.9 | 0.5 | 0.8 | 0.4 | 30 | 65 |
| Horse | 0.5 | 0.3 | 0.6 | 0.3 | 27 | 69 |
| Swine | 0.6 | 0.5 | 0.4 | 0.2 | 16 | 78 |
| **Dried** | | | | | | |
| Cattle | 2.0 | 1.5 | 2.2 | 2.9 | 70 | 8 |
| Sheep | 1.9 | 1.4 | 2.9 | 3.3 | 54 | 11 |
| Poultry | 4.5 | 2.7 | 1.4 | 2.9 | 59 | 9 |

**Successful organic gardening begins with healthy soils.**

**Buckwheat is an excellent summer annual green manure.**

manure is typically higher in nitrogen and phosphorus relative to other manures. Both poultry manure and dairy manure have fewer weed seeds that could carryover in the garden.

To interpret Table 1, note that each 100 pounds of fresh cattle manure contains one-half pound of available nitrogen, while 100 pounds of dried cattle manure contains about 2 pounds.

Successful gardeners do not overapply manure. Like any fertilizer, manure can leach and pollute groundwater and streams. In addition, too much nitrogen from overapplying manures can reduce the yield and quality of many vegetables.

**Compost:** If manure is not readily available, compost can be made from lawn clippings, leaves and other plant materials. Composting organic matter stabilizes nitrogen, kills pathogens and weed seeds while recycling organic matter on the farm. In addition, composting enables the use of materials such as raw manure and sawdust that should not be applied directly to growing vegetables.

Adding compost to the garden soil improves soil structure, increases the population of beneficial microbes, increases soil moisture retention, reduces nutrient loss, boosts pH and can suppress certain diseases. Most compost contains 1–3 percent nitrogen. Generally in field vegetable production, compost is applied 4-8 tons/acre while garden application rates are 10–20 tons/acre (1–2 lb/ft$^2$) for soil development, with 0.5–1 lb/ft$^2$ applied for soil fertility maintenance. For detailed information on making compost, see MU publication G6956, *Making and Using Compost.*

**Cover crops and green manures:** Cover crops and green manures are an excellent way to build soil quality. Green manures are used to provide nitrogen to the succeeding vegetable crop while cover crops are planted to protect the soil from erosion. Besides adding organic matter, cover crops reduce soil erosion, provide habitat for beneficial insects and spiders, provide nitrogen, suppress weeds and loosen the subsoil. Cover crops are usually established in the fall (September-October) in Missouri and are allowed to grow during the winter and early spring before being plowed in. Cover crops can be interseeded with a fall vegetable crop toward the end of the growing season to allow the cover crop to get established while you harvest the fall vegetable crop. Popular winter cover crops include annual ryegrass, winter rye, winter pea, wheat, oats, triticale, clovers and hairy vetch. Also, fast-growing cover crops such as buckwheat, soybean, cowpeas and sudangrass can be established during the summer to suppress weeds and add organic matter to the soil.

Legume cover crops (e.g., hairy vetch, clovers) fix nitrogen from the air and transform it for use by plants. As much as 120 pounds per acre of actual nitrogen can be fixed by certain legume cover crops. Mixed seeding of grass and legume cover crops is commonly done by using one-third the normal seeding rate for the grass cover crop and two-thirds of the normal seeding rate for the legume (Table 2). Most legumes should be seeded in early fall, whereas grass cover crops can be seeded up to mid-October in Missouri. The following spring, the cover crops are mowed or rolled. Wait 1–2 weeks after killing the cover crop to plant vegetables.

**Table 2. Seeding rate for select cover crop species.**

| | Seeding rate[a] | |
|---|---|---|
| Cover crop | Lb/acre | Oz/100 ft$^2$ |
| Annual ryegrass | 15-30 | 1 |
| Rye | 90-160 | 4-6 |
| Wheat | 60-150 | 3-6 |
| Oats | 110-140 | 4-6 |
| Buckwheat | 60-96 | 4-6 |
| Sorghum-Sudan grass | 40-50 | 2 |
| Crimson clover | 22-30 | 2-3 |
| Hairy vetch | 25-40 | 2 |
| Sweet clovers | 10-20 | 1.5 |
| White clover | 5-14 | 1.5 |
| Red clover | 10-12 | 3 |

[a]Broadcast rate.
**Source:** *Managing cover crops profitably*. 1998. Sustainable Agriculture Network. A. Clarke (ed.).

Do not wait until seed head formation on cereal grains to mow. Most cereals can be incorporated into the soil when they reach 24 inches in height. Legumes should be plowed or incorporated into the soil just before full flowering for maximal nitrogen content.

## Organic fertilizers

The amount of fertilizer applied to any vegetable crop depends on soil type and characteristics (pH, organic matter and cation exchange capacity), previous cropping history and nutrient uptake by the vegetable. For example, heavy-feeding vegetables like tomatoes can remove as much as 120 pounds of nitrogen per acre each year. Soil testing should be done every two years to determine total nutrients within the soil.

Table 3 lists various types of organic fertilizers that can be used to supply nutrients.

**Table 3. Nutrient content of select organic fertilizers.**

| Material | N (%) | $P_2O_5$ (%) | K (%) | Other nutrients | Relative availability of nutrients |
|---|---|---|---|---|---|
| Rock phosphate | 0 | 25 | 0 | 25% Ca | Slow |
| Greensand | 0 | 0 | 9 | | Slow |
| Alfalfa pellets | 3 | 0.5 | 3 | | Slow |
| Bone meal (raw) | 2 | 15 | 0 | 20% Ca | Slow |
| Fish emulsion | 4 | 2 | 2 | 1% Ca | Fast |
| Blood meal | 13 | 0 | 0 | | Slow |
| Wood ashes | 0 | 2 | 5 | 20% Ca | Fast |
| Soybean meal | 7 | 2 | 2 | | Medium |
| Cottonseed meal | 7 | 2 | 2 | | Slow |
| Compost | 1.5 | 1 | 1.5 | 2% Ca | Slow |
| Epsom salts | 0 | 0 | 0 | 10% Mg | Fast |
| Gypsum | 0 | 0 | 0 | 22%Ca; 16% S | Medium |
| Corn gluten | 9.5 | 0.5 | 0.5 | | Medium |

**Note:** Adapted from Ferro, D. N., ed., 1998–1999 New England Vegetable Management Guide, Univ. of Connecticut, University of New Hampshire, University of Maine, University of Rhode Island, University of Massachusetts and University of Vermont.

## Organic disease management of vegetable crops

Plant diseases may seriously stunt or kill vegetable plants. Diseases often appear as leaf spots, wilts, stunts, rusts or lesions. Vegetable plant diseases may be caused by fungi, bacteria, viruses, mycoplasms or may be the result of a stressful environment that produces disease-like symptoms. For example, many vegetable plants will wilt not only from too little water, but also from excessive water in the root zone. The key to successful organic disease management is prevention. The following strategies can be used to prevent diseases on vegetable crops.

**Resistance:** Whenever possible, choose disease-resistant vegetable varieties. Disease resistance means that although a plant may occasionally contract the disease, it is much less likely than other varieties to do so, and if attacked, may not be seriously affected. Tolerance to a disease means that the plant usually contracts the disease when present but is able to survive despite the infection.

**Disease-free transplants.** Many vegetables can be established as transplants. Carefully inspect transplants for any spots or lesions on the stems or leaves. Remove a few transplants from the planting container and inspect the root system. Healthy roots are white or light in color, and there is no decay or excessive wrapping of the fibrous roots around the root ball. Avoid purchasing vegetables that have already set fruit.

**Site selection:** Always choose a well-drained soil for growing vegetables. Root rots and other soil borne diseases thrive in wet soils. Low spots in the field also are pockets of high humidity in the plant canopy, creating a favorable environment for diseases. Avoid planting close to trees or buildings that may reduce air circulation or the intensity of duration of sunlight. Use raised beds to promote soil aeration and drainage whenever possible.

**Crop rotation:** Crop rotation is a long-established agricultural practice. Continuous cropping of plants in the same botanical family allows for buildup of disease organisms. Vegetables that are in the same botanical family should not be grown in the same area for at least three years. For example, watermelon, cucumber, squash, cantaloupe and pumpkins are in the Cucurbit family and often are attacked by the same disease organisms. Rotating this group of vegetables with vegetables in the Solanceous family such as peppers, tomatoes, eggplants or potatoes can potentially lower the incidence of diseases.

**Plant spacing and training:** Dense plantings can often increase susceptibility to diseases. By increasing the spacing between plants, air circulation and light intensity are enhanced, creating a less favorable environment for disease development. Always stake or cage tomato plants to keep the vines and fruit from touching the soil.

**Mulching:** Organic mulches such as straw, hay, compost, newspaper or wood shavings will aid in disease prevention by reducing direct contact between soil and the plant. Mulch thickness should be 4-6 inches. Many soil-borne diseases infect the plant from rain-splashed soil on the lower leaves. Organic mulches usually lower soil temperatures. Thus, warm-season vegetables such as tomatoes and peppers should be mulched only after the soil has been allowed to warm up. Plastic mulches can be used by organic growers. Plastic mulches are available in a variety of colors and are particularly effective in warming the soil.

Black plastic is the most commonly used plastic mulch for spring and early summer vegetables in Missouri. Infrared-transmitting (IRT) plastic mulch allows certain wavelengths to penetrate the plastic increasing the soil temperature significantly more than black plastic mulch. Growers wishing to plant later in the summer can use white plastic to keep the soil cooler. If plastic mulch is used, water must be supplied by a drip tube or soaker hose under the plastic.

**Rogue infected plants:** Pull up and destroy any plants showing severe disease symptoms to prevent the spread to adjacent plants.

**Sanitation:** To prevent carryover of plant diseases from one growing season to the next, clean all planting trays and growing supplies such as wooden tomato stakes, planting trays and harvest containers. Most materials can be soaked in a hydrogen peroxide solution or steam sterilized. Clean crop residue from fields and burn or discard diseased plants. Do not compost diseased plant residue. Eliminate weeds around the perimeter of the garden because these can serve as hosts for plant diseases.

**Seed saving:** Many diseases are seed borne. Some organic gardeners save seed from favorite varieties. If you choose to save seed, make sure the plants from which the seeds were harvested have no disease symptoms.

**Organic pesticides:** Organic fungicides include copper (Bordeaux mixtures or sulfates), compost tea, hydrogen peroxide, and sodium bicarbonate (baking soda). In addition, biological fungicides (beneficial bacteria or fungi) are available to organic gardeners. Most organic fungicides are applied to prevent the development of a disease.

**Protected crop culture:** High tunnels (hoop houses) are plastic-covered, solar greenhouses that are used to lengthen the traditional growing season and protect the growing vegetable crop from rain, wind, hail and erratic temperatures. High tunnels also exclude many pests that routinely attack vegetable plants in the Midwest. Most diseases need free moisture to become activated. By keeping the plant canopy dry and using drip irrigation, diseases are less likely to develop. For more information about high tunnels, consult MU publication M170, *High Tunnel Tomato Production*.

## Organic weed management

Weeds are plants that compete with vegetables for light, water and nutrients. Weeds also interfere with harvesting and can harbor many diseases. While completely eliminating weeds in the garden is not realistic, several strategies can be employed to reduce weed competition.

**Reduce the weed seed bank.** Raw manure, immature compost, hay or straw may contain weed seeds. Clean tillage or harvesting equipment after use to prevent contamination from adjacent fields. Do not allow weeds to form seed heads.

**Mulches:** Mulches shade the soil to prevent weed seed germination and smother the growth of weeds. Both organic and plastic mulches are available to gardeners. Mulches can be added to the crop throughout the growing season, or the crop can be seeded or transplanted into an established mulch, a practice called *conservation tillage*. Cover crops can be grown during the summer to suppress weeds for the fall garden.

**Rotation:** Rotating the garden with cover crops or different types of vegetables may prevent the buildup of a single weed species.

**Plant spacing:** The critical weed-free period for most warm-season vegetable crops is about 45 days after planting. Thus, early-season weed control is critical. Decreasing the spacing between plants or between rows so that the crop shades the soil rapidly can aid in weed management.

**Cultivation:** Three or four weeks before planting, the soil can be tilled and weeds can be allowed to germinate and emerge. The weeds can be tilled in to the soil several times before the crop is established. This technique, called a *stale seedbed* method will reduce the weed population by breaking their natural cycle of emergence in the vegetable garden.

**High tunnels protect vegetables from stressful environments and pest outbreaks.**

**The perimeter of the high tunnel (or garden) can be planted in flowering cover crops to serve as habitat for beneficial insects.**

**Vegetable type:** Certain vegetables are relatively more competitive with weeds. For example, potatoes (Irish and sweet), winter squash, sweet corn and tomatoes can effectively compete with weeds.

**Transplanting:** Use transplants if possible. Transplants enable a uniform stand of the crop and also allow the vegetable plants to get a head start over any weeds that emerge.

**Flame weeding:** Flame weeding, or using a hot flame to kill weeds, is effective for stale seedbed weed removal or weeds that emerge before the vegetable crop. Flame weeding is effective for weed control in slow-germinating vegetables such as onions, parsnips and carrots. Some growers have successfully used flame weeding on transplanted onions that are 8-10 inches tall. Sweet corn that has just emerged and potatoes up to 2 inches tall can be flame weeded.

**Drip irrigation:** By reducing the soil area that receives water, weed emergence is reduced.

**Organic herbicides:** Various organic herbicides can be used by organic gardeners. These include acetic acid (vinegar), citric acid and corn gluten.

## Organic insect management

Organic management of insect pests is based on avoiding a pest outbreak rather than dealing with the pest after it has acquired a foothold in the garden. The following are a few techniques that can be used to control insects organically:

**Inspect plants:** Scout the garden often, specifically the border or outside rows in the garden. If a harmful insect is observed, it can be physically removed before the population spreads to adjacent plants.

**Habitat for beneficial insects:** Create an environment favorable for natural enemies of harmful insects. More than 100 families of insects, spiders and mites contain species that are natural enemies of harmful insects. Plant the borders of the garden in native flowers or plants such as clover or alfalfa to attract beneficial insects such as lady beetles. Avoid planting vegetable crops in large blocks. Mixing different types of plants slows the spread of insects that are present.

**Row covers:** Row covers are lightweight, spunbonded fabrics that can be suspended or draped over vegetables to protect them from invasive insects. Row covers are particularly effective in reducing damage by flea beetles and cucumber beetles.

**Trap crops:** Plant a less desirable plant close to the garden that will attract insects away from the important vegetables in the garden. The trap crop can be destroyed after it becomes infested with insects.

**Resistant crops:** Some varieties or types of vegetables are less attractive to insects. For example, 'County Fair' pickling cucumber is much less attractive to cucumber beetles than most other cucumber varieties.

**Date of planting:** Many vegetable insects will have peak populations throughout the growing season. By adjusting the planting date, you can avoid high populations of insects. For example, early-planted sweet corn will have much less corn earworm infestation than late-planted corn.

**Intercropping:** Growing two or more vegetables in the same area during the same growing season is referred to as intercropping. Avoid planting large blocks of any single vegetable in the garden. Mixing vegetables prevents a buildup of harmful insects.

**Keep plants healthy:** Healthy plants are less attractive to insects, and those that are attacked are better able to survive and produce a marketable crop.

**Sanitation:** Remove plants after harvest to prevent them from becoming resovoirs for harmful insects.

**Fall plowing:** Plowing the vegetable garden after fall harvest exposes insects and insect eggs to birds or to desiccation during winter freezing and thawing.

**Organic insecticides:** Several organic insecticides are available for use by vegetable gardeners, including Bt *(Bacillus thuringiensis),* pyrethrums, rotenone, insecticidal soaps, diatomaceous earth, neem, and horticultural oils. Check the labels and consult your certifying agency before using.

**Row covers protect vegetables from frost and pest invasion.**

## For more information

**From Missouri Extension 1-800-292-0969**

M170, *High Tunnel Tomato Production*

**On the Web**

Appropriate Technology Transfer for Rural Areas (ATTRA)
www.attra.org

Organic Materials Review Institute
www.omri. org

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