Chapter 25

ORGANIC GARDENING

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I. Organic Gardening Overview

A movement has been growing over the past several decades to produce food organically. The realm of gardening is no exception to this movement. Organic growing is more of a mind set rather than rules and regulations to be followed. It is striving to maintain a natural balance in the growing of plants. This natural balance involves soil, plants grown, water, insects, beneficial fungi, and bacteria, wildlife, and other components that complete the natural equilibrium of living things. It is a holistic approach that includes using local materials as much as possible to replenish what is taken away from the total system.

Organic gardening does not allow the use of synthetic fertilizers or pesticides in the production system.

Organic gardening requires an added time commitment. Since one cannot rely on quick fixes through the use of synthetic materials, gardening organically often involves much greater hand labor, at least in the first few years until the garden plot becomes more naturalized to the organic practices being used.

Weeding will generally be the major effort for the first few years, but insect and disease pressures can also take considerable time to get under control organically. Once the problems are recognized and methods developed to deal with them the time commitment is reduced.

Organic gardening has many similarities to conventional gardening, yet there are important differences.

A. Definitions—Legal definitions of organically produced agricultural products must be met if the produce is intended for market. Find further information on growing plants and animals to be marketed as organically produced at: http://www.agri.state.id.us/Categories/PlantsInsects/Organic/indexOrganicHome.php.

Levels of organic production fall within the realm of organic growing of food that do not necessarily qualify legally as organically produced commodities. This chapter will give you some of the basics of growing in the organic tradition.

Basically organic production means growing crops and animals without the use of synthetically produced materials. In Idaho organically grown food means food products produced without the use of synthetically compounded fertilizers, pesticides, or growth regulators for a period of 36 months prior to harvest. To produce commodities and market them as organic, one must follow established rules. (See section IV for Idaho information.)

B. Organic pesticides—Organic pesticides can be used by the organic gardener, but many problems exist that are difficult to solve without synthetic pesticides. Because of these challenges, it becomes very important to follow good husbandry practices when gardening in the organic tradition.

C. Site selection—The simple step of choosing a gardening site becomes very important when growing organically. If a poor site is picked the plants will be stressed and subject to insect and disease problems that may be very difficult to control. Weeds can also be a serious problem in an organic garden. Very few herbicides exist that are able to be used in organic production.

Pick a site with good soil, good drainage, and adequate sunlight. Try and find one with few weed problems, if possible, espe-
cially noxious weeds. If the soil is poor, be sure to add organic matter to help with the tilth, fertility, water holding capacity, and organic content of the soil.

II. Soil Fertility and Amendments

Organic gardening begins with the soil. The healthier the soil the healthier the plants and the better success the gardener will have, be it an organic garden or otherwise. Given the limited resources to deal with pest problems, maintaining the health of the plants becomes paramount.

Soil aspects of organic gardening will need at least yearly attention. The addition of compost and other organic material is very important to replace nutrients lost in the production and harvesting of garden produce. The sources of this organic matter may be leaves from the trees, vegetables, kitchen scraps, lawn clippings, compost in its various forms, as well as other organic material that may be locally available.

Table 1. Average plant food content of natural and organic fertilizer materials (Percentage on a dry-weight basis.)

<table>
<thead>
<tr>
<th>Organic materials</th>
<th>%N</th>
<th>%P</th>
<th>%K</th>
<th>Availability</th>
<th>Soil Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish scrap</td>
<td>5.0</td>
<td>3.0</td>
<td>0</td>
<td>slowy</td>
<td>acid</td>
</tr>
<tr>
<td>Fish meal</td>
<td>10.0</td>
<td>4.0</td>
<td>0</td>
<td>slowy</td>
<td>acid</td>
</tr>
<tr>
<td>Guano, peru</td>
<td>13.0</td>
<td>8.0</td>
<td>2.0</td>
<td>moderately</td>
<td>acid</td>
</tr>
<tr>
<td>Guano, bat</td>
<td>10.0</td>
<td>4.0</td>
<td>2.0</td>
<td>moderately</td>
<td>acid</td>
</tr>
<tr>
<td>Sewage sludge</td>
<td>2.0-6.0</td>
<td>1.0-2.5</td>
<td>0.0-0.4</td>
<td>slowly</td>
<td>acid</td>
</tr>
<tr>
<td>Dried blood</td>
<td>12.0</td>
<td>1.5</td>
<td>0.8</td>
<td>mod. slow</td>
<td>acid</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>7.0</td>
<td>1.2</td>
<td>1.5</td>
<td>slowly</td>
<td>v. sl. acid</td>
</tr>
<tr>
<td>Tankage, animal</td>
<td>9.0</td>
<td>10.0</td>
<td>15.5</td>
<td>slowly</td>
<td>acid</td>
</tr>
<tr>
<td>Tankage, garbage</td>
<td>2.5</td>
<td>1.5</td>
<td>1.5</td>
<td>very slowly</td>
<td>alkaline</td>
</tr>
<tr>
<td>Tobacco stems</td>
<td>1.5</td>
<td>0.5</td>
<td>5.0</td>
<td>slowly</td>
<td>alkaline</td>
</tr>
<tr>
<td>Seaweed</td>
<td>1.0</td>
<td>---</td>
<td>4.0-10.0</td>
<td>slowly</td>
<td>---</td>
</tr>
<tr>
<td>Bone meal, raw</td>
<td>3.5</td>
<td>22.0</td>
<td>---</td>
<td>slowly</td>
<td>alkaline</td>
</tr>
<tr>
<td>Urea*</td>
<td>45.0</td>
<td>---</td>
<td>---</td>
<td>quickly</td>
<td>acid</td>
</tr>
<tr>
<td>Castor pomace</td>
<td>6.0</td>
<td>1.2</td>
<td>0.5</td>
<td>slowly</td>
<td>acid</td>
</tr>
<tr>
<td>Wood ashes</td>
<td>---</td>
<td>2.0</td>
<td>4.0-10.0</td>
<td>quickly</td>
<td>alkaline</td>
</tr>
<tr>
<td>Cocoa shell meal</td>
<td>2.5</td>
<td>1.0</td>
<td>2.5</td>
<td>slowly</td>
<td>neutral</td>
</tr>
<tr>
<td>Cotton seed meal</td>
<td>6.0</td>
<td>2.5</td>
<td>1.5</td>
<td>slowly</td>
<td>acid</td>
</tr>
<tr>
<td>Ground rock phosphate</td>
<td>---</td>
<td>33.0</td>
<td>---</td>
<td>very slowly</td>
<td>alkaline</td>
</tr>
<tr>
<td>Green sand</td>
<td>---</td>
<td>1.0</td>
<td>6.0</td>
<td>very slowly</td>
<td>---</td>
</tr>
<tr>
<td>Basic slag</td>
<td>---</td>
<td>8.0</td>
<td>---</td>
<td>quickly</td>
<td>alkaline</td>
</tr>
<tr>
<td>Horn and hoof meal</td>
<td>12.0</td>
<td>2.0</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Milorganite</td>
<td>6.0</td>
<td>2.5</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Peat and muck</td>
<td>1.5-3.0</td>
<td>0.25-0.5</td>
<td>0.5-0.10</td>
<td>very slowly</td>
<td>acid</td>
</tr>
<tr>
<td>Spent mushroom compost</td>
<td>2.0</td>
<td>0.74</td>
<td>1.46</td>
<td>moderately</td>
<td>6.4</td>
</tr>
</tbody>
</table>

*NOTE: Urea is an organic compound, but since it is synthetic, it is doubtful that most organic gardeners would consider it acceptable.

Approximate nutrient content of soil amendment materials commercially available in bulk are listed in this table. It also gives information on availability of nutrients to soil and plants. Slowly available material means nutrients last relatively longer and are available to plants longer in the soil compared to quickly-released nutrients.

The soil reaction column indicates if the material will have an acidifying or alkaline impact on soil. For basic soils, adding acidifying material helps lower the pH.

Note: Tables 1, 2, and 3 are slightly modified from CIR375 of the Horticultural Sciences Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original published in April 1993, it was updated in May 2003. Find it at http://edis.ifas.ufl.edu.
Compost is organic matter that has been broken down by microbial action, insect, and other invertebrate animals. Composting is a natural process that can easily be accomplished by the home gardener. For detailed information on the art and science of composting refer to Chapter 7 on Backyard Composting. The composting of material treated with synthetic pesticides is not allowed in organic gardening.

Both inorganic and organic fertilizers can cause plant burn, groundwater contamination, excessive buildup of toxic materials in the soil, and plant nutrient excesses and deficiencies. To avoid these problems, it is important to have an understanding of the types and amounts of nutrients you are applying to the soil when you add any type of material to your garden.

Organic matter is the main source of fertility in organic growing systems. Since synthetic fertilizers are not permitted in organic gardening it sometimes becomes challenging to find and provide the necessary nutrients the plants need. Before planting the garden, it should be fertilized with needed components. Plants will get needed nutrients through the compost and other organic matter added yearly to the soil.

Usually plant nutrition is in the form of animal manures, plant manures, cover crops, compost, compost tea, or mixed organic fertilizer. Animal manures are generally the most complete source of nutrients for organic gardening but there are several other sources that can be utilized. Refer to tables 1, 2, and 3 to get a relative idea of which types of organic matter add what nutrients to the soil. There are mineral sources for certain nutrients for the organic gardener.

Green manures have been shown to benefit organic gardening. Not only do they add organic matter to the soil, many of them have the ability to reduce insect, disease, and weed problems. Members of the Brassica family, especially the oil seed radishes, contain natural chemicals that inhibit and kill soil-inhabiting pest problems.

The three tables that follow offer guidance on managing your compost piles to meet needs in your soils. Chapter 4 Soils and Fertility, page 8 in this book explains the significance of macronutrients N (Nitrogen), P (Phosphorous—designated P₂O₅ as phosphate in fertilizers), and K (Potassium—designated K₂O or potash in fertilizers).

### Table 2. Composition—fresh manure with normal quantity of water.

<table>
<thead>
<tr>
<th>Kind of manure</th>
<th>%Water</th>
<th>%N</th>
<th>%P</th>
<th>%K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow</td>
<td>86</td>
<td>.55</td>
<td>.15</td>
<td>.50</td>
</tr>
<tr>
<td>Duck</td>
<td>61</td>
<td>1.10</td>
<td>1.45</td>
<td>.50</td>
</tr>
<tr>
<td>Goose</td>
<td>67</td>
<td>1.10</td>
<td>.55</td>
<td>.50</td>
</tr>
<tr>
<td>Hen</td>
<td>73</td>
<td>1.10</td>
<td>.90</td>
<td>.50</td>
</tr>
<tr>
<td>Hog</td>
<td>87</td>
<td>.55</td>
<td>.30</td>
<td>.45</td>
</tr>
<tr>
<td>Horse</td>
<td>80</td>
<td>.65</td>
<td>.25</td>
<td>.50</td>
</tr>
<tr>
<td>Sheep</td>
<td>68</td>
<td>1.00</td>
<td>.75</td>
<td>.40</td>
</tr>
<tr>
<td>Steer or feed yard</td>
<td>75</td>
<td>.60</td>
<td>.35</td>
<td>.55</td>
</tr>
<tr>
<td>Turkey</td>
<td>74</td>
<td>1.30</td>
<td>.70</td>
<td>.50</td>
</tr>
</tbody>
</table>

This table gives an approximate amount of the noted nutrients that are added to the compost pile when composting fresh manure. The finished compost will vary in nutrient level depending on composting efficiency.

### Table 3. Composition of various materials thrown into compost piles.

<table>
<thead>
<tr>
<th>Compost material</th>
<th>%N</th>
<th>%P</th>
<th>%K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana skins (ash)</td>
<td>---</td>
<td>3.25</td>
<td>41.76</td>
</tr>
<tr>
<td>Cantaloupe rinds (ash)</td>
<td>---</td>
<td>9.77</td>
<td>12.21</td>
</tr>
<tr>
<td>Castor bean pomace</td>
<td>5.00</td>
<td>2.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Cattail reeds</td>
<td>2.00</td>
<td>0.81</td>
<td>3.43</td>
</tr>
<tr>
<td>Coffee grounds</td>
<td>2.08</td>
<td>0.32</td>
<td>0.28</td>
</tr>
<tr>
<td>Corn cob ash</td>
<td>---</td>
<td>---</td>
<td>50.00</td>
</tr>
<tr>
<td>Corn stalks &amp; leaves</td>
<td>0.30</td>
<td>0.13</td>
<td>0.33</td>
</tr>
<tr>
<td>Crabgrass, green</td>
<td>0.66</td>
<td>0.19</td>
<td>0.71</td>
</tr>
<tr>
<td>Eggs, rotten</td>
<td>2.25</td>
<td>0.19</td>
<td>0.15</td>
</tr>
<tr>
<td>Feathers</td>
<td>15.30</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Fish scrap</td>
<td>2.00-7.50</td>
<td>1.50-6.00</td>
<td>---</td>
</tr>
<tr>
<td>Grapefruit skins (ash)</td>
<td>---</td>
<td>3.58</td>
<td>30.60</td>
</tr>
<tr>
<td>Oak leaves</td>
<td>0.80</td>
<td>0.35</td>
<td>0.15</td>
</tr>
<tr>
<td>Orange culls</td>
<td>0.20</td>
<td>0.13</td>
<td>0.21</td>
</tr>
<tr>
<td>Pine needles</td>
<td>0.46</td>
<td>0.12</td>
<td>0.03</td>
</tr>
<tr>
<td>Ragweed</td>
<td>0.76</td>
<td>0.26</td>
<td>---</td>
</tr>
<tr>
<td>Tea grounds</td>
<td>4.15</td>
<td>0.62</td>
<td>0.40</td>
</tr>
<tr>
<td>Wood ashes*</td>
<td>---</td>
<td>1.00</td>
<td>4.0-10.00</td>
</tr>
</tbody>
</table>

The composition of materials commonly found in or near the home are listed. If your soil is deficient in a certain nutrient, add material to the compost pile that is high in that nutrient to raise its level in the finished compost.

*Note: Do not compost wood ashes if you are going to apply the finished compost to alkaline soil.
III. Dealing With Pests

The first approach to fighting pests is cultural control methods. In some cases this is the only option. For organic growing, the goal is to reach a stability or balance between pests and desirable plants. This balance comes about by maintaining diversity within the system. Reaching a good diversity level in a small garden plot is somewhat more difficult than in a large-scale operation, but it is a sound concept to strive for at any level of organic production.

The first thing to do is to be sure to practice crop rotation. Crop rotation is the practice of rotating different families of plants in the same area in the garden. For example, if you plant potatoes one year then tomatoes the next year you are planting crops within the same family. This encourages both soil borne and above-ground pests that cause problems in this family to increase.

On the other hand, following carrots, which tend to compact the soil, with corn, which tends to loosen the soil, helps soil tilth. Very few pests attack both of these crops.

- Higher crop yields—Through crop rotation the garden area reaps several benefits. Higher crop yields have been demonstrated when crops are rotated.
- Microbial biomass—There is also an increase in soil microbial biomass, which helps ward off soil borne diseases and increases carbon dioxide generation.
- Nitrogen increase—There is also an increase in soil nitrogen (related to the increased microbial biomass), which can decrease the need to add additional nitrogen.
- Drainage and moisture-holding—Crop rotation has also been demonstrated to increase drainage and moisture holding capacity and reduce soil compaction.
- Weed suppression—Another great benefit of crop rotation is in weed suppression. Different crops are prone to different types of weeds. For example squash is considered a weed suppressive crop because it shades the ground and inhibits weed seed germination while corn is generally widely spaced and takes some time to grow sufficiently to shade out weeds.

IV. Pest Control Strategies, Idaho Information

One may think that any organic substance would be allowable for use in organic production. This is not the case. For example, tobacco dust (nicotine sulfate) is not allowed in Idaho because of its extreme toxicity. Federal and state regulations list what materials may be used in organic food production. In Idaho, get detailed information by writing to IDA Division of Ag Inspection, PO Box 790, Boise, Idaho, 83701-0790.

V. Weed Control

Weed control is probably the most challenging part of organic gardening. Very few acceptable organic chemical controls are available for fighting weeds.

A. Vinegar—One notable exception is vinegar, which has been shown to control many annual weeds when used at 10 to 20 percent strength. Household vinegar is typically about 5 percent. In its concentrated state, vinegar can cause burns and eye damage. Availability is somewhat limited, but as the demand grows it will become more available in local nurseries. Sources can be found on the Internet. As with any pesticide, care should be taken when using vinegar for controlling weeds.

B. Corn gluten—Corn gluten is another herbicide that may be used in organic growing. Used as a pre-emergent, it has been shown to be effective against a large number of weeds. It reduces weed seed germination with no apparent effects on transplanted materials. It is also effective in lawns as a pre-emergent herbicide. Corn gluten can usually be found in well stocked nurseries and also on the Internet.

C. Cultivation—The most common way to control weeds is through cultivation. In small garden plots, the hoe becomes your best friend. In larger gardens, a rototiller can be used effectively, especially if crop rows are properly spaced. A drawback to the use of rototillers is that they can damage crop roots if you go too deep or too close to desirable plants. Another disadvantage is that you can create a hardpan in your soil through the repeated use of a rototiller. As
the tines go down into the soil and rotate they tend to compact the soil just below the depth of the cultivation. Overall, however, rototillers are a great asset in the battle against weeds.

D. Mulching—Mulching is a very effective way to keep weeding to a minimum. Almost any material that will allow moisture to reach the soil but keep the light off the soil will work as a mulch. Such things as compost, sawdust, grass clippings, leaves, weed matting, newspapers (non-colored inks), black plastic with perforations to allow water to reach the soil, as well as many other items will greatly aid in the fight against weeds. Make sure the mulch is thick enough to keep sunlight from hitting the soil surface, but do not pile it so high as to reduce oxygen in the soil, or start the composting process, which could produce heating problems around the desirable vegetation. Probably 4 inches is a good maximum depth. Mulching can be done anytime of the year.

E. Thermal weeding, flaming—Another technique that saves time in a large garden is thermal weeding or flaming. This method dehydrates weeds and is very effective. It can be used as a pre-plant, pre-emergent, post-emergent, or pre-harvest treatment. A device such as a propane burner is lighted and passed over the tops of the offending weeds just before planting the desired crop. A good technique in pre-emergence crops, especially in carrots and beets, is to allow weeds to germinate, and then plant crop seeds among weed seedlings. Wait about a week, then flame the weeds in the pre-plant state, thus allowing seeds to sprout in a weed-free environment.

During post-emergence and pre-harvest, take care to keep heat of the flame away from desirable vegetation, either by distance or use of heat-resistant shields, such as tin or other metal. Also use pre-harvest flaming to remove potato foliage prior to harvest.

F. Soil solarization—A method of controlling weeds, soil dwelling insects, and soil borne diseases is soil solarization. Soil is more or less pasteurized through the heat of the sun. Benefits include reduction of pest problems and stimulation of beneficial organisms. First, till the soil to enhance the conduction of heat, moistening the ground to be treated to at least one-foot deep. Then place clear plastic over the soil. Anchor the ends securely to keep the plastic in place. This technique is mainly useful in USDA Zones 5 and above. If you live in a Zone 4 or less, the generated heat units will probably not be sufficient to heat the soil enough to kill very many weed seeds, insects, or disease organisms.

G. Soap-based and oil-based herbicides—Some soap and oil-based herbicides are cleared for organic food production. They work by burning the foliage back and can be effective in certain situations. When using them be sure to keep desired vegetation protected because they will burn the leaves of all plants. They generally are not effective in controlling perennial weeds.

H. Other methods—Other methods also may reduce weed pressure.

1. Weed-free manure/mulch—Make sure manure and mulch sources are weed free if possible.

2. Remove weeds—Be sure that weeds are removed from the garden before going to seed.

3. Check equipment—If you borrow equipment, check to see that you do not bring in weed seeds from soil or other matter adhering to the equipment.

4. Avoid weed hitchhikers—Vehicles, clothing, and animals may also transport weed seeds.

5. Composting—Composting weeds that have weed seed attached is not a good plan. If the composting process is done incorrectly, weed seeds may survive and become a problem.

6. Timing planting—The timing of planting may prevent weed pressures. For example, mustards are generally an early spring problem. Delaying planting until the mustards have emerged and been removed may reduce weed problems.
7. Avoid bare soil, green manure—Maintain a crop cover instead of leaving bare soil to inhibit or prevent weed seed from germinating.

To accomplish this, use green manures before or after the crop is put in. Green manures such as winter rye, buckwheat, mustards, oil seed, radishes, crimson clover, hairy vetch, or subterranean clover have all demonstrated the ability to suppress certain weeds.

8. Geese—Several species of geese have been used successfully to weed out grasses from crops and may be of some use in a garden.

IV. Insect Control

The best control of insect pests is through maintaining healthy plants. Many insect pests are attracted to unthrifty plants. An ounce of prevention is indeed worth a pound of cure. Insects can pose serious problems in an organic garden. It is vital that you scout your garden for insects and try and control them before they have a chance to multiply. Three methods can be used to control insects organically: Mechanical control, biological control, and insecticides (chemical control).

A. Mechanical Control

Mechanical control is the first line of defense in combating insect pests.

1. Remove by hand—Probably the most common and effective way to control insects is to use the tried and true method of removing them physically from the plants. This method is very effective in a small garden. You can either pluck them from the surface or use a leaf to squash them. You will also be able to see egg clusters and remove them before they hatch.

2. Water jet—Another easy way to remove certain insects from plants is to use a strong jet of water and wash them off the plant. This is especially effective with aphids. Once on the ground, aphids become prey for several ground dwelling predators.

3. Floating row covers—A very effective defense against flying insects are floating row covers, available at well-stocked lawn and garden stores. They work by physically excluding access to the crop by flying insects. Row covers are generally not effective against soil dwelling insects. They need to be in place before the insects have a chance to lay eggs on the plants. Floating row covers are effective in controlling lepidopteron larvae (caterpillars), flying pests of onions, carrots, and some leaf mining insects, as well as other pests.

4. Sticky traps—Sticky traps used in combination with insect attractants can be effective.

5. Bug vacuums—Bug vacuums available commercially are very useful in removing large numbers of insect pests. However, they remove all insects, including beneficial ones. If you have beneficial insects helping you out, then this is a less attractive method.

6. UV bug zapper—Should you be tempted to use a UV bug zapper to control insects, be aware that you will probably kill more beneficial insects than injurious ones.

B. Biological Control

This method uses insect predators, parasites, and pathogens to help control pestiferous insects. When using this method of control, it is important to recognize and understand beneficial insects, their life cycles, and how to maintain them.

1. Strategies

a. Plant diversity—Plant diversity is important in maintaining a viable beneficial insect population. Many helpful insects are nectar feeders so flowering plants are desirable. Many plants in the Apiaceae (formerly known as Umbelliferae) family—such as fennel, angelica, coriander, dill, parsley, and wild carrot—provide several tiny flowers needed by parasitoid wasps. Colvers, yarrow, and rue also attract parasitoid and predatory insects.

b. Low-growing plants—Ground-dwelling beneficial insects such as ground beetles seek low-growing
plants for protection. Thyme, rosemary, or mint provide such shelter. Composite flowers, such as daisy and chamomile, and mints attract predatory wasps, hover flies, and robber flies.

c. Safe haven—If possible, dedicate a small area of the garden to plants that attract beneficial insects. Think of it as a safe haven. Insects will be able to maintain their populations by living off the deleterious insects in nearby untreated areas.

2. Helpful beneficial insects

The following is a partial list of organisms that can be used to your advantage in combating insect infestations:

a. Ladybird beetles (ladybugs) — These familiar insects are very beneficial in consuming soft-bodied insects, especially aphids and mealy bugs. Both adults and larvae dine on these pests, but the larvae consume substantially more than do adults. The larvae somewhat resemble miniature alligators and many gardeners think they are harmful, so make sure you recognize them. Ladybird beetles may be purchased from several sources. Be sure to have some way to contain them, such as a fine meshed net or a tent (be careful to ventilate to avoid heat buildup) for a few days when you release them to get them established in your backyard. When first released they have a tendency to disperse and mate.

b. Lacewings—These insects also prey on soft-bodied insects, eggs, and mites. Adults have delicate wings and a faint smell of moth balls. The larvae, as with ladybird beetles, are voracious eaters. Lacewing eggs are laid singly on a stock and are fairly common in organic as well as conventional systems.

c. Wasps—Many wasp species parasitize several different orders of insects. They are generally very small and pose no threat to humans. They attack insect eggs, larvae, and adults.

d. *Bacillus thuringiensis* (Bt) — Several strains of this bacterium have been very effective in controlling insect pests. They form a crystal that is toxic to certain insects but not to warm-blooded mammals. The crystal is dissolved in insects’ digestive systems. When first discovered, these bacteria were found to be very useful in controlling lepidopteran pests (caterpillars), including codling moths and cabbage loopers. Since then other Bt strains have been found that are effective against certain coleopteran pests (beetle family) including Colorado potato beetles. For this control method to work, the material has to be eaten by the insect. Several products on the market contain Bt. Make sure you purchase the type that is effective against pests you are trying to control. Unfortunately, some resistance to Bt has begun to show up in certain insect populations, especially the diamond back moth, a pest to cole crops, so caution is advised when using Bt as a control. Whenever there is a possibility of a pest species gaining resistance to a certain control strategy, it is very wise to rotate control methods.

In several crops, this toxin has been genetically engineered into the plant. Any genetically engineered plant or other organism is not acceptable in organic production.

e. Nematodes—These organisms are microscopic simple roundworms. Several nematodes are available that control several soil borne pests. Nematodes may be purchased at many well-stocked lawn and garden outlets. When purchasing them, be sure you know the targeted pests you wish to control because the nematodes have a fairly specific host range. They have been shown to be very successful in controlling certain insect pests when applied strictly according to label instructions. They are very sensitive to desiccation (extreme drying) and to ultraviolet radiation.
Nematodes especially beneficial for Idaho pests include:

1) *Heterorhabditis bacteriophora*— for root weevils on ornamentals, billbugs, and scarabs (June beetles) in lawns and also for root weevils in berries

2) *Steinernema feltiae*— for fungus gnats, and

3) *S. carpocapsae*— for armyworms, cutworms webworms, girdlers, and wood borers.

4) Other nematode species may also be effective. There are undoubtedly other nematodes that will be developed to control problem insects.

3. Beneficial Fungi

Specific fungi are commercially available that have shown control in aphids, whiteflies, leafhoppers, flies, beetles, caterpillars, thrips, mites, and some beetle larvae. These fungi may also attack beneficial insects. Under the right conditions they can be very effective, but as with most fungi, humid conditions are usually needed for efficacious control. *Beauveria bassiana* is the most common fungal insecticide used.

4. Beneficial Viruses

Certain viruses are effective in controlling insect pests, mainly in the Lepidoptera (moths) family. To be effective, viruses must be consumed by the insect. As with the other biological control methods mentioned here, these viruses pose no threat to human health. They also do not directly cause problems for insect predators. Viruses are currently limited in their availability but through diligent searching one may find a source. The Internet may be of benefit, or universities and private companies involved in this line of research.

C. Chemical Control

At first thought, the use of pesticides in organic gardening seems incompatible with the total concept of organic gardening, yet several pesticides are used in organic production. They are not synthetically made, however, and materials allowed in organic pest control are subject to close scrutiny. The fact that pesticides are considered all right to use in organic food production and are naturally derived does not mean that they are non-toxic. Some allowed substances are very toxic, and it is vital that labels be read and understood before using any pesticide. Just as common chemicals are given toxicity ratings, so are chemicals from botanical and mineral-bearing sources. "CAUTION" means low toxicity or fairly safe to use; "WARNING" means moderately toxic; and "DANGER" means highly toxic.

To qualify as an organic pesticide, the product must be from natural sources, cannot be genetically modified, and must be certified as a pesticide that is useable in organic food production.

The following insecticides are some of the more common ones currently registered in Idaho for use in organic production. This is not a complete list. New pesticides become available to the organic grower on a fairly regular basis.

Each state may recognize different chemicals as proper to use in organic production. If you are growing produce to sell organically, be sure to check the most current information. Contact information for Idaho is listed at the end of the chapter.

1. Pyrethrum/pyrethrin

Extracted from chrysanthemums, this pesticide affects the nervous system of insects and is very effective against a wide variety of insect pests. Several formulations available, some containing ingredients are not allowed in organic production.

One common additive—piperonyl butoxide (PBO)—is not permitted in organic production systems, so be sure to read the label when purchasing pyrethrum-based insecticides. Several instances of allergic skin reactions have been reported, so take care to keep it off your skin.

Pyrethroids are synthetically made materials based on the chemistry of natural pyrethrins. Because they are synthetic, they are not allowed for use on organic crops.
2. Boric Acid
Boric acid has been used for a long time in controlling pests. It is allowable in organic production systems as long as it does not get on edible portions of the plant. There are various bait and dust formulations.

3. Diatomaceous Earth
This material is composed of fossilized skeletons of microscopic water plants called diatoms. They extract silica from the water and incorporate it into their skeletal systems. When they die their skeletons form a diatomite deposit. After being ground, this material turns into very small glass-like particles able to cut the cuticle of insects and cause desiccation. It is fairly safe to use, but the dust can irritate lungs and eyes.

4. Sabadilla
Derived from seeds of the sabadilla lily, the active ingredient is an alkaloid known as veratrine. It is both a contact poison and a stomach poison. Sabadilla is one of the least toxic of the botanical pesticides. It can, however, be highly irritating to eyes and can cause sneezing if inhaled. Sunlight quickly inactivates this material so applications in the evening are best.

5. Neem
Used in India and Africa for more than 4,000 years for medicinal and pest control purposes, neem is derived from seeds of the neem tree, a native of India. Compounds derived from the seeds have both insecticidal and fungicidal properties. Neem blocks a molting hormone in insects and terminates the molting process. Effective against a wide range of insect pests, neem is effective, but not a fast-acting insecticide, so do not expect quick results. It has a very low mammalian toxicity.

6. Rotenone
A compound produced by the roots of two members of the Leguminosae family, rotenone is effective on leaf-feeding insects such as caterpillars, beetles, aphids, and thrips. As with neem this is a slow-acting chemical. Insects stop feeding shortly after ingesting the material. This material is extremely toxic to fish but only moderately toxic to most mammals.

7. Horticultural, Summer, Dormant Oils
Oils, effective against a wide range of insects, are only to be used on woody plants. They can be very effective in controlling things like scale, mealy bugs, and insect eggs, coating and smothering insects and their eggs. Oils are relatively more effective against active insects than dormant ones. Several different, and sometimes confusing, names are used for horticultural oils. Heavier oils are used during the dormant period—late winter and early spring—on woody plant material, so are called dormant oil. Summer oils, or horticultural oils, are lighter in consistency and relatively safe to use when plants are in leaf, but may cause leaf burn. Most horticultural oils are petroleum-based, but other types of oils—neem, vegetable, and fish—can also be effective.

Sulfur is sometimes a problem in horticultural oils, and some oils have a “UR” (unsulfonated residue) rating. The higher the UR rating, the lower the sulfur content. Most horticultural oils have a UR rating of 90 or above. Oils are fairly safe around beneficial insects because most of them have the ability to escape. Some beneficials, such as predatory mites, will succumb to oil applications since they cannot remove themselves from harm’s way.

Oils such as carrot and weed oils are not permitted for use in organic production. A few plant species are very sensitive to oil applications, among them Japanese and red maple, hickories and black walnut, plume cedar, and smoke tree. Other sensitive plants are redbud, junipers, cedars, spruce, and Douglas firs. If you apply oil to a blue spruce, the blue color will be lost.

8. Insecticidal Soaps
Insecticidal soaps are very safe and useful in controlling a wide variety of insects. Many gardeners are tempted to
substitute household soaps instead of buying the material that is labeled for insect control. All clothes detergents will cause harm to your plants as will most other forms of dry soaps, usually by burning the foliage. Insecticidal soaps are formulated with potassium salt of fatty acids. Commercially available insecticidal soaps are selected to control insects, to minimize potential plant injury, and are of consistent manufacture.

9. Sulfur
Sulfur is probably the oldest known pesticide in use. The Greek poet, Homer, described the benefits of "pest-averting sulfur" 3,000 years ago. It can be used in several forms such as a dust, wettable powder, paste, or liquid. It can help control spider mites, psyllids, and thrips and can be used on a variety of crops including beans, potatoes, tomatoes, and peas. It also is used on a number of fruit crops such as apples, cherries, grapes, peaches, pears, plums, and prunes. Sulfur is relatively safe to use, although it may cause eye and skin irritation, and, if applied when temperatures are above 90°F, it can burn the plant. Also, it reacts with other pesticides so it is best to apply it alone. If you use oils, be sure not to use sulfur within 20 to 30 days as sulfur and oil react together to cause phytotoxicity.

10. Other products
Several other effective products are available to control insects and are certified for use in organic production, including garlic and herb preparations, lime sulfur, insect extracts, pheromones, etc. As you gain experience with organic gardening, you will become more familiar with these products. Several books and online resources to help you further resolve pest problems, along with references and additional reading material, are at this chapter’s end.

VII. Disease Control
As with insect control, the best way to control diseases is to maintain healthy plants. Choosing the proper plants for the garden, matching the plant to the soil type, proper light levels and irrigation needs, correct sanitation, and proper fertilization and pruning will go a long way to maintaining a healthy garden.

Prevention is extremely important when it comes to dealing with plant diseases. Once established, diseases are almost impossible to eradicate from stricken plants, and they act as a reservoir for infection of healthy plants. Don’t start out with a disease problem. Purchase disease-free stock. Generally, vegetatively-propagated material will have some type of certification stating it is either virus free or, at worst, has low levels of virus present.

In fighting diseases, remember the disease triangle. The three components needed to have disease are: a susceptible host, a pathogen capable of causing disease, and the proper environment for the disease to thrive.

Armed with this basic knowledge, one can approach disease control from several angles. For example, if you have problems with your tomatoes and Verticillium wilt, probably the easiest way to correct it would be to purchase Verticillium-resistant tomato plants. Many garden vegetables that are susceptible to Verticillium wilt have cultivars with resistance bred into them.

Another approach to minimizing disease is to remove diseased plant material, thus reducing the pathogen population. Such steps as removing fallen diseased leaves, pruning out diseased portions of a plant, or removing the entire diseased plant will help reduce disease pressure.

Most plant diseases are caused by fungi. Fungi like high humidity. By changing the environment through such things as drip irrigation and wider spacing of plants, the overall humidity is reduced thus decreasing the chances of fungi-causing problems.

Organic fungicides are available that are fairly effective against several disease problems faced by gardeners. As with herbicides and insecticides, fungicides should be used only after other controls have failed.

Popular Fungicides. Below is a brief discussion on some of the more popular fungicides used by organic gardeners.

A. Sulfur.
In addition to being an effective insecticide, sulphur has fungicidal properties and is effective in controlling and suppressing sev-
eral plant diseases. First used some 2,000 years ago by the Greeks to control rust on wheat, sulfur is used as a preventative fungicide, which means it has to be on the plant surface before the disease gets inside the plant to be effective.

It is useful against powdery mildews, rose black spot, rusts, and other diseases. It works by inhibiting the germination of the fungal spores. It is available in several forms, including dusts, liquids, and wettable powders.

Keep in mind that sulfur can burn foliage if the temperatures are above 80°F and if oils have been used within the last 20 to 30 days. Plants sensitive to sulfur include apricots, some raspberries and blackberries, gooseberries, currents, and cucurbits.

B. Lime Sulfur
Lime sulfur is made by boiling lime and sulfur together. The lime helps the sulfur penetrate the plant tissue. This mixture has insecticidal properties as well as fungicidal properties. It helps control diseases such as anthracnose and powdery mildew when used as a dormant spray. It also aids in the control of scale insects, thrips, and eriophyoid mites.

**Drawbacks** to using lime sulfur are its smell of rotten eggs, and it can burn exposed skin and eyes. It will also injure plants if temperatures are above 80°F.

C. Bordeaux Mixture
This is a natural pesticide produced by a reaction between copper sulfate and calcium hydroxide (hydrated lime). It was first used in Bordeaux, France, to control downy mildew on grapes, hence its name.

Like sulfur, Bordeaux is a preventative fungicide that needs to be in place before the disease shows up. It has a very long track record—more than 150 years. Fungicidal as well as bacterial properties extend its utility in organic production.

Bordeaux has the advantage of sticking to plants despite rain or irrigation. It controls bacterial leaf spots, blights, various types of anthracnose, downy mildews, and cankers. It also repels many insects.

**Uses.** Bordeaux is labeled for use on many vegetables, tree fruits, and nut crops.

**Drawback.** One drawback is that, like sulfur and lime sulfur, it can be phytotoxic to plants. It can burn leaves and cause russetting of fruits if applied in cool wet weather.

**Formulations.** There are various formulations of Bordeaux mixture, but perhaps the best all-around mix is 4-4-50—four pounds of copper sulfate and four pounds of hydrated lime in 50 gallons of water. Generally a weaker solution of Bordeaux is recommended for foliage in early spring and a heavier solution for late in the season applications for protection against serious diseases like late blight.

**Copper caution.** One caution to keep in mind with Bordeaux mix is that excessive use will cause a buildup of copper in the soil. Copper is toxic to fish and is a heavy metal. Bordeaux fungicide can be purchased pre-mixed, but it is more effective if prepared just before use. Plants, including ornamental sorghum and corn, are sometimes sensitive to copper-based pesticides. Also, use caution when applying Bordeaux to tender leaves of apple, pear, plum or rose as they may be burned. Geraniums, ivy, pansy, celery, strawberry, azaleas, dogwood, and juniper are also sensitive and dilute sprays are advised.

D. Other Fungicide Options
Neem oil has fungicidal properties.

Hydrogen peroxide, dormant oils, the antibiotics streptomycin and tetracycline, as well as several mineral and plant based materials can be valuable in protecting your crop. The further reading section at the end of the chapter and online resources will aid your search for solutions to problems.

E. Seek Reliable Data
When using compounds to control pests in an organic system, it is advisable to make sure reliable data supports its use and that it is registered for use on the intended plant species you wish to treat. Many homegrown recipes are purported to solve all sorts of problems. In some cases, they may be effective but may also cause unwanted side
effects, such as buildup of harmful compounds in the soil, unexpected detrimental effects on beneficial fauna and flora, and possible toxic generated materials and side effects.

VIII. Summary

Gardening organically can be very rewarding. Through the process one will gain a much greater appreciation of natural checks and balances. Once we are able to work within the parameters nature has defined for us, we will gain a deeper understanding of how natural processes work in our favor. Organic food production involves a certain state of mind, as well as a defined food production system. Organic growing involves a holistic approach to growing, instead of the more common approach of treating problems individually. There will certainly be a learning curve associated with this approach, but once the gardener understands how things interrelate, the process becomes much more manageable and enjoyable.

Further Reading

**Books**


**Utah State University Extension**

HG-510 Selecting and Using Organic Fertilizers

**Washington State University Extension**

EBO 648 Organic Gardening

**Web Sites**


Idaho OnePlan provides data and software to help growers develop a single conservation farm plan that can be pre-endorsed by the various agencies, streamlining and simplifying the regulatory process that farmers face. [http://www.oneplan.org/Crop/OrganicFarming.shtml](http://www.oneplan.org/Crop/OrganicFarming.shtml)

Oregon State University Extension

EC 1247 Gardening with Composts, Mulches, and Row Covers


PNW Weed Management Handbook. Oregon State University, Administrative Services-A442, Corvallis, OR 97331 ISBN 1-931979-12-X

Published 2007.