ORGANIC GARDENING

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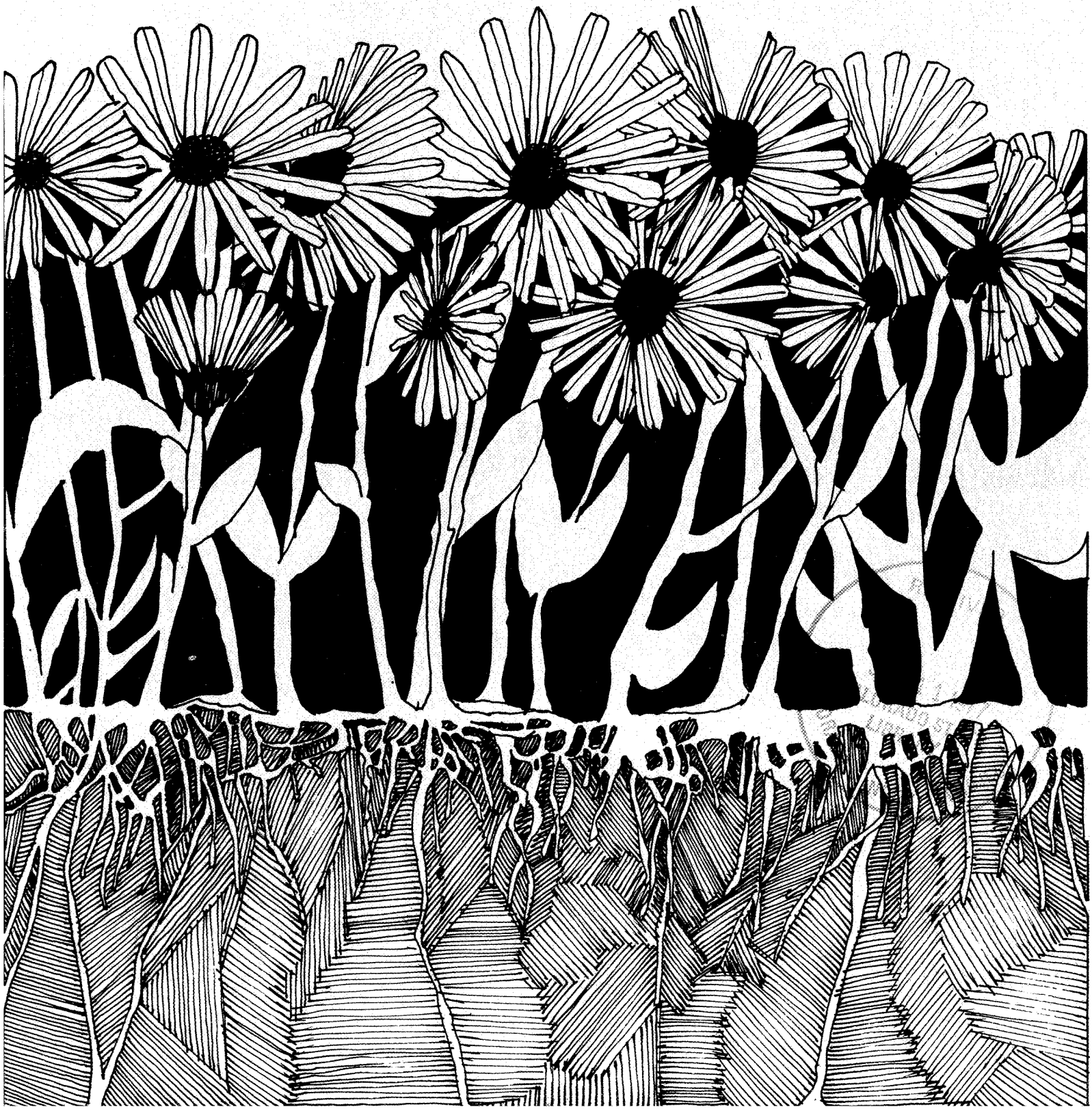

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ORGANIC GARDENING

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INTRODUCTION

Organic gardening emphasizes the use of organic soil amendments to improve the nutrient content and physical characteristics of the soil, and the use of biological and physical methods for controlling garden pests. Synthetic fertilizers, insecticides, fungicides, and herbicides are not used. The presence of decomposing organic matter in soils has long been recognized as a nutrient source for plants as well as a useful tool in maintaining and improving structure and tilth in clay soils and in improving the water-holding capacity of sandy soils. Moreover, organic matter contains natural organic complexes which make micro-nutrients such as zinc and iron more available to plants.

Gardeners use a wide variety of both plant and animal organic materials in organic gardening. Use those which are most economical and readily available from local sources. One of the attractive aspects of this type of gardening is that the gardener is often able to productively use materials that would otherwise be discarded, thus eliminating some potential environmental pollutants.

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While organic gardening may demand more labor and care than chemical gardening, it remains one of the oldest and most personally satisfying forms of cultivation. By using organic materials to supply nutrients and to maintain or improve the physical characteristics of soil, you can contribute to the general health of the environment while producing your own crops.

MAJOR NUTRIENTS

Of the three major nutrients, crops in Colorado respond most often to the addition of nitrogen and phosphorous; a response to the addition of potassium is rare. Although organic materials contain all of the major nutrients, they are present in widely varying ratios. Thus few organic materials can be regarded as complete or balanced sources of plant nutrients. For example, even though manures are good nitrogen sources, they are relatively low in phosphate. Therefore, you should probably supplement manures with steamed bone meal. Activated* sewage sludge, on the other hand, is generally satisfactory used alone. Remember that continued heavy applications of manures may increase soil salts to harmful levels, a condition which you can avoid by periodically testing your soil. This soil test and others mentioned in this bulletin are done in the State Soils Laboratory. See Service in Action Sheet No. 499 or contact you County Extension Office.

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*Activated and digested designate sludge from two different sewage treatment processes. Find out from your source which kind of sludge you are getting.

You should always have some idea of the content and availability of plant nutrients in the materials you are adding to the soil. Many materials contain nutrient elements in forms plants can't use and these may be very slowly converted to available forms. Table 1 gives some representative values for nutrient content of organic materials and estimates of their availability. (For example, 50-75% of the nitrogen in cow manure may be available in the first growing season).

Table 1. Approximate nutrient content and availability of some organic materials.*

Material	% Nitrogen	% Phosphate	% Potash	Availability
Steamed bone meal	0.7 - 4.0	18 - 34	----	slow - med.
Compost	1.5 - 3.5	0.5 - 1.0	1.0 - 2.0	slow
Dried blood	12	1.5	0.57	med - fast
Cattle manure	0.25 - 2.0	0.15 - 0.9	0.25 - 1.5	med
Horse manure	0.3 - 2.5	0.15 - 2.5	0.5 - 3.0	med
Sheep manure	0.6 - 4.0	0.3 - 2.5	0.75 - 3.0	med
Swine manure	0.3	0.3	0.3	med
Poultry manure	1.1 - 2.8	0.5 - 2.8	0.5 - 1.5	med - fast
Peat	1.5 - 3.0	0.25 - .50	0.5 - 1.0	very slow
Sawdust	0.2	0.1	0.2	very slow
Milorganite	0.5	2 - 5	2	med
Sewage Sludge (activated)**	2 - 6	2 - 7	0 - 1	med
Sewage Sludge (digested)**	1 - 3	0.5 - 4.0	0 - 0.5	slow
Wood ashes	0	1 - 2	3 - 7	rapid

*The nutrient content of most organic materials is quite variable and depends upon the specific source and how the material has been handled and stored.

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Some organic materials may require special handling, most often in the form of composting, before use in the garden. For instance,

sawdust, straw, or other stemmy plant tissue with low nitrogen content or slowly available nitrogen may actually cause a temporary deficiency of nitrogen in crops if directly incorporated into the soil. This happens because the microorganisms decomposing this material require nitrogen for their own tissues and thus compete with crops for it. Avoid nitrogen deficiency by composting the low nitrogen material (with added nitrogen in the form of dried blood or poultry manure) before adding it to the soil. Coarse material, such as corn stalks and other plant residues, decompose slowly and may also present problems in soil preparation and cultivation if added directly to the soil. Shredding alone is not as effective as composting to handle these materials, but it is helpful. Since direct application of high nitrogen materials such as dried blood and poultry manure in large amounts may "burn" plants, use them in moderate amounts. Composting with low nitrogen materials may be advisable. Table 2 provides the approximate amounts of nitrogen required to decompose some organic materials. High nitrogen and low nitrogen materials should be mixed together when building the compost heap.

Table 2. Approximate nitrogen required for decomposition.

Material	Lbs. nitrogen required per ton organic material	Cups dried blood per bushel
Ground corn cobs	22	2/3
Grass hay	8	1/4
Sawdust	26	3/4
Wheat straw	18	1/2
Grass clippings	4	1/8

The simplest method of composting is to build a heap by alternating layers of organic material and soil; the layers of soil may be 1/2 to 2 inches thick and the layers of organic material 6 to 12 inches thick. If the organic material is composed of more than one-half manure, no additional nitrogen is required, although 1/2 cup of bone meal per bushel may be useful. If the organic material is primarily vegetation, add nitrogen with the help of information in Table 2. As you build the heap, water the material until it is moist but not soggy. Cover the final heap with 2-4 inches of soil. After a few weeks, turn the material for aeration, mix well and move the outer parts to the center. The whole composting process should be complete in about three months in warm weather. See Service in Action Sheet 7.212 for further information on composting.

Nitrogen becomes available to plants in the form of nitrate or ammonium by decomposition of organic matter; the resulting nitrate is either taken up by plants (vegetables typically remove 30-100 pounds of nitrogen/acre), leached from the soil, or lost to the atmosphere as gaseous nitrogen. In the intense production typical of gardens, it is essential that you supply decomposable organic matter to replace these losses.

A typical fertilizer recommendation for a Colorado garden soil might call for 100 pounds nitrogen and 120 pounds phosphate per acre. A manure containing .25% nitrogen and .15% phosphate applied at the rate of 20 tons per acre furnishes 100 pounds nitrogen and 60 pounds phosphate. Add steamed bone meal containing 25% phosphate at the rate of 240 pounds per acre to supply the remaining 60 pounds of

phosphate. Twenty tons of manure per acre is equivalent to about 900 pounds per 1000 square feet or about 3 bushes per 100 square feet; 240 pounds of bone meal per acre is equivalent to about 5 1/2 pounds per 1000 square feet, or about 1 1/2 cups per 100 square feet. Table 3 gives some useful conversions.

Table 3. Equivalent weights of fertilizing materials per unit area and equivalent volume measurement for 100 sq. ft. Adapted from U.S.D.A. Leaflet No. 307.

Material	Weight specified per Acre	1000 sq.ft.	100 sq.ft.	Approximate Volume Measure for 100 sq. ft.
Bone Meal	175 lb.	4 lb.	6 1/2 oz.	1 cup
Sewage Sludge	300 lb.	7 lb.	11 oz.	1 pint
Manure	13 tons	600 lbs.	60 lb.	2 bushesl loose 1 bushel packed

Add phosphate to soil or compost heaps by using steamed bone meal. Although rock phosphate is often recommended to organic gardeners, it becomes available slowly, if at all, in the alkaline soils of the West.

Phosphate made available by decomposition of organic matter is generally either removed by plants or fixed in slowly available mineral complexes in the soil. Vegetables typically remove 10-50 pounds of phosphate per acre per year from the soil. Soil retains excess phosphate unlike nitrogen, making it available to future crops. As the phosphate level of the soil is built up, you may decrease or stop supplementing the manure with bone meal.

Of 3,400 soil samples tested in the CSU Soil Testing Laboratory in 1971-1972, only one percent were rate low in potassium. Therefore, when you add organic matter to the soil, you may assume the potassium needs are being met.

MICRONUTRIENTS

Iron and zinc are the only micronutrients which have been verified as deficient in Colorado soils. Vegetables most likely to exhibit these deficiencies are corn, potatoes, and beans; many woody plants are also sensitive to lack of iron and zinc. Iron deficiency commonly appears as yellow areas between greener veins of young leaves. In zinc deficient plants, leaves and stems often fail to grow to normal size. There may also be yellowing between the veins of leaves, but usually on older leaves. Decomposing organic matter supplies these necessary nutrients. In addition, organic complexes (chelates) may be formed. These hold the nutrients in a form available to plants and protect them from fixation in the soil in unavailable forms.

Since the requirements of plants for iron and zinc are very small, they will almost certainly be met by any program adding a variety of organic materials to the soil. Of course, materials slow to decompose such as peat and sawdust will be less effective than manures or dried blood.

OTHER EFFECTS OF USING ORGANIC MATTER

In general, organic matter improves the aeration, structure, and tilth, or working characteristics, of heavy clay soils, and increases the water-holding capacity of sandy soils. Microorganisms and small animals of the soil depend on organic matter as a food source and, in turn, are active in the decomposition process which makes nutrients available to the crop.

OTHER SOIL ADDITIVES

Limestone and wood ashes are often recommended in gardening literature as methods of decreasing soil acidity. Since the soils of Colorado and the arid West in general are alkaline, not acid, these are not necessary and, if added, may even cause iron deficiency. Iron deficiency is common on alkaline, high lime soils where iron may be present, but in forms unavailable to plants. Rock phosphate and colloidal phosphate are extremely slow to decompose and are of little or no value in alkaline soils. Potassium sources such as greensand, granite meal, wood ashes, and kainite, are generally not needed when organic materials are added to the soil.

MULCHES

Straw, hay, ground corn cobs, wood shavings, sawdust, grass clippings, and a number of other materials are commonly used as mulches. Applied as a layer over the surface of the soil, they serve three purposes: insulation to reduce soil temperature fluctuations, prevention of evaporation of water from the soil surface, and control of weeds.

Apply mulches in the spring to keep soil surface temperatures lower through the summer. On perennials such as strawberries, apply mulches in the fall to prevent early warm-up in the spring and frost-heaving due to alternate freezing and thawing through the winter. A porous mulch such as these named above will allow water penetration, prevent crusting of the soil surface, and reduce losses of water

by evaporation; coarse gravel mulches may also prevent evaporation. Organic mulches are commonly rather ineffective for weed control; however, results depend on the thickness of the mulch layer and the weed species involved.

Over a period of time, the organic mulch material in contact with the soil surface will decompose and become incorporated into the soil. Thus if you work large quantities of mulch material into the soil, some nitrogen source should also be added to speed decomposition. Service in Action Sheet 7.214 has more information on mulches.

PLANT PESTS

The primary pests of the garden are insects, pathogens (bacteria, fungi, and viruses), and weeds. Pests such as deer, mice, rabbits, and birds may be annoying, but are usually successfully dealt with by trapping, fencing, or repellents. For example, cloth bags containing dried blood hung on posts in the garden repel deer. In general, however, you must be willing to accept some damage and even an occasional crop failure from disease and insects if you do not use chemical control methods.

Weeds

Weeds are the easiest of the pests to cope with and can always be controlled by the effective, if laborious, method of pulling and hoeing. Even perennials such as bindweed and Canada thistle can be eliminated if the top growth is continually eradicated until root reserves are depleted. It is important to destroy all weeds while small to prevent competition with the crop and to prevent the weeds

from going to seed. If ditch water is being used for irrigation, you may want to use screens to prevent introduction of weed seeds from this source. Geese have been used to eliminate grasses in strawberry beds since they prefer grasses to strawberry plants. Mulches can also help control weeds; the most effective weed control mulch is a layer of black plastic film or paper. Black plastic film is available from garden supply stores, hardware stores, and lumber yards.

Insects and Diseases

While insects in the garden are always abundant and often destructive, some are nevertheless helpful and necessary. Many crops will not fruit without pollination by insects, and many harmful pests are preyed upon by other beneficial insects. In any case, success in coping with insect problems almost always depends upon the integrated application of several control measures.

The release of sterile males to mate with native females, thereby disrupting the reproductive cycle, is one such control measure. However, since large populations must be reared, sterilized, and released to dilute the population of native males, this must usually be done by a public agency on a large scale to be effective.

Quarantines to prevent the introduction of pests are operated by government agencies, but you can operate your own private quarantine by exercising caution in bringing plant material or soil into your garden. Introducing new soil indiscriminately could result in problems such as nematodes, insects, bacteria, and fungi. Plant materials,

too, may harbor insects and disease. Vegetatively propagated plants such as potatoes and berries require particular attention, as these plants are especially likely to carry viruses, bacteria, or fungi. If in doubt, look for certified seed potatoes; they have been checked carefully for disease by an independent agency. Some nurseries also carry virus indexed berry plants which have been tested and found virus free. Inspect transplants before purchase, and since some diseases may be seed-borne and very difficult to detect, purchase seed only from reliable sources. Plants with lesions on foilage or stems; mottled, stippled, or blotched foliage; or malformed growth should be rejected.

Physical barriers can sometimes be used to exclude insects. For example, wire screening or fine netting are effective; paper collars 2" in diameter and 2" below the soil surface will protect young plants from cutworms; and trenches 12" deep with steep, smooth sides can prevent the entry of army worms. Traps may be useful, but are not usually selective and may decrease the population of beneficial species. Selective traps use lures of various kinds, including the natural mating attractants of the target insect. If an insect has feeding preferences, a trap crop may be used; for example, you can plant a bed of kale to attract harlequin bugs from cabbage. Use shallow pans of stale beer to trap slugs; lay boards on the soil surface to attract slugs, squash bugs, and others seeking shelter. Once trapped, destroy them by spraying with kerosene or a light oil.

You may want to use other effective control methods such as washing plants with a strong stream of water to control spider mites.

Use a layer of aluminum foil over the soil under squash plants to repel aphids. Hand pick and destroy such pests as tomato hornworm, Colorado potato beetle, and Mexican bean beetle.

Sanitation is often effective in limiting damage from both disease and insects. Since some weed species are alternate hosts for garden pests, weeds growing near the garden may provide a convenient breeding place. You can limit spreading by immediate removal of diseased plants. Remove all plants and compost or turn them under the soil at the end of their season.

Because the population of a pest tends to build up over a period of time when its host is present in the same area year after year, rotate crops to limit insect and disease damage even if you have only a small garden. Also, closely related groups of crops are often hosts to the same pests and should be rotated as a group. Some of these groups are: legumes--peas, beans, sweet peas; crucifers--cabbage, broccoli, brussels sprouts, cauliflower, turnip, radish, mustard, kale; cucurbits--pumpkin, squash, muskmelon, watermelon, cucumber, gourd; solanaceous fruits--tomato, pepper, eggplant; allium--onion, leek, garlic, chive, shallot. Crop rotation may be particularly helpful in dealing with soil-borne diseases.

In the literature and lore of gardening, there are also a number of plans for companion cropping or interplanting of species, resulting in one species repelling insects from the other. Although little controlled experimentation has been done in this area, marigolds, garlic, and chives reputedly repel a number of insects. If companion cropping is used, select companions with care to avoid shading or excessive competition for water and nutrients.

Of all the control methods, selection of varieties with resistance to disease and insect attack is one of the best. Many newer varieties have been bred for disease resistance or tolerance. A partial list of these is given in Table 4. Make use of descriptive catalogs issued by seedsmen that give the kinds of resistance incorporated into specific varieties.

Table 4. Disease tolerance available in vegetable varieties.

Crop	Disease
Snap bean	mosaic
Lima bean	downy mildew
Cabbage	yellows
Cantaloupe	powdery mildew, downy mildew
Cucumber	mosaic, scab, anthracnose, downy mildew, powdery mildew
Onion	pink root
Pea	wilt
Pepper	tobacco mosaic
Spinach	blight, downy mildew
Squash	squash mosaic, cucumber mosaic
Tomato	fusarium, verticillium, gray leaf spot, leaf mold, early blight
Watermelon	anthracnose, fusarium

As a good example of insect resistance, sweet corn varieties with tight husks extending well beyond the tip of the ear usually have lighter infestations of corn ear worm. Likewise squashes such as Early Summer Crookneck and Butternut are less attractive to squash bugs than some other varieties.

Biological control measures (the use of parasites and predators to control a pest population) can be very successful, but in many cases, requires large scale efforts by a public agency. Finding a

suitable control organism and determining the conditions for establishment of an effective control population generally requires a great deal of research followed by a large development effort. You can, however, encourage natural populations of control organisms and, in some cases, introduce these organisms. You may buy the spores of Bacillus thuringiensis, which causes a fatal disease of imported cabbage worm, tomato hornworm, and cabbage looper. These spray formulations may be slow acting.

Lady beetles and their larvae prey on aphids, spider mites, and scale insects. The beetles are collected and sold to gardeners by the gallon, but apparently most of the beetles released promptly move out of the area of release or fail to feed and reproduce. Other insects and their eggs are also sold, but for various reasons are of dubious effectiveness in establishing a resident population in the garden. It is probably more productive to provide good conditions for the natural population growth of control organisms in the garden than to introduce exotics. Gardening practices that encourage biological life in general will usually encourage the control organisms. Don't overlook the possibility of attracting insect-feeding birds to the garden to control insects.

Vigorous growing plants are generally more able to withstand insect and disease attacks. Good gardening with particular attention to soil fertility and good irrigation practices will help minimize damage. Since some bacterial diseases such as bean blights are spread by splashing water, use surface application rather than sprinkling for irrigating beans as a control method. Don't harvest

or cultivate beans when the plants are wet. As some fungus spores need a water film on the plant surface for germination, sprinkler irrigation should be done during the day to encourage quick drying. Planting at the proper time can also help avoid disease; don't plant warm season crops such as beans and melons until the soil temperature reaches 60°F. Lower soil temperatures favor pathogenic organisms which cause seed rot and damping-off of the seedlings.

You may want to work barley straw into the soil to promote populations of enemies of root rot organisms (wheat straw may also be effective). Working organic matter into the soil and other practices that encourage good aeration seems to limit the severity of root rots, but excessive applications of manure or other nitrogen sources may encourage the root rot organisms.

Some plant extracts with insecticidal properties such as pyrethrum have relatively low toxicity to warm-blooded animals. However, use pyrethrum, rotenone and other plant extract insecticides with care since they can also kill beneficial species and, if misused, may result in more severe pest problems.