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Organic Vegetable Gardening

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What is Organic Gardening?

There is considerable discussion, even among those claiming to be organic gardeners, as to exactly what constitutes organic gardening. Generally, however, organic gardening is a system of gardening that attempts to use only sustainable, ecologically sound gardening procedures. Organic gardening generally differs from traditional gardening in two important ways: use of agricultural chemicals and use of artificial or processed fertilizers.

Commercially, organic growers in Tennessee are certified by the Tennessee Land Stewardship Association. There are currently three levels of certification. More information may be obtained from T.L.S.A., P.O. Box 328, Bell Buckle, TN 37020

Organic Gardening and Pesticides

Organic gardening rejects the use of all artificial agricultural chemicals, including pesticides used to control insects, diseases, weeds and nematodes, as well as other agricultural chemicals used to affect physiological processes and conditions such as flowering, fruit color and firmness. Organic gardeners differ concerning which, if any, naturally derived pesticides are permissible and when and how they may be used. Recent trends have been toward using fewer pest control agents in organic gardening, regardless of their origin.

Organic Gardening and Fertilization

Most organic gardeners consider soils to be a living, biotic system and reject artificial chemical fertilizers as too harsh to be applied to living soils. Organic gardeners emphasize building soil organic matter and then rely on natural sources of supplemental nutrients.

Why Garden Organically?

Quality

Organic gardeners generally feel that organically grown food is superior to non-organically grown food with respect to one or more components of quality. Some would argue that organic food has higher nutritional quality or better taste; however, there is no evidence to support this. Since plants take up nutrients dissolved in water as ions, and ions from all fertilizer sources are identical, there is no reason to suspect taste or nutritional differences directly because of nutrient source. Organic fertilization can, however, affect soil organic matter content, structure, moisture retention and nutrient release. Some of these may affect plant vigor, cell size or content, thereby indirectly affecting nutritional quality or taste. Very possibly, any effect on nutritional quality or taste is the result of organically grown vegetables being locally grown and thus fresher. Both nutrient content and taste are generally at a maximum at harvest and decline thereafter.

Many people garden organically partially because of concern over pesticide residues on food, or in soil or groundwater. However, careful use of pesticides according to their labeled instructions need not leave residues in soils or groundwater. Furthermore, the residues found in food are generally believed to be much higher than they really are. One should also remember that residue tolerances for food are generally set at only 1/100 of the amount thought to be harmful.

A discussion of the effect of organic gardening on food quality should not end without mention of insect and disease damage. Organic gardeners are generally willing to tolerate some damage that traditional agriculture perceives as reduced quality. Organic gardeners generally feel occasional insect or disease injury or reduced color and shelf stability are worth the environmental benefits of growing vegetables organically.

Effect on Soils

There is little doubt that organic gardening improves soils because of the emphasis on increasing soil organic matter. Increased soil organic matter improves soil tilth and structure, improves water retention, evens out nutrient release and may reduce erosion and run off. It should be pointed out, however, that the heavy applications of manure sometimes used by organic gardeners can create their own run-off problems.

Psychological Effect

A final reason for organic gardening, and perhaps one of the best reasons, is that it helps some people feel safer. When gardening organically, they no longer worry about damaging their environment or family with chemicals. There seems to be little harm in this, as long as gardeners realize that even organic products must be used as they are designed and labeled to be used and can be harmful if misused.

Limitations of Organic Gardening

Lack of Organic Alternatives

Some pest problems are easily controlled by organic alternatives. Others are controlled only with difficulty or have no reliable organic controls. Some crops either must be avoided by organic gardeners or these gardeners must be willing to risk significant losses from pests.

Climatic Effect

Climate varies regionally and annually. A pest may pose little or no problem in one climate but be a severe problem in another. Aphids, for example, require high humidity to shed their skins and are not a severe problem in regions of low humidity. They are, however, a severe problem in Tennessee and much of the humid Southeastern United States.

Even within a single state, climatic factors vary with altitude, nearness to bodies of water, slope of the land, etc. These differences also affect plant susceptibility to problems and limit the effectiveness of organic controls as well as chemical controls.

There are also annual climatic differences which affect host and pest. An organic control measure that works well one year may not work well the following year because of this climatic variation.

Population Cycles

Natural populations tend to expand until they are limited by their food supply or by another organism. An insect species, for example, may have only scattered individuals in an area, but have ample food. Its numbers increase rapidly for a few years and it becomes abundant. It then either consumes most of the available food or becomes infested by a disease organism and most individuals die. The remaining scattered population then begins a new cycle. The significance of this for organic gardeners is that a pest may be much more severe in one year than in another. It is difficult to determine how well an organic control is working because of these natural population cycles.

Inability to Tolerate Damage

Many organic control methods rely on maintaining an equilibrium between pest and host. This means the organic gardener frequently must be willing to tolerate some damage. How much damage will be tolerated depends on the individual and also on whether or not any produce is to be sold. Consumers frequently complain if even a single insect or fraction of an insect is found, and lawsuits are not unknown.

Cost of Organically-Grown Vegetables

It would seem, at first, that not using agricultural chemicals or commercial fertilizers would reduce the cost of organically grown vegetables. This is seldom the case. Organic vegetables are often more expensive than traditionally grown vegetables for several reasons.

First, organic sources of nutrients or organic pest control measures are often more expensive than traditional sources. Second, marketable yields are frequently less with organic production. Lastly, organic produce may not store or ship as well as traditional produce.

Sources of Nutrients and Organic Matter

Organic production frequently relies, at least partially, on manure, organic material and nutrients brought in from outside the growing area. These resources are limited and may restrict the expansion of organically-grown vegetables. Increased use of cover crops, green manure crops, crop rotation, etc. can minimize the effect of the limitations of natural resources.

Despite the limitations of organic gardening, there are many proven techniques that will reduce the need for artificial pesticides and improve soils without artificial fertilizers. We will now examine some of these.

Alternative Means of Pest Control

Choose Vegetables and Varieties Wisely

A few vegetables can frequently be grown without serious damage from insects and diseases. Examples include beets, carrots, garlic, okra, onions, radishes and many herbs. Many other vegetables are susceptible to frequent attack by a number of insect or disease organisms.

Grow Resistant Varieties

The University of Tennessee Agricultural Extension Service factsheet SP277-K, "Disease Resistance in Recommended Vegetable Varieties for Home Gardens," lists more than 50 varieties of 21 vegetables reported as resistant to one or more diseases. Many of these varieties have resistance to three or more diseases. It is important to remember that resistance is not immunity. A resistant variety will probably not totally escape a pest, but may be attacked later or bear a fair crop despite being attacked by the pest. Selecting vegetable varieties resistant to several pests is well worthwhile if you desire to reduce the use of plant protective chemicals.

Grow Hybrid Varieties

Hybrid varieties are often more pest resistant than non-hybrid varieties. This is because hybrids are crosses of true breeding lines. They are frequently selected to contain specific pest resistance from both parent lines. Hybrids also tend to be high-yielding, earlier-bearing and longer-living than non-hybrid vegetables, when grown under favorable conditions. Their increased vigor may permit them to tolerate or outgrow a minor attack.

Unfortunately, many organic gardeners prefer non-hybrid varieties. Hybrid varieties do require favorable growing conditions to reach their full potential. They also must be grown from purchased seed, which is expensive because of the labor involved in making the crosses necessary to produce the seed. Plants grown from seed saved from hybrid varieties will vary in numerous characteristics rather than being identical to the parent plants. Saving seed of hybrid varieties is not recommended.

Despite these disadvantages, hybrid vegetables are generally a wise choice for gardeners. They have increased vigor, pest resistance and longevity, and seem to be equal in taste and nutrition to non-hybrid varieties. The fruit, in fact, frequently has improved shelf life and improvements in both appearance and quality.

Obtain Quality Seed and Transplants

A last consideration in the choice of vegetables and varieties is the source of the vegetable seed or transplants. Seed collected locally may carry a wide range of diseases. It may not be true to type and will not germinate well unless it is stored properly.

Commercially produced seed is much less likely to carry diseases, because the seed are produced in areas having low humidity where diseases and insects are much less common. Also, obviously diseased or off-type plants are rogued out before they produce seed. These seed are also packed and stored properly, so they will germinate well.

Inspect transplants for the presence of insects, leaf spots or yellowing and dying leaves. Never purchase transplants showing signs of insect infestation or diseases. Young, vigorously growing transplants in individual cells of a cell pack are likely to grow most vigorously; bare-root and older plants, least vigorously. Inspect the roots of bare-root plants and do not buy them if the roots have dried and died.

Use Cultural Controls

A wide range of cultural techniques can be used to reduce problems of home gardens. Methods of control vary considerably from one pest to another, depending on the kind of pest, the vegetable affected and the interaction of the two. The damage or loss of one or a few plants is usually considered insignificant. Control measures are generally aimed at saving the majority of the crop rather than individual plants. Most control measures aim at helping plants avoid contact with pests, as well as eradicating or reducing the numbers of pests in the area. These methods include sanitation, proper row spacing, varying planting dates and seeding rate, crop rotation, planting on raised beds, adding to soil organic matter, using mulches, irrigating properly and many others. Most cultural pest control methods are effective against more than one type of pest. Gardeners should be familiar with them and use as many as possible.

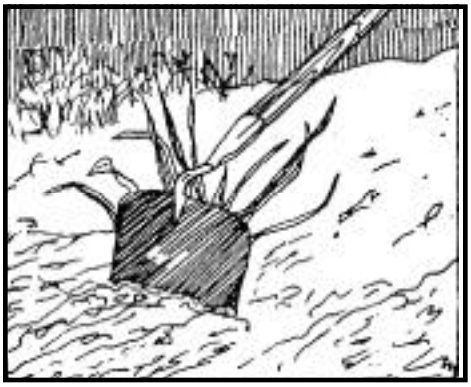

Figure 1. Control weeds mechanically while they are small to reduce the need for herbicides.

Eliminate Plant Debris

Many insects and diseases survive on plant residues. Their numbers decrease markedly as the decay process proceeds. Begin by maintaining the garden area free from plant debris. Mow or mechanically remove weeds before they produce seed. Individual plants of some weeds can produce as many as a million seed. Remove dead, dying and spent vegetable plants from the garden or chop them into pieces and turn them under as soon as harvest is complete. This will speed up decay and reduce potential for disease and insect buildup by removing overwintering sites of insects and diseases.

Multiple plowings or tillings will not only insure that all plant residues are worked into the soil where they will rapidly decay, but will mechanically eliminate many soil insects such as grubworms, cutworms and wireworms. Working the soil several times is especially important in gardens that have previously been in sod for several years, as soil insects are likely to be present in the sod in large numbers. Weed seeds will germinate as they are brought to the surface and be killed as the soil is worked. This can reduce future weed problems.

Soil free from surface plant debris and organic mulches will also dry out earlier in the spring so it can be worked and planted. This is important because cool-season crops must be planted early if they are to mature before summer heat halts their growth and reduces yield and quality.

Increase Soil Organic Matter

Turning plant debris under also increases soil organic matter. This is discussed in considerable detail in the "Managing Soils Organically" section of this publication (p 17). The primary concern here is the effect of soil organic matter on nematode populations. Increasing soil organic matter has been widely reported to reduce nematode populations. Organic matter apparently enhances the environment for other organisms that feed on nematodes or directly inhibits their growth. Plantings of wheat, oats, cereal rye or French marigolds seem especially effective in reducing nematode populations when grown in mass plantings and turned under several weeks before the gardening season. There is no evidence indicating that scattered marigolds growing in a vegetable garden will significantly reduce insect or nematode populations. For more information on nematodes, see Extension factsheet SP341-L, "Nematode Control in the Home Garden."

Rotate Plant Families

Rotation of plant families (closely related plants) is yet another means of reducing insect and disease problems. Families of plants tend to be susceptible to many of the same insect, disease and nematode problems. By grouping vegetable plants into families and moving each family to a different location within the garden every year, many insect and disease problems can be reduced. Table 1 lists several vegetable groups which can be rotated to help reduce pest problems.

Table 1: Examples of Crop Groupings to Reduce Diseases[1]

Group	Crop	Disease(s) Reduced
Group A	Cantaloupe	Microdochium Blight
	Cucumber	Fusarium Wilt
	Pumpkin	Gummy stem blight
	Squash	Anthracnose
	Watermelon	Scab
		Belly rot
		Angular leaf spot
		Nematodes
Group B	Brussels sprouts	Black leg
	Cabbage	Club root
	Cauliflower	Black rot
	Collards	
	Lettuce	
	Mustard	
	Radish	
	Rutabaga	
	Spinach	
	Swiss chard	
	Turnip	
Group C	Eggplant	Bacterial canker
	Irish potato	Early blight
	Okra	Nematodes
	Pepper	Potato scab
	Tomato	
Group D	Beet	Scurf
	Carrot	Black rot
	Garlic	Wilt
	Shallot	Nematodes
	Sweet potato	
Group E	Sweet corn	Smut
Group F	Bean	Fusarium root rot
	Cowpea	Nematodes
	Peas	Anthracnose

[1] Rotate to a crop in a different group when planting successive crops in the same location in the garden

Avoid Stress

Healthy plants withstand or outgrow problems better than stressed plants. Maintain optimum growing conditions to reduce plant stress whenever possible. Develop soils with proper pH, organic matter content, particle size, particle arrangement (structure) and fertility as recommended in the "managing soils" section of this publication. Garden only in locations receiving six hours or more of sunlight daily. Sidedress with nitrogen-containing fertilizers or compost (see Table 5). Choose a well-drained site or plant on ridges to improve drainage. Plant. recommended varieties at recommended dates, planting depths and spacings. Avoid purchasing plants that have been stressed. See Extension PB 901, "Growing Vegetables in Home Gardens," and SP 291-A, "Growing Vegetable Transplants for Home Gardens," for specific recommendations. Supplement rainfall with irrigation when necessary. Control weeds while they are small, and insects and diseases before they become severe. The result will be vigorous plants better able to withstand occasional stress.

Try Companion Planting

Companion planting is the concept of planting plants together for their mutual benefit. A tremendous amount has been written about companion planting, but very little has actually been proven about its benefits. It is obvious that shade-loving plants in the forest benefit from taller plants that shade them. It seems reasonable that deep-rooted plants absorb nutrients from deep soil layers and deposit them on or near the surface as they decay. These nutrients can then be used eventually by shallow-rooted plants. Some plants may benefit other plants by attracting or repelling insects, diseases or nematodes by scent, color or various secretions. There is, however, little consensus as to what combinations are beneficial, and specific companion planting recommendations will not be made here.

It is known that black walnut trees produce a substance that inhibits growth and causes wilting of many plants. Avoid planting vegetables, especially tomatoes, near black walnut trees.

Use Intercropping

Raising two or more crops in the same area at the same time is called intercropping. Intercropping can reduce a wide range of pest problems. Common examples of intercropping include either pole beans or pumpkins planted with corn, and a cool-season vegetable such as lettuce or radishes planted between tomatoes. The cool-season vegetable will mature and can be harvested before the tomatoes need the space.

Insects seem to recognize large areas of a single vegetable more easily than isolated plants or interplanted combinations of several vegetables. Insects and disease may also spread more slowly when infesting interspersed host and non-host plants than when in large areas of only one vegetable.

Time Plantings Carefully

Careful timing of plantings is an excellent way to reduce the severity of some problems. Cutworms, aphids and root maggots, for example, tend to be more severe early in the spring and decline in severity as temperatures increase and rainfall decreases. Corn, however, usually suffers less damage from corn earworm, European cornborer and armyworms when planted early. The later corn is planted, the more severe the damage from these insect pests becomes. Virus diseases and pickleworms also tend to increase with later plantings of the vine crops. Know your potential problems and time plantings to avoid them when possible.

Time Irrigation Properly

Many people believe that watering during the hot part of the day causes plants to "burn" or die. There is very little, if any, evidence that this is true. Watering when it is hot or windy will increase evaporation and waste water, but is unlikely to directly harm plants. Watering late in the evening may increase disease if plants remain wet at night. Any kind of water application that wets foliage is likely to increase plant foliage diseases somewhat. Trickle, drip or furrow irrigation conserves water and avoids increasing foliage disease problems, but can contribute to root rot problems. Sprinkler irrigation is probably best done during cool, non-windy morning hours.Another common error in timing irrigation is to apply small amounts of water every day or two. This works well when using drip or trickle systems where a small amount of water will soak deeply into the soil. When using sprinkler irrigation, however, apply 1 to 1 1/2 inches of water at one time and then wait several days until the soil surface dries before irrigating again. Less frequent irrigation will be less likely to increase plant foliage and root diseases and will not create a shallow layer of moist soil over drier, deeper layers. Plants will then be less dependent on frequent watering for growth and even survival.

Provide Air Circulation

The longer a plant remains wet, the more likely it is to develop a disease problem. Good air circulation is vital if plants are to dry off promptly and avoid undue disease problems. Planting on slight slopes or ridges will help. Morning sun is also important in drying surfaces as soon as possible. Planting at recommended spacings is very important, as are properly pruning and supporting plants off the ground. A pruned and supported tomato, for example, receives better sunlight because of reduced foliage and better air circulation. Fewer aphids colonize the drier plant and it is easier to spray if sprays are used. The fruit are also held off the damp soil and are less likely to rot. If vegetable plants are spaced and supported properly, many problems will be reduced.

Use Mulches

Mulches may reduce certain pest problems, but can increase others. Mulches reduce plant stress, prevent weed growth and maintain soil moisture. They may reduce some insect and disease problems, as well as increase soil tilth and organic matter. Mulches are discussed more extensively in this publication under "Barriers" (p.11). The soils section of this unit also contains a discussion of mulches as they affect soils. Extension factsheet SP291-H, "Mulching Vegetable Gardens," discusses the benefits of mulches and how to mulch gardens with both organic and inorganic mulch.

Consider Using Solarization

Solarization offers one of the few non-chemical possibilities for reducing some soil insects, nematodes, diseases and weed seed simultaneously. This procedure requires bare, moist soil and the hottest possible temperatures. The best conditions for solarization are periods of bright, sunny weather, which generally occur during the long, warm days of summer. Begin the procedure in June or early July.

To solarize soil, first remove all vegetation. Work the soil as if it were to be planted, and water with as much water as it will comfortably hold. Cover the saturated soil with a sheet of clear plastic stretched tightly over the soil. Place 1 inch cubes of wood or plastic foam on the plastic about a foot apart. Cover the grid with another clear sheet of plastic so you have two sheets of plastic with a 1-inch air space between them. Seal the edges with soil. Leave the plastic in place one to two months. During sunny, hot days, the soil temperature should reach 120 degrees F, or more, at a 2-inch depth, which will reduce the population of many soil pests. If only a single sheet of plastic is used, temperatures will not be as high or stay high as long, and the treatment will be less effective. After solarization, it is very important that soil not be worked deeply. The deeper soil is worked, the more likely it is that disease organisms and weed seed will be brought to the surface where they will grow.

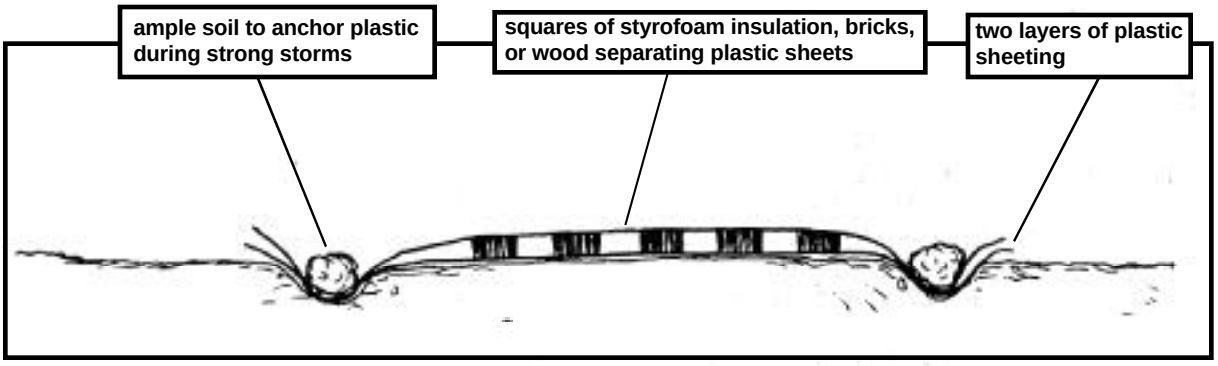

Figure 2. Soil solarization procedure.

Avoid Introducing Pest Problems

Plant diseases, nematodes, weed seed and even insects can be carried from place to place on equipment, introduced into the garden with transplants or moved by insects and human hands. Keep equipment clean. Remove soil from tillers and garden equipment after using them. This is especially important if they are to be moved between farms, fields or even parts of the yard.

Transplants grown in pasteurized soil or artificial media will be less likely to harbor pests. Purchase transplants certified free of insects and disease if possible. Always inspect transplants for the presence of insects and diseases before purchasing them.

Avoid the use of tobacco if you grow tomatoes, peppers or Irish potatoes. Tobacco contains tobacco mosaic virus (TMV) which will get on your hands and be spread to plants which you touch. Equipment, insects or anything touching an infested plant and then another plant is also likely to transfer the disease from plant to plant. TMV is very hard to control and reduces both fruit set and fruit size. Total yield of TMV-infested plants may be reduced slightly or nearly wiped out. Leaves of infested plants may be distorted and will probably have a mottled appearance rather than a solid green color. Remove isolated plants showing these symptoms as soon as they appear.

Use Plant Supports

Plant supports can be an important part of the organic garden. They make plants easier to tend and harvest and extend the harvest season. More importantly, supported vegetable plants have fewer disease and insect problems because of improved air circulation and less contact with wet, disease-infested soil.

Tomatoes, English peas, sugar snap peas, cucumbers and pole beans are some of the vegetables that are commonly grown on supports. These vegetables may be trained on a fence, in a wire cage or on a trellis. Pole beans may be grouped around individual stakes or several stakes may be pulled together at the top and tied for additional strength. Trellises may be constructed from cane supported by a wire on top, string woven between top and bottom wires or from nylon netting.

Tomatoes respond especially well to vertical culture, since many of the fruit may rot if they touch the ground. Tomatoes are usually supported by 5-or 6-foot stakes or a trellis. Use stakes at least 1 1/2 inches square and drive them a foot or more into the ground. Plants are pruned to one or two stems and tied loosely to the support at 8- to-12-inch intervals.

A second method of supporting tomatoes is with wire cages constructed from concrete reinforcing wire. Cages should be 20 to 22 inches in diameter, which requires a 6-foot length of wire bent into a circle. Firmly anchor each cage so it will not blow over. Cages may be anchored by tying them to stakes or by tying them to a wire that is attached to posts at each end of a row of cages.

Set a single tomato plant in each cage. Allow the plants to grow without pruning. Push the ends back into the cages as they grow out. Harvest fruit by reaching through the mesh.

Grow caged cucumbers like caged tomatoes but use a 10-foot length of concrete reinforcing wire. This will make a 3-foot diameter cage that will probably not need anchoring. Plant cucumbers 6 to 10 inches apart around the outside of the cage. Push the growing vine tips into the cage until they begin to climb. A small hollow in the center of the cage makes a convenient place to fertilize and water the cucumbers. Benefits of this system include more fruit, an extended harvest season, increased ease of harvesting and reduced disease pressure.

Other Alternatives

Several things can be done to prevent some insects and diseases from reaching plants. Methods of controlling certain insects without using insecticides are also available. Most of these are compatible with the organic gardening philosophy and can be of help to gardeners.

Barriers

Several types of barriers can be used to prevent certain insects from reaching a plant or plants. Small paper or plastic cups with the bottoms removed, for example, can be pushed into the ground around young transplants to protect them from cutworms. Aluminum foil wrapped around young plants will serve much the same purpose. Six-inch lengths of sewer pipe may also be placed over young plants as a combination cutworm barrier and windbreak. Nylon bird mesh or mesh berry baskets placed over the plastic cups or sewer pipe will protect young seedlings from birds.

Figure 3. Mechanical barriers can reduce cutworm damage to young plants.

Figure 4. Netting will prevent birds from feeding on bush fruits and small fruit-bearing trees.

Diatomaceous earth, a chalk-like substance consisting of microscopic, sharp, shell particles, sprinkled around young plants may protect them from slugs, snails and some soft-bodied insects. Wood ashes are reported to have the same effect.

Individual collars placed around cabbage or broccoli will frequently protect them from root maggots. Cut 6-inch squares or disks of foam rubber, carpet padding or tarpaper. Punch a small hole in the middle and make a slit from the edge to the hole. Fit the barriers tightly around vulnerable plants and cover each barrier with enough earth to hold it down.

Hot caps, small domes made of translucent paper, may also prevent insects or disease spores from reaching individual plants. Other barriers can protect entire rows of plants. Spun-bonded row covers, for example, can be placed over young plants of the cabbage family to exclude various cabbage feeding insects, or over cantaloupe and cucumbers to keep cucumber beetles off. Spun-bonded row covers should be applied loosely so they can be lifted by the plants as they grow. Heavy rain may cause the covers to become stuck to mineral soils, requiring re-loosening of the covers. Apply them immediately after planting before insects attack the plants. Remove covers from cucumbers and other plants requiring pollination when the plants begin to flower. Water will pass through spun-bonded row covers, but a small amount of heat will be retained as an additional benefit of this material. Controlling weeds growing beneath the covers may be a severe problem. Remove the row covers when it is cloudy and water the plants to reduce shock.

Mulches, both plastic and organic, can serve as a barrier against diseases that are spread partially by soil splashing onto plants. Early blight and buckeye rot of tomatoes are examples. Mulches will not eliminate these diseases, but may delay their onset and eventual severity. Organic mulch applied around tomatoes while the soil is still cool may delay ripening a few days, but black plastic mulch will warm the soil and speed ripening.

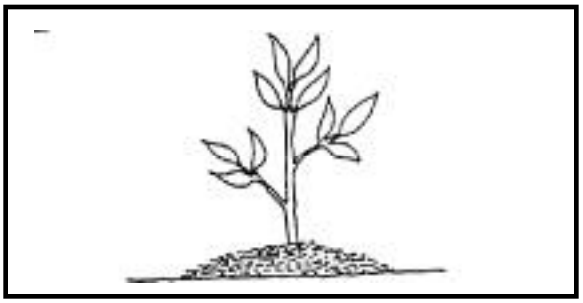

Figure 5. Apply organic mulches 2 to 3 inches deep around established plants after the soil warms up.

Mulches also reduce numbers of some insects, such as Colorado potato beetles, by preventing their emergence from the soil where they overwintered and by slowing their migration from weedy overwintering sites to plants in the garden.

Gardeners should be aware that mulches can serve as hiding places for some insects and increase the incidence of some diseases by retaining too much water around plant roots. Black plastic, for example, may increase damping off and root rot of peas and

beans, or bacterial diseases of tomatoes. This is especially true when it is used around seedlings growing in poorly-drained soil.

Repellents

It would be great to be able to use a repellent to keep insects from bothering plants but, unfortunately, there are no effective, broad-based repellents. Some gardeners have used solutions made from hot peppers, garlic or strong-smelling herbs to discourage insects. It is unclear whether these solutions are toxic to some insects, repel them or work at all. The Extension Service has no data regarding their usefulness but cautions that these solutions are seldom legal to use on vegetables grown to be sold.

Reflective plastic mulch in various colors and aluminum foil mulch can be used to repel thrips and aphids on some vegetables. Reducing aphid and thrips infestations may also reduce the spread of viruses carried by these insects. These mulches apparently confuse thrips and aphids, making it more difficult for them to locate vegetable plants.

Mulch the area under very young plants completely for best results. However, mulching too early may prevent the soil from warming up and delay maturity. It may also be necessary to provide holes in the mulch to allow moisture to reach the plant roots.

Numerous repellents have been used to keep moles from gardens. These include caster beans, gopher spurge, windmills, etc. Their common trait is that none of them produce consistent results. The best way to eliminate moles is to trap them. Mole traps are difficult to use properly, but can be very effective. More detailed information can be found in Extension factsheet SP293-A, “Mole Control in Tennessee.”

Traps

Shingles, boards and even inverted cabbage leaves placed in the garden will collect slugs, cutworms, squash bugs and other pests that hide in moist, dark places. They can be collected from these hiding places and destroyed by dropping them into a container of water covered with a thin layer of oil.

Pheromone traps are mechanical devices containing scents that attract a specific insect species. Pheromone traps are available for Japanese beetles and a wide range of other insects. The insects are enticed into the trap by the scent and are unable to get out. These traps attract pests from a considerable distance, but do not immediately catch all the insects they attract. They are best used some distance from the garden to attract the insects away from, not into, the garden. Pheromone traps may provide adequate control of several pest species.

Light traps have been used outdoors for control of various flying insects. There is little or no evidence that light traps adequately control many garden insects.

Sticky red spheres or sticky yellow traps will attract and trap a variety of insects. They are better used to monitor insect populations than to control specific insect species.

Baits

Sometimes pests can be attracted away from growing vegetables and killed. Some slug baits, for example, can be placed in small piles on boards or in containers. Slugs are attracted to these baits, eat them and die.

Another way to trap slugs is to place shallow containers filled with beer in the soil with the top of the container level with the soil surface. Slugs will be attracted to the beer and drown. A solution of 1 pound of sugar and 1 teaspoon of yeast in a gallon of water fermented two or more days works well. This makes use of both the trap and the bait concept.

All of these baits must be replenished frequently. Traps need to be cleaned and refilled. Baits will last longer if some sort of a cover is provided to keep rain from diluting or destroying them.

Birds

Many birds eat large amounts of insects or weed seed. Encouraging these birds can greatly reduce insect and disease problems in home gardens. Encourage birds by planting berry-forming shrubs and small trees, by providing a source of water (a bird bath) and by providing nesting sites and birdfeeders. Extension factsheet SP239-D, “Building Bird Houses,” discusses construction of a wide range of bird houses and how to locate them.

Some birds also consume vegetables. Do not permit any seed to remain visible on the surface of the ground when planting vegetables. It may also be necessary occasionally to make use of netting or spun-bonded row covers to protect vegetables from birds. Imitation snakes, owls and hawks repel birds only if they are moved frequently from place to place and then only for a short time. Plastic foam cups inverted over corn ears after pollination may protect ripe corn ears from blackbirds.

Beneficial Insects

Most insects are neither particularly harmful nor beneficial to home gardens. It is important to identify the insects present in a garden to determine whether or not controls are needed. It is also important to study the insect's life cycle to determine how best to assist or control it. Table 2 lists some common beneficial insects and the pests they feed on.

Table 2. Some Common Beneficial Insects

Insects	Description	Pest(s) Controlled
Ground Beetles	Large, shiny, dark brown beetles	Feed on caterpillars, armyworms and cutworms
Ladybugs	Small, round, colorful beetles; blue-yellow striped larva	Feed on aphids, mites, scale and many insect eggs
Predaceous Stink bugs	Medical shield shape	Feed on many insects
Ambush Bugs	Large, dark bug with long, narrow head	Feed on whatever they can catch
Tachnid flies	Drab small fly	Parasitize many insect larvae
Lacewings	Stalked egg 1 inch long insect lacy wings	Feed on aphids, mites, scale insects and many insect eggs
Praying Mantids	3-inch long insect with triangular head	Many insects
Predatory Mites	Very small, 8 legs, not true insects	Spider mites

Some gardeners purchase and release various beneficial insects into their garden to control harmful insects. A variety of companies sell beneficial insects. Extension factsheet SP290-Z, "Commercial Sources for Predators and Parasites," lists several such companies.

Lady bugs and many other beneficial insects are extremely mobile and may not stay where you put them. Others such as preying mantids will consume each other. Introducing large numbers of insects into a small garden may be of limited value. Encouraging natural populations, however, can be very helpful. Begin by growing a variety of vegetables in the garden. Allowing natural vegetation to survive near the garden may increase beneficial insects, but may also increase harmful insects. To successfully use beneficial insects, you should learn not only which insects are beneficial, but also which host plants encourage which insects. Unnecessary chemical applications should also be avoided if beneficial insects are to be encouraged.

Handpicking

Gardeners may control some insects by handpicking. This method of control is most successful in small gardens and with large insects that are present in small numbers. Tomato hornworms, squash bugs, cabbage worms, Colorado potato beetles and other large insects may be controlled this way. After insects are removed from the plants, they may be killed by crushing or being dropped into a container of soapy

water or water covered with a thin layer of oil or kerosene. While handpicking squash bugs, also crush or remove the reddish or bronze egg masses found on or under the leaves.

Insects such as blister beetles and some caterpillars can sting or burn when they are touched. Wear gloves or learn to identify common garden insects.

Protective Chemicals

Sometimes the severity of a pest problem increases until the gardener must either actively control the problem or lose yield and quality. Following the basic principles of pest control will make control easier, more effective and less damaging to non-target organisms.

Begin by inspecting the garden frequently. Walk though it several times a week looking for weeds, insects, diseases, plants that need pruning or staking, rows that need thinning, etc. The first step in controlling a pest problem is to recognize its presence.

Next identify the problem. Many agricultural chemicals work on only one, two or a few pests. When the problem is identified, select a pesticide that will control the problem but damage few other organisms. A properly selected treatment is more likely to be effective and less likely to damage beneficial insects and other non-target organisms.

Line drawings of common garden insects and their description are shown in Extension PB 595, "You Can Control Garden Insects." This publication and other Tennessee publications mentioned are available to Tennessee residents at no charge at UT county Agricultural Extension Service offices. County Extension personnel can also assist in identification of insects, diseases and weeds.

Begin control practices early. Plant diseases can sometimes be halted, but they can seldom be reversed. If damage is too severe when control measures are begun, losses in production and quality will occur. Control insects while they are immature and few in numbers. The more mature the insects and the larger their populations, the more difficult they are to control.

Sprays are generally more effective in controlling insects and disease than dusts.

Sprays cover the complete surface of the plant. Sprays are also easier to apply to the bottom surface of leaves than dusts. Many insect problems begin on the bottom surface of the leaf rather than the top. Use the least toxic spray that will be effective. Sometimes a stream of water, horticultural oil or an insecticidal soap solution will be effective. Use the more toxic chemicals only when less toxic sprays will not do the job.

Lastly, always follow the label. Any material sold as a crop protection chemical in the United States must be registered with the Environment Protection Agency (EPA) and labeled. The label must be followed. Failure to do so is illegal and can be dangerous. Labels list time and rate of application and the vegetables and pests on which the product can be used. They also contain other information, such as safety precautions. Always read the label and use the chemical only where and how it is permitted. It is possible to cause severe environmental or bodily injury if agricultural chemicals are misused. In no case does the Agricultural Extension Service recommend the use of any plant protection substance in a manner inconsistent with its label.

Natural Protective Substances

Water

The simplest natural substance for removing insects from plants is water. A forceful stream of water may be applied to the underside of plant leaves with any type of sprayer or even with a hose and nozzle. Aphids, spider mites, thrips, whiteflies and other small pests can be dislodged and washed to the ground. Many will be unable to find their way back onto the plants and may die. Repeated treatments may be required to destroy all pests. More pests may hatch from eggs or mature from crawling stages that cannot be washed from plants. Be aware, however, that the more frequently water sprays are used, the more disruption of natural enemies may occur. Frequently, water sprays may also increase plant disease problems, especially if plants remain wet at night.

Bug Juice

Many organic gardeners have had success in controlling some insects using diluted solutions containing ground up caterpillars or mature insects. Anywhere from a few individuals to a half a cup of insects are collected and blended with two cups of water. The liquid is strained through cheesecloth, diluted and used to spray vegetable crops. Success is not consistent. Success is more likely if dead or dying insects are used, since they are more likely to be diseased and spread the disease to other insects. This technique may be more successful when used in combination with other biological sprays. Do not use your household blender.

Hot Pepper

Hot pepper sprays are also widely used by organic gardeners. One half cup, or more, of hot peppers are chopped or ground, then mixed with a pint of water. The mixture is allowed to stand a day or two, then strained and sprayed on the infested plant. Be careful not to get this spray in your eyes and be sure to wash your hands. Sometimes crushed garlic, onions or strong-smelling herbs are added to these sprays. There are many, many recipes that have been tried. A garlic repellent is also commercially available. Unfortunately, home remedies are neither labeled for use as pesticides, nor does The University of Tennessee have information concerning their effectiveness. Their use is not recommended.

Soaps

Many types of soaps have been used to kill, dislodge or repel certain garden pests. They vary greatly in effectiveness and in toxicity to plants. They are frequently effective against thrips and other small, soft-bodied insects such as aphids, mealybugs and whiteflies. Their disadvantages are that they are expensive and they need to be reapplied frequently, possibly every three or four days.

Several commercial brands of soap are especially formulated and labeled for use on garden vegetables. Some of these may be mixed with other pesticides to increase the effectiveness of both. Commercially labeled soaps are the only soaps recommended for use in the home garden. Be sure to use them only as recommended on the label.

Oils

More than one grade of oil can be used as a spray on horticultural plants. Most are heavy-grade oils suitable for use only on dormant plants. The newer, lighter-weight horticultural spray oils are thinner and can be tolerated by many growing plants. They work by suffocating mites, scales and soft-bodied insects, and may be the preferred method of controlling some scale insects. Use them precisely according to the label to avoid crop damage.

Mineral oils are also used to reduce corn earworm infestation. Two or three drops applied to corn silk with an eyedropper may protect the ear from infestation by corn earworms for a few days. Do not apply until the silk has wilted and begun to turn brown on the ends or pollination may be affected.

Microbial Agents

"Bacillus thuringiensis" (Bt) is a type of bacterium that kills certain harmful insects and is harmless to beneficial insects. The most common forms of Bt are sold under the tradenames Dipel™, Thuricide™ and MVP™. They are effective against the larva of butterflies and moths and may be used on a wide range of plants. They can be reapplied as plants grow within the limits listed on the labels.

A new form of Bt, sold as M-one™, is effective against Colorado potato beetles. Other forms of the bacterium are being investigated and may soon be available to control additional insects.

Another bacterium, "*Bacillus papillae*", causes milky spore disease in grubs of Japanese beetles. This product is commercially available as Doom™ or Japademic™ but may be very hard to locate. The powder is applied to the ground and, in time, infects the grubs over large areas. Once established, the bacteria may survive in the soil for several years.

Sulfur

Sulfur may be used to control certain fungal diseases of a variety of vegetables, fruits and grains as well as several kinds of mites. It is one of the few substances used by organic gardeners to control diseases. Some organic gardeners do not use sulfur because of the possibility that it might disrupt soil microorganisms. It can also have a negative effect on beneficial insects and burn plants when used during hot, humid weather. Products that contain sulfur include Wettable Sulfur (recommended for commercial use only), Thiolux™, Lime-Sulfur and several combinations of sulphur and other materials generally acceptable to organic gardeners.

Copper

Basic copper sulfate, copper oxychloride sulfate and derivations of these products are used to control mildews, rots, blight and leafspots on many crops. These can be effective but may also damage plants. Be sure to follow the label precisely and to observe all precautionary statements.

Other Protective Chemicals Used by Organic Gardeners

Sodium hypochlorite, also called common household bleach, has been used as a seed treatment. Seeds are soaked for one minute in a solution containing one part bleach and 10 parts water. This solution may also be used to sterilize pruning shears, grafting

tools and seeding containers to reduce the spread of disease-causing agents.

Avermectin (Avid™) is a product used in commercial crop production. The chemical is produced by bacteria and is used to control leafminers and spider mites. Sodium aluminofluoride or cryolite (Kryocide™) has been used for many years in organic crop production. This product is used to control several types of insects on a wide variety of crops.

ClandoSan™ is a chitin protein found in crustacean shells and is labeled for nematode control. ClandoSan™ is a new product still being evaluated. The product acts to stimulate the growth of certain soil microorganisms that produce chitanase and other enzymes that destroy plant-pathogenic nematodes.

Botanically-Derived Chemicals

Several insecticides are extracted from plants. These are frequently referred to "botanical insecticides." Five of the most common include pyrethrin, rotenone, ryania, sabadilla and neem. These are sometimes used by organic gardeners because they are effective against many insect pests and because they quickly break down into substances thought to be harmless. Gardeners should follow the same precautions when using these insecticides as when using any other insecticide. Always follow the label. Use the insecticide only on the vegetables, at the times and in the concentrations for which it is labeled. Even botanicals are toxic and care must be followed in applying them. Special restrictions should be noted if environmental damage is to be avoided. Rotenone, for example, is 10 times more toxic to people than Malathion and is very dangerous to fish. Sabadilla is toxic to bees. Lastly, remember that botanical insecticides will not differentiate between beneficial and harmful insects and may severely damage populations of beneficial insects.

Managing Soil Organically

Introduction

Soils consist of a combination of gases, water, minerals and organic compounds. They vary greatly in how much of each of these they contain, the size of the particles, particle arrangement and in the composition of each of the four individual components. There are also differences in the amount and types of living organisms found in soils, in the ability of soils to hold or release water and in nutrients.

Soils are important to plants because they provide support and supply plants with water and nutrients. Growing plants remove large amounts of water and smaller amounts of nutrients and gases from soils. The nutrients removed are especially significant when plants or plant parts are harvested, as is the case with gardening. Therefore, gardeners must return nutrients to the soil and maintain the soil's ability to retain them until they are required by growing plants. There are two approaches to this problem, that of traditional agriculture and that of organic farming and gardening.

Traditional agriculture views soil as a relatively inert holder of moisture and nutrients. Effort is made to conserve the soil, maintain its structure and resupply nutrients and water as they are removed. The easiest and cheapest way to supply water is through irrigation. The easiest way to supply nutrients is in the most concentrated form, high-analysis chemical fertilizers.

Organic gardeners consider soil to be a complex system which includes lifeforms, gases, water, minerals and organic materials. Chemical fertilizers are viewed by most organic gardeners as too harsh to be applied to living soils. They are believed to contribute to the loss of proper soil function and to restrict the life processes of beneficial organisms that recycle nutrients and contribute to the health of living soils. This section will attempt to assist the organic gardener in maintaining or improving the ability of garden soils to support and provide nutrients to vegetable plants.

Maintaining or Increasing Soil Organic Matter

High soil organic matter is the basis of managing soils organically. Organic matter improves soil structure so it will hold water and oxygen and be easier to work. It greatly increases the microbial content of soils, which is sometimes thought to reduce a plant's chances of becoming diseased. Most importantly, soil organic matter plays a large role in storing and releasing nutrients for plant use.

Soil organic matter is a product of the decay of plants and animals. It usually includes a large number of things in various stages of decomposition. Most plant and animal materials break down rapidly at first, then more slowly as the easily decomposed parts disappear. All of these plant and animal residues are collectively referred to as organic matter. The fraction of organic matter in a relatively advanced state of decay, now decaying only slowly, may be referred to as humus.

The amount of organic matter in a soil is a balance between the amount produced and the amount lost, mostly through decomposition. More is produced with long growing seasons and soils that support vigorous plant growth. More is lost in warm-moist climates, and in soils rich in oxygen and soil microorganisms. Coarse soils usually contain less organic matter than fine soils. The more soil mixing that occurs, the greater the potential for decomposition. Because Tennessee has a warm, moist climate, relatively large amounts of organic matter are decomposed annually. Because of this, organic matter will quickly decrease to less than 1 percent in Tennessee soils unless it is replaced.

Organic gardeners utilize a wide range of procedures to increase soil organic matter. Some of these follow.

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Using Crop Residues

Crop residue is the portion of plants remaining after harvest. This residue is a significant source of organic material. It can be left on the surface where it grew, used as a mulch, composted or turned under. Leaving crop residue on the soil surface where it grew or around plants as a mulch allows it to help control soil erosion. Breakdown of the organic material is slowed so total soil organic material increases. It may, however, increase insect, disease and weed problems due to these pests overwintering in this debris. Turning crop residue under breaks it down faster, which may release nutrients. Some insects and diseases are also less likely to survive if their host plant material is eliminated.

Crop Rotation

Crop rotation is a regular scheme of planting requiring that a different crop be grown in a given location each year for two, three, four or more years. The section concerned with pest control (p 8) discusses rotation for that purpose and makes specific recommendations concerning groups of plants to rotate. Crop rotation can also play a part in maintaining soil high in organic matter and fertility. Some vegetables, such as Irish potatoes, tomatoes, cantaloupe, corn and the cabbage family, are heavy feeders and remove large amounts of nitrogen, phosphorus and potassium from the soil. Others, such as root crops and herbs, are light feeders. Legumes have the ability to absorb and hold nitrogen from the air and can actually add nitrogen to the soil. One might plant heavy-feeding vegetables in a given area the first year, a legume green-manure cover crop the second year and light feeders the third year. This is an example of a three-year rotation.

Green-Manure Cover Crops

Green-manure cover crops are usually planted in late summer or early fall and plowed under either late in the fall or several weeks before spring planting. They provide large amounts of organic matter, some nutrients and protection from erosion over the winter. They are useful to gardeners trying to improve their soils, especially those who are unable to compost enough material for their large gardens. They may also be used over the growing season in a rotation system designed to control plant pests or improve soils.

There are two types of green-manure cover crops, legumes and non-legumes. Legumes can add nutrients to the soil because they have root nodules that contain nitrogen-fixing bacteria. They fix more nitrogen when mixed with a non-legume crop in the garden than when grown by themselves. It is not unusual for a mixed legume planting to fix 100 pounds of nitrogen per acre. Legumes may also have very deep roots, which improve soil drainage and bring up nutrients from the subsoil to levels where shallow-rooted plants can use them. Peas, beans, clover, vetch and alfalfa are examples of legumes.

The non-legumes used as green-manure cover crops are mostly grasses. They are grown because they are economical, easily established and can quickly produce large amounts of organic material. Examples include annual rye, oats, wheat and millet.

A list of suitable green-manure cover crops and some of their characteristics is contained in Table 3.

Table 3. Green-Manure Cover Crops for Tennessee Growers

Crop	Legume/ Nonlegume	Annual/ Perennial	Planting Time	Seed per 1,000 ft.	Comments
Alfalfa	Legume	Perennial	Spring or fall	1/2 lb.	Deep-rooted. Apply lime if pH is below 6. High in protein and nitrogen.
Buckwheat	Nonlegume	Annual	Late spring to early fall	2 lbs.	Deep-rooted. Attracts bees. Multiple crop possible.
Field Peas	Legume	Annual	Late spring to early fall	2 1/2 lbs.	
Crimson Clover	Legume	Annual	Aug. 15 Sept. 15	1/2 lb.	Does well in mixture of ryegrass. Hard seed may germinate over several years.
Annual Lespedeza	Legume	Annual	Spring or fall	1 lb.	
Millet	Nonlegume	Annual	May to July	1 lb.	Attracts doves.
Oats	Nonlegume	Annual	To Oct. 1	1 1/2 lb.	Will overwinter.
Annual Rye	Nonlegume	Annual	Sept. 15 Oct. 15	1/2 lb.	
Soybeans	Legume	Annual	Spring to mid-summer	2 lbs.	
Sudangrass	Nonlegume	Annual	April to July	1/2 lb.	

Many are available. They may be chopped or mowed with a rotary lawn mower if they are too tall to easily turn under. Do this before their seed matures.

Cover crops may also be chopped and left to decay on the soil surface. Allowing a cover crop to remain on the soil surface will provide about the same amount of nitrogen as turning it under, and may help to reduce erosion. It could, however, also provide a place for insects and disease pathogens to overwinter. A cover crop left on the soil surface will help retain soil moisture. This may be a disadvantage when planting an early, cool-season crop, but is an advantage later in the growing season. If cover crops are turned under, be sure to allow at least six weeks for them to decay before planting. This will reduce nitrogen tie-up problems.

The Effect of Mulches on Soils

There are two kinds of mulches, organic and inorganic. Black plastic is the most common inorganic mulch. It absorbs sunlight and increases soil temperature compared to un-mulched soils. In addition to controlling weeds and retaining soil moisture, mulch reduces erosion and the need to cultivate.

Plastic mulch is applied over moist, worked, fertilized soil a week or so before planting. Because soil beneath plastic remains moist, plant roots grow more profusely near the surface. Crusting is reduced. Earthworms and soil microbes are also encouraged by plastic mulches. The result is that soils beneath black plastic mulch generally are looser, easier to work and have better tilth than un-mulched soil.

Organic mulches have many of the same effects on soil as inorganic mulches. One major difference is that they are lighter in color than un-mulched soil and reduce the rate at which soil warms up. A second difference is that organic mulches will decay and can be worked into the soil at the end of the growing season, where they will add to soil organic matter. Plastic mulches will not decay and their removal and disposal should be considered when using them.

Almost any organic material may be used as a mulch. Some common organic mulches include grass clippings, hay, sawdust, pine needles, leaves, compost and newspapers. Fresh material, such as grass clippings, should be composted or allowed to dry a few days before use so it will not injure plants as it heats up. It should also be placed a few inches away from plants. A few sheets of newspaper may suffice as a mulch, but several inches of leaves or pine needles will be required as these materials settle. When materials high in carbon, such as sawdust, are used as a mulch, their decay will tie up significant amounts of nitrogen. Extra nitrogen should be supplied to avoid problems with nitrogen deficiencies. More information on using mulches in home gardens can be found in Extension factsheet SP291, "Mulching Vegetable Gardens."

Making and Using Compost

Compost is partially decayed organic matter. Composting greatly decreases the volume of organic material, making it easier to handle. Nutrient concentration and microorganism numbers are increased. Insects, disease and viable weed seed decrease and may even be eliminated. Materials such as manure or kitchen waste become more pleasant to work with. Sometimes the large mass of material produced in the garden or around the home is difficult to incorporate directly into the soil. This might be the case, for example, with cornstalks, grass clippings or leaves. A compost pile can be a convenient place to store these materials, as well as bulky materials brought in from elsewhere to amend soils.

Composting, however, is more than a way of recycling plant wastes. Compost builds soil structure, increases the ability of soil to retain water, reduces erosion, improves aeration and supplies nutrients. Nutrients from compost are supplied slowly early in the season when plants are small, then more rapidly as soils warm and plants grow faster. Certain nutrients continue to be supplied for several years as compost breaks down; thus, compost enriches soils in proportion to the amount used.

Almost any organic material can be composted, but avoid meat scraps, grease, bone and other animal remains. It is also best not to compost weeds with mature seed or diseased plants, since weed seed and disease organisms may not be destroyed during composting.

Begin by chopping or shredding the organic materials. This increases their surface area so microorganisms can break them down faster. The compost pile can be also be turned and kept moist more easily if it consists of small particles.

Build a 6-inch layer of plant residue, then cover it with a 2-inch layer of manure. Dried or dense plant materials tend to contain too much carbon and not enough nitrogen to compost rapidly. Unless nitrogen-rich materials are added, they will compost very slowly. Fresh manure, bone meal, cotton seed meal and other high-nitrogen, organic fertilizers can supply the needed nitrogen, as can large amounts of succulent plant material such as grass clippings. If manure is not used, a one-eighth inch covering of soil will provide needed microorganisms. A sprinkling of lime, phosphate rock, granite dust or wood ashes will increase the pH and mineral content of the pile.

Additional layers may be added to the height desired. Keep the pile moist but not soggy. It may heat up to almost 150° F in only a few days and begin to shrink in size. Turn it with a pitchfork after two or three weeks and again after five or six weeks. Be sure to place the outer parts of the pile toward the center when it is turned. The heat generated will kill many weed seed, insects and disease organisms. Compost made this way should be ready to use in three to six months. A pile of plant materials not chopped, amended or turned may require a year or two to compost properly. Compost is ready to use when the plant residues are fragmented, dark brown and have an earthy odor.

Use compost by working a 1- to 3-inch layer into the top 4 inches of soil a month or so before planting. Some gardeners use compost as a mulch around growing plants or as a sidedressing.

Organic materials may also be placed in a layer over garden soil and allowed to compost where they are to be used. This is called sheet composting. A more detailed discussion of composting is available in Extension PB 1479,"Composting Yard, Garden and Food Wastes at Home."

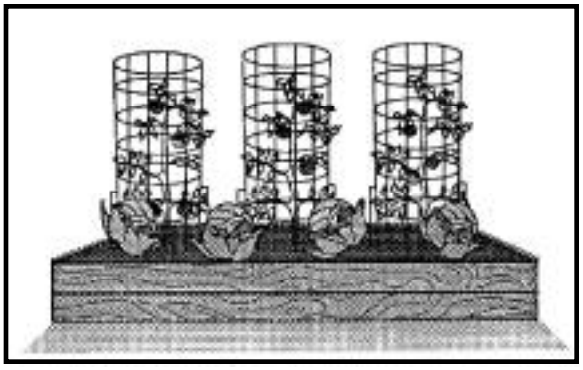

Figure 6. Raised beds are highly suited to organic gardening techniques.

Using Lime and Organic Fertilizers

Sometimes it may be desirable to add nutrients in a form more quickly available or more concentrated than those derived from the above soil-building techniques. It may also be desirable to adjust the soil acidity so the nutrients present are more available to vegetable plants. There are a number of ways to add nutrients and adjust soil pH that are acceptable to organic gardeners.

Increase Soil pH

Ground limestone (lime) is usually used to increase the pH of acid soils, thus making them less acid. The amount of lime needed depends on a number of factors, such as the current acidity level of the soil, the quality of the limestone and the soil it is applied to. The only really accurate way to know how much lime is required is to have a soil test done. Local county Extension offices can explain how to take a soil sample, where to send it for analysis and the nominal fee involved. Testing soil before applying lime is important because too much lime creates plant-growth problems very similar in appearance to too little lime.

Various liming materials are used to raise soil pH in addition to ground limestone. Organic gardeners, however, generally use only calcitic or dolomitic limestone. Calcitic limestone is essentially calcium carbonate. As it reacts in the soil, it frees calcium, an essential nutrient for plants. Dolomitic limestone contains both calcium and magnesium and can supply both of these to growing plants. Both kinds of lime are equally effective in raising soil pH, but some organic gardeners prefer not to use them.

Basic slag, a by-product of iron ore smelting, is sometimes used in place of ground limestone. It is about 70 percent as effective as ground limestone. Wood ashes are yet another substance having the ability to raise pH. Its efficiency varies depending on the type of wood, completeness of combustion, purity of the ashes and whether or not water has leached any of the materials out of them. Fresh hardwood ashes are about 30 percent or more as effective in altering soil pH as ground limestone. It is important that household ashes be spread over a considerable area and not thrown in the same place over long periods of time, as they may raise soil pH too high. Wood ashes also contain phosphorus and potash as listed in the organic fertilizer table of this publication.

Adding Nutrients — Manure

Manure is probably the most common organic fertilizer. It contains nitrogen, potassium and phosphorus ,as well as other essential plant nutrients and large amounts of organic material. These nutrients can be concentrated enough in fresh manure to burn tender plant materials or dilute enough in leached manure to make no appreciable differences in soil fertility levels. It is thus important to store manure out of the rain until it is used. The type of animal, its bedding, diet, age, and the amount of decomposition of the manure are some of the factors that influence nutrient content of manure. These variables make it difficult to accurately estimate the amount of nutrients contained in a given kind of manure. Table 4 contains some general estimates of the three primary nutrients found in various animal manures.

Table 4. Chemical Composition of Various Animal Manures[1]

Animal	Percent Water	Pounds Per Ton		
		Nitrogen	Phosphate	Potash
Broiler	25	34	37	30
Hen	35	47	60	24
Beef	80	14	9	11
Dairy	84	12	5	12
Horse	60	12	5	9
Sheep	65	21	7	19
Pig	75	10	7	13

[1] Varies greatly according to bedding material, moisture, length of storage, application method, etc.

Applying manure to vegetable gardens can be done in a variety of ways. We have already mentioned its usefulness in producing compost. A second way is to make a manure tea of 100 pounds of manure in a 60-gallon barrel of water. Let the solution steep for two or three weeks, then stir and use the solution to water plants. Manure may also be used to mulch plants, so long as it is kept several inches away from plants so it won't burn them.

The most common way to use manure is to spread it uniformly over the garden area several weeks before planting and to turn it under. Two hundred and fifty to 500 pounds of large animal manure per 1000 square feet will improve soil fertility significantly while adding considerable organic material to the soil. One hundred to 200 pounds of poultry manure will suffice.

Some vegetable crops respond better to manure than others. Squash, pumpkins, cucumbers, cantaloupe and watermelon respond especially well and are sometimes planted in hills or rows over concentrations of manure.

Corn, leafy greens and root crops also do well in manured soil. Irish potatoes and sweet potatoes are exceptions. Irish potatoes tend to develop scab and sweet potatoes to crack when fertilized with manure. Peas and beans require little if any supplemental nitrogen and do not respond well to manure applications.

Adding Nutrients — Non-manure

Organic gardeners use several substances besides manure to add nutrients to garden soils. Some are widely available, while others are available only via mail order or in small localized areas. The composition of these substance also varies widely. Some of the more commonly found organic fertilizers and the appropriate ranges of nutrient concentrations are given in Table 5.

Table 5. Percentage Composition of Common Organic Fertilizers

Fertilizer	Nitrogen(N)	Phosphate(P2O5)	Potash(K2O)
Blood meal	8-15	0-3	———
Bone meal	2-4	12-28	———
Cornstalks	0.75	0.5	0.9
Cottonseed meal	6-7	1-2	1 -1.5
Granite dust	———	———	3.5
Greensand	———	1 - 1 1/2	5-6
Guano	1/2 - 12	4-8	1-3
Oak leaves	0.8	0.35	0.15
Phosphate rock	———	25-32	———
Wood ashes	———	1-2	3-7

Also, remember that nutrients obtained from organic fertilizers will generally be much more expensive than the same nutrients obtained from commercial fertilizers. Rather than broadcasting these expensive materials over the entire garden, they can also be banded near the row or applied only to the area to be planted.

Gardeners must check their particular source of organic fertilizers to be sure how much nutrient they contain. Sometimes it is possible to use a single substance such as guano or cottonseed meal as a fertilizer. It may be necessary to mix a substance high in one nutrient with others to make up a complete fertilizer high in all three primary nutrients. You should also consider how quickly the nutrients will be released for plants to use. Fertilizers that dissolve, such as blood meal, release nutrients more rapidly than more stable substances, such as granite dust. The best organic fertilizers contain significant amounts of the three primary nutrients, some of which dissolve quickly and some very slowly.

Traditional agriculture considers only those substances containing one or more of the three primary nutrients as fertilizers. Many companies sell mixtures of the above substance designed to contain all three of the primary nutrients, i.e., designed to be complete fertilizers. Numerous other acceptable, complete organic fertilizers are derived from fish, fish products, seaweed and combinations of many organic substances. These will have three numbers on their container to express their nutrient content. The first number always represents the percent of nitrogen in the fertilizer. The second number represents the percent of phosphate and the third, potash.

Soil Amendments

Many organic gardeners broaden the definition of fertilizer to include anything added to the soil to improve fertility. Traditional agriculture considers substances such as lime added to the soil primarily to alter soil properties to be soil amendments. Organic gardeners sometimes use a wide range of products designed to add trace elements, vitamins or microorganisms to the soil or to assist various soil reactions. These substances are soil amendments. They are generally quite expensive and have little proven effect on soil fertility. There are a great many of them and they come and go very rapidly. The use of most of them is not recommended by The University of Tennessee Agricultural Extension Service.

References

Several fact sheets and publications referred to in this publication may be useful to organic gardeners. They may be obtained from your county Agricultural Extension Service. These include:

No.	Title
PB595	You Can Control Vegetable Garden Insects
PB901	Growing Vegetables in Home Gardens
PB1215	Disease Control in the Home Vegetable Garden
PB1228	Gardening for Nutrition
PB1479	Composting Yard, Garden and Food Waste at Home
PB1622	Disease and Insect Control in Home Fruit Plantings
SP277-K	Disease Resistance in Recommended Vegetable Varieties for Home Gardens
SP290-Z	Commercial Sources of Predators and Parasites
SP291-H	Mulching Vegetable Gardens
SP291-I	Weed Control in Home Gardens
SP293-A	Mole Control in Tennessee
SP293-D	Building Bird Houses
SP341-L	Nematode Control in the Home Garden

Precautionary Statement

To protect people and the environment, crop protection chemicals must be used safely. This is everyone's responsibility, especially the user. Read and follow label directions, carefully before you buy, mix, apply, store or dispose of these chemicals. According to laws regulating them, they must be used only as directed by the label.

This information is directed at home gardeners rather than production for sale. State and federal regulations may regulate commercial production and should be consulted before considering commercial production of organic vegetables.

Visit the Agricultural Extension Service Website at: http://www.utextension.edu/

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