# Appendix 2
# Biological Controls



If you were to ask the average farmer or backyard gardener how to control a particular insect or plant pest, you might be given the name of some poisonous spray or bait that has proved "effective" in the past. Evidence that spraying with such substances yields only temporary results, however, has been mounting for many years, and the spraying is frequently followed by even larger invasions of pests. Also, the residues of poisonous sprays often accumulate in the soil and disrupt the microscopic living flora and fauna essential to the soil's health. The problem is compounded and the ecology further upset when large amounts of inorganic fertilizers are added. As increasing numbers of people become aware of the devastating effects of pesticides and herbicides on the environment, they have been turning to **biological controls** as an alternative to the use of poisonous sprays. To the surprise of some, such controls are often more effective than traditional controls.

Poisonous sprays often promote pest invasions because the sprays usually kill beneficial insects along with the undesirable ones. In addition, the pests, through mutations, often become resistant to the sprays. In undisturbed natural areas, weeds are never a problem, and even though pests may be present, they seldom destroy the community. Why is this so? You may recall from your reading that all members of a community are in ecological balance with one another. The plants produce a variety of substances that may either repel or attract insects, inhibit or promote the growth of other plants, and generally contribute to the health of the community as a whole.

Virtually all insects have their own pests and diseases, as do most other living organisms. Each pest ensures, at least indirectly, that the various species of a community are perpetuated. This principle of nature can be applied, to a certain extent, to farming and gardening. The following are some general and specific biological controls now in widespread use. Others being tested showing promise for the future are included.

## GENERAL CONTROLS

### Establishment of Beneficial Organisms

#### *Ladybugs (Family Coccinellidae)*

The small and often colorful beetles called *ladybugs,* and particularly their larval stages, consume large numbers of aphids, thrips, insect eggs, weevils, and other pests. They are obtainable from various commercial sources (e.g., Planet Natural, P.O. Box 3146, Bozeman, MT 59772 [1-800-289-6656 or http://www.planetnatural.com/]; Nature's Way Organics, P.O. Box 228, Rimrock, AZ 86335) but, if given a chance, they probably will establish themselves without being imported. When obtained from outside of the local area, they should be placed in groups at the bases of plants on which pests are present, preferably in the early evening after watering.

#### *Lacewings (Families Chrysopidae and Hemerobiidae)*

*Lacewings* are slow-flying, delicate-winged insects that consume large numbers of aphids, mealybugs, and other pests. They lay their eggs on the undersides of leaves, each egg being borne at the tip of a slender stalk. The larvae consume the immature stages of leafhoppers, bollworms, caterpillar eggs, mites, scale insects, thrips, aphids, and other destructive pests. Commercial sources include Nature's Way Organics, P.O. Box 228, Rimrock, AZ 86335 (1-800-493-1885); All Pest Control, 6030 Grenville Lane, Lansing, MI 48910.

### *Praying Mantis (Family Mantidae)*

About 20 species of *praying mantis* are now established in the United States. These are voracious feeders that prey somewhat indiscriminately on flying insects and sometimes even on other mantises. They can be established by tying their egg cases to tree branches or at other locations above the ground. The egg cases, which form compact masses about 2.5 to 5.0 centimeters (1 to 2 inches) long, are obtainable from various commercial sources, including Peaceful Valley Farm Supply, P.O. Box 2209, Grass Valley, CA 95945; Planet Natural, P.O Box 3146, Bozeman, MT 59772 (1-800-289-6656 or http://www.planetnatural.com/).

### *Trichogramma Wasps (Family Trichogrammatidae)*

*Trichogramma wasps* are minute insects, mostly less than 1 millimeter (1/25 inch) long; they parasitize insect eggs and are known to have significantly reduced populations of well over 100 different insect pests, including alfalfa caterpillars, armyworms, cabbage loopers, cutworms, hornworms, tent caterpillars, and the larvae of many species of moths. As with other insects used as biological controls, trichogramma wasps should not be released unless there are pest eggs in the vicinity, as the wasps may otherwise parasitize eggs of beneficial butterflies and other useful insects. They are available from commercial sources such as Unique Insect Control, P.O. Box 15376, Sacramento, CA 95851; New Earth, 4422 East Hwy. 44, Shepherdsville, KY 40165.

### *Ichneumon Wasps (Family Ichneumonidae)*

The *ichneumon wasps* belong to a very large family of wasps that are mostly stingless. These tiny wasps tend to be slender and have long ovipositors that are sometimes longer than the body. Most insects are parasitized by at least one species of ichneumon; many species parasitize the larval stages of insects, consuming the host internally after hatching from eggs deposited on the body; alternatively, they may complete development in a later stage. Ichneumons will usually appear naturally in a backyard or farm population of pests if toxic sprays and other unnatural conditions have not interfered with their normal activities.

### *Tachinid Flies (Family Tachinidae)*

Many members of the large family of *tachinid flies* resemble houseflies or bumblebees. All parasitize other insects, including a large variety of caterpillars, Japanese beetles, European earwigs, grasshoppers, gypsy moths, tomato worms, sawflies, and various beetles. Contact Mad Planter Beneficials at 1-800-548-8199 for further information.

### *Mites (Phytoseiidae and others)*

Species of several genera of mites prey on red spider mites and have been used successfully to control other mites and scale insects.

### *Mosquito Fish (Gambusia affinis)*

Mosquito fish have been added to bodies of fresh water all over the world to control mosquitoes. The fish feed on mosquito larvae, particularly as the larvae rise to the surface for air. One mosquito fish can consume thousands of larvae per day.

## Use of Pathogenic Bacteria

*Bacillus thuringiensis* (Bt) is one of several pathogenic bacteria registered for use on edible plants in the United States. It reproduces only in the digestive tracts of caterpillars and is harmless to humans and all other wildlife, including earthworms, birds, and mammals. It is exceptionally effective against a wide range of caterpillars, such as tomato hornworms and fruitworms, cabbage worms and loopers, grape leaf rollers, corn borers, cutworms, fall webworms, and tent caterpillars. It is mass-produced and sold in a powdered spore form at nurseries and garden supply stores under the trade names of *Dipel, Biotrol,* and *Thuricide.* The powder is mixed with water and applied as a spray. Beneficial bacteria are available from Solutions Unlimited, Sharon Springs, NY 13459.

## Establishment of Toads and Frogs

It has been estimated that a single adult toad will consume about 10,000 insects and slugs in one growing season. Toads and frogs feed at night when snails, slugs, sowbugs, earwigs, and other common pests are active.

## Use of Beneficial Nematodes

Several species of these abundant microscopic roundworms are notorious for damaging economically important crops when they invade plant roots and other underground organs. Most species, however, are either harmless or beneficial to plants. They have been used successfully in parasitizing cabbage worm caterpillars, codling moth larvae, Japanese beetle grubs, and tobacco budworms and have shown considerable potential against other pests. One species that has been particularly effective in controlling ants, beetles, bugs, flies, wasps, and many other insects is the caterpillar nematode (*Neoaplectana carpocapsae*). It carries a symbiotic bacterium (*Xenorhabdus nematophilus*), which multiplies rapidly in the host, killing most insects within 24 hours after initial contact. It may be obtained from Nematode Farm, Inc., 2617 San Pablo Avenue, Berkeley, CA 94702.

## Use of Limonoid Sprays

*Limonoids* are bitter substances found in the rinds, seeds, and juice of citrus fruits (especially grapefruit). If the rinds and seeds of two or three fruits are ground up, soaked overnight in a pint of water, and the solid material is strained out, the liquid may then be sprayed on plants. The bitter principle apparently stops or reduces the feeding of larvae on the foliage. In experiments, limonoid sprays have proved effective against corn

earworm, fall armyworm, tobacco budworm, and pink bollworm, but undoubtedly will deter many other pests as well.

## Use of Liquefied Pest Sprays

Jeff Cox, an editor of Rodale's *Organic Gardening* magazine, called attention to this method of pest control in the magazine in October 1976, and again in May 1977. Insect pests or slugs are gathered in small quantities and liquefied with a little water in a blender. The material is then further diluted with water and sprayed throughout the infested area. It is not known why spraying with "bug juice" is effective against pests. It is known, however, that virtually all organisms harbor viruses. It has been theorized that even the inactive viruses carried by healthy insects and slugs may somehow be activated in the process of liquefaction. The viruses would be spread throughout an entire yard or farm if all parts of the area were sprayed. Most viruses are highly specific, generally attacking a single species of organism. M. Sipe, a Florida entomologist who recommended the "bug juice" technique, also suggested that the odor of the liquefied insects possibly attracts their predators and parasites or that the insects' distress **pheromones** (naturally produced insect chemicals that influence sexual or other behavior) are released by the blender, with the pheromones acting as an insect repellent. Possibly the observed effects of spraying "bug juice" are the result of a combination of viruses, predator attraction, and repellent pheromones. Sipe warns that if one tries this method of pest control, care should be taken to use only pest species and only those that are doing significant damage. Failure to heed this warning could disrupt the activities of natural predators and other natural controls present. This approach needs extended testing and investigation of its safety for use by humans, but test results over the past 20 years in various areas of North America have yielded impressive results with no evidence of harm to humans or beneficial organisms.

## Use of Resistant Varieties

Many plants may kill or inhibit disease fungi or bacteria with chemicals known as *phytoalexins.* Phytoalexins are synthesized at the point of attack or invasion by the pathogen and are toxic to the fungus or bacterium. In selecting for improved fruit quality, vigor of growth, or other desirable characteristics, horticulturists in the past have sometimes unknowingly bred out a plant's capacity to produce certain phytoalexins, although general vigor is usually accompanied by disease resistance. Now that this aspect of a plant's defense mechanisms is known, breeders are concentrating on developing varieties capable of producing phytoalexins against various fungi, bacteria, and even nematodes. Several tomato varieties, for example, are listed as being *VFN.* The letters *V* and *F* indicate a resistance to *Verticillium* and *Fusarium* (common pathogenic fungi), while the letter *N* denotes a resistance to *root-knot nematodes.*

Other aspects of plant disease resistance include thick cuticles; the secretion of gums, resins, and other metabolic products that may interfere with fungal and bacterial spore germination; and the presence within all the cells of the plant of chemical compounds toxic to pathogens.

## Interplanting with Plants that Produce Natural Insecticides or Substances Offensive to Pests

Many plant species produce substances that repel a significant number of pests, but none produce anything that repels all pests. Among the best-known plant producers of insect repellents are marigolds; garlic; and members of the Mint Family, such as pennyroyal, peppermint, basil, and lavender. An expanded discussion of this subject is given in Appendix 3.

# SPECIFIC CONTROLS

## Weeds

In 1974, the Weed Science Society of America published a special committee report (*Weed Science* 22: 490–95) on the biological control of weeds, summarizing the status of projects on the biological control of weeds with insects and plant pathogens in the United States and Canada. Table A2.1 is condensed from that report and supplemented with additional information. Many other biological controls for these and other weeds are currently under investigation.

## Insects

The maintenance of ecological balance in nature includes a vast array of predator-prey relationships between animals, birds, insects, and other organisms. Specific biological controls for several types of insect pests, in addition to the general controls previously discussed, are given in Table A2.2.

# COMPANION PLANTING

The "Additional Reading" list reveals that the literature on the chemical interactions among plants and also among plants and their consumers is already extensive. Despite the scientific evidence on the subject to date, however, a significant amount of the "backyard biological control" that is practiced today is based primarily on empirical information. Such information has been obtained from thousands of gardeners and farmers who have tried various techniques with their plantings and pest controls. As a result, they have come to conclusions that certain things work, while others do not, but they have not deliberately set up controlled experiments, nor have they necessarily understood the scientific basis for what they have observed. This does not mean that their observations are not useful or that they are invalid. In fact, such empirical observations have often been the inspiration for investigations

## TABLE A2.1

# Specific Weeds and Agents Involved in Their Biological Control

| WEED | AGENT(S) OF BIOLOGICAL CONTROL |
|---|---|
| **Alligator weed** (*Alternanthera philoxeroides*) | Flea beetles (*Agasicles hygrophila*) |
| **Bladder campion** (*Silene cucubalus*) | Tortoise beetle (*Cassida hemisphaerica*) |
| **Brazil peppertree** (*Schinus terebinthifolius*) | Weevil (*Bruchus atronotatus*) and others |
| **Brushweed** (*Cassia surattensis*) | Imperfect fungus (*Cephalosporium* sp.) |
| **Curly dock** (*Rumex crispus*) | Rust (*Uromyces rumicis*) |
| **Curse** (*Clidemia hirta*) | Thrip (*Liothrips urichi*) and others |
| **Cypress spurge** (*Euphorbia cyparissias*) | Sphinx moth (*Hyles euphorbiae*) |
| **Dalmatian toadflax** (*Linaria dalmatica*) | Leaf miner (*Stagmatophora serratella*) and others |
| **Emex** (*Emex australis*) | Seed weevils (*Apion antiquum*) and others |
| **Gorse** (*Ulex europaeus*) | Seed weevils (*Apion ulicis*) and others |
| **Halogeton** (*Halogeton glomeratus*) | Casebearer (*Coleophora parthenica*) and others |
| **Hawaiian blackberry** (*Rubus penetrans*) | Sawflies (*Pamphilius sitkensis, Priophorus morio*) and others |
| **Jamaica feverplant** (**puncture vine**) (*Tribulus terrestris*) | Weevils (*Microlarinus* spp.) |
| **Joint vetch** (*Aeschynomene virginica*) | Imperfect fungus (*Colletotrichum gloeosporioides*) |
| **Klamath weed** (*Hypericum perforatum*) | Leaf beetles (*Chrysolina* spp.), buprestid beetle (*Agrilus hyperici*) |
| **Lantana** (*Lantana camara*) | Seed weevil (*Apion* sp.), ghost moth (*Hepialus* sp.), plume moth (*Platyptilia pusillidactyla*), hairstreaks (*Strymon* spp.), and others |
| **Leafy spurge** (*Euphorbia esula*) | Wood-boring beetle (*Oberea* sp.) and others |
| **Mediterranean sage** (*Salvia aethiopis*) | Snout beetles (*Phrydiuchus* spp.) |
| **Milkweed vine** (*Morrenia odorata*) | Oomycete fungus (*Phytophthora citrophthora*), rust (*Aecidium asclepiadinum*) |
| **Prickly pear** (*Opuntia* spp.) | Moth (*Cactoblastis cactorum*), cochineal insects (*Dactylopius* spp.), and others |
| **Puncture vine (*see* Jamaica feverplant)** | Weevils (*Microlarinus* spp.) |
| **Scotch broom** (*Cytisus scoparius*) | Seed weevil (*Apion fuscirostre*) and others |
| **Skeleton weed** (*Chondrilla juncea*) | Gall mite (*Aceria chondrillae*), root moth (*Bradyrrhoa gilveolella*), rust (*Puccinia chondrillina*), powdery mildews (*Erysiphe cichoracearum, Leveillula taurica*) |
| **Spiny emex** (*Emex spinosa*) | Seed weevil (*Apion antiquum*) |
| **Tansy ragwort** (*Senecio jacobaea*) | Seed fly (*Hylemya seneciella*), cinnabar moth (*Tyria jacobaeae*), leaf beetle (*Longitarsus jacobaeae*) |
| **Thistles:** | |
| **Bull thistle** (*Cirsium vulgare*) | Weevil (*Ceuthorrhynchidius horridus*), tortoise beetle (*Cassida rubiginosa*) |
| **Canada thistle** (*Cirsium arvense*) | Weevil (*Ceutorhynchus litura*), flea beetle (*Altica carduorum*), stem gall fly (*Urophora cardui*) |
| **Diffuse knapweed** (*Centaurea diffusa*) | Seed fly (*Urophora affinis*) |
| **Italian thistle** (*Carduus pycnocephalus*) | Flea beetles (*Rhinocyllus conicus, Psylliodes chalcomera*), weevil (*Ceutorhynchus trimaculatus*) |
| **Milk thistle** (*Silybum marianum*) | Flea beetle (*Rhinocyllus conicus*) |
| **Musk thistle** (*Carduus nutans*) | Weevils (*Ceutorhynchus trimaculatus, Ceuthorrhynchidius horridus, Rhinocyllus conicus*), flea beetle (*Psylliodes chalcomera*) |
| **Perennial sowthistle** (*Sonchus arvensis*) | Peacock fly (*Tephritis dilacerata*) |
| **Plumeless thistle** (*Carduus acanthoides*) | Tortoise beetle (*Cassida rubiginosa*), seed weevil (*Rhinocyllus conicus*), weevil (*Ceuthorrhynchidius horridus*) |
| **Russian thistle** (*Salsola kali var. tenuifolia*) | Casebearer (*Coleophora parthenica*) and others |
| **Slenderflower thistle** (*Carduus tenuiflorus*) | Weevil (*Ceutorhynchus trimaculatus*) |
| **Spotted knapweed** (*Centaurea maculosa*) | Seed fly (*Urophora affinis*) and others |
| **Star thistle** (*Centaurea nigrescens*) | Weevil (*Ceuthorrhynchidius horridus*) |
| **Yellow star thistle** (*Centaurea solstitialis*) | Seed fly (*Urophora siruna-seva*) |
| **Water hyacinth** (*Eichhornia crassipes*) | Weevils (*Neochetina bruchi, N. eichhorniae*), moth (*Sameodes albiguttalis*) |
| **Water purslane** (*Ludwigia palustris*) | Snout beetle (*Nanophyes* sp.) |

## TABLE A2.2

# Specific Biological Controls for Several Types of Insect Pests

| INSECT | CONTROL |
|---|---|
| **Ants (about 8,000 spp. within the Superfamily Formicoidea)** | Ants that carry aphids into trees and consume ripening fruits can be prevented from getting farther than the trunk by applying a band of sticky material around the trunk. A commercial preparation sold under the trade name of *Tanglefoot* is particularly effective. A water suspension of ground hot peppers *(Capsicum* spp.) used as a spray can act as an ant deterrent. *Caution:* Many ants are beneficial to a balanced ecology; they should not be decimated indiscriminately. |
| **Grasshoppers (there are several families of grasshoppers, but the insects that usually constitute the most serious pests are species of *Melanoplus,* Family Acrididae)** | In 1980, the Environmental Protection Agency permitted private companies to begin the mass culture of a protozoan, *Nosema locustae,* for use in controlling rangeland grasshoppers. Tests have shown that properly timed applications of spores mixed with wheat bran can reduce grasshopper populations by up to 50%. |
| **Gypsy moths (*Porthetria dispar*)** | Parasitic wasps (*Apanteles flavicoxis, A. indiensis*) imported from India lay their eggs in gypsy moth caterpillars and kill large numbers. |
| **Japanese beetles (*Popillia japonica*)** | The pathogenic bacterium *Bacillus popillae,* which is sold commercially, is specific for Japanese beetle larvae. It causes what is known as "milky spore disease" in the grubs while they are still in the soil, and it is very destructive. It is available from St. Gabriel Laboratories, 14540 John Marshall Hwy., Gainesville, VA 20155 (1-800-801-0061 or http://www.milkyspore.com). |
| **Mealybugs (*Pseudococcus* spp.)** | The small brown beetles called *crypts* (*Cryptolaemus montrouzieri*) effectively control mealybugs in greenhouses and also outdoors on apple, pear, peach, and citrus trees. Order from Rincon-Vitova Insectaries, Inc., P.O. Box 95, Oak View, CA 93022. |
| **Mosquitoes (*Culex* spp., *Anopheles* spp., and others)** | The bacterium *Bacillus thuringiensis* var. *israelensis* has proved to be very effective in destroying mosquito larvae. A fungus *(Lagenidium giganteum)* has also proved highly effective against mosquito larvae if the temperature is above 20°C (68°F). The bacterium is available from several sources, including Abbott Laboratories, Dept. 95-M, 1400 Sheridan Rd., N. Chicago, IL 60064; Sandoz, Inc., 480 Camino del Rio S., San Diego, CA 92108. |
| **Red spider mites (*Tetranychus telarius*)** | Predatory mites (*Phytolesius persimilis,* which works best when weather is not hot, and *Amblyseius californicus,* which is more effective in hot weather) effectively control populations of red spider mites. |
| **White flies (*Trialeurodes vaporariorum*)** | A minute wasp, *Encarsia formosa,* parasitizes white flies exclusively. The wasps have been known to be very effective in greenhouses. They are obtainable from White Fly Control Co., Box 986, Milpitas, CA 95035; Rincon-Vitova Insectaries, Inc., P.O. Box 95, Oak View, CA 93022. White flies are attracted to the color yellow. Large numbers of white flies are trapped when a yellow board is sprayed or painted with any sticky substance and placed in the vicinity of the pests. |

## TABLE A2.3

# Companion Plants

| PLANT | COMPANIONS AND EFFECTS |
|---|---|
| **Asparagus** | Tomatoes, parsley, basil |
| **Basil** | Tomatoes (improves growth and flavor); said to dislike rue; repels flies and mosquitoes |
| **Beans** | Potatoes, carrots, cucumbers, cauliflower, cabbage, summer savory, most other vegetables and herbs; around house plants when set outside |
| **Beans (bush)** | Sunflowers (beans like partial shade, sunflowers attract birds and bees), cucumbers (combination of heavy and light feeders), potatoes, corn, celery, summer savory |
| **Beets** | Onions, kohlrabi |
| **Borage** | Tomatoes (attracts bees, deters tomato worm, improves growth and flavor), squash, strawberries |
| **Cabbage Family** | Potatoes, celery, dill, chamomile, sage, thyme, mint, pennyroyal, rosemary, lavender, beets, onions. Aromatic plants deter cabbage worms |
| **Carrots** | Peas, lettuce, chives, onions, leeks, rosemary, sage, tomatoes |
| **Catnip** | Plant in borders; protects against flea beetles |
| **Celery** | Leeks, tomatoes, bush beans, cauliflower, cabbage |
| **Chamomile** | Cabbage, onions |
| **Chervil** | Radishes (improves growth and flavor) |
| **Chives** | Carrots; plant around base of fruit trees to discourage insects from climbing trunk |
| **Corn** | Potatoes, peas, beans, cucumbers, pumpkin, squash |
| **Cucumbers** | Beans, corn, peas, radishes, sunflowers |
| **Dill** | Cabbage (improves growth and health), carrots |
| **Eggplant** | Beans |
| **Fennel** | Most plants are supposed to dislike it |
| **Flax** | Carrots, potatoes |
| **Garlic** | Roses and raspberries (deters Japanese beetle); with herbs to enhance their production of essential oils; plant liberally throughout garden to deter pests |
| **Horseradish** | Potatoes (deters potato beetles); around plum trees to discourage curculios |
| **Lamb's quarters** | Nutritious edible weed; allow to grow in modest amounts in the corn |
| **Leek** | Onions, celery, carrots |
| **Lettuce** | Carrots and radishes (lettuce, carrots, and radishes make a strong companion team), strawberries, cucumbers |
| **Lovage** | Plant here and there in garden |
| **Marigolds** | The workhorse of pest deterrents; keeps soil free of nematodes; discourages many insects; plant freely throughout garden |
| **Marjoram** | Here and there in garden |
| **Mint** | Cabbage family; tomatoes; deters cabbage moth |
| **Mole plant** | Deters moles and mice if planted here and there throughout the garden |
| **Nasturtium** | Tomatoes, radishes, cabbage, cucumbers; plant under fruit trees. Deters aphids and pests of cucurbits |
| **Onion** | Beets, strawberries, tomato, lettuce (protects against slugs), beans (protects against ants), summer savory |
| **Parsley** | Tomato, asparagus |
| **Peas** | Squash (when squash follows peas up trellis), plus grows well with almost any vegetable; adds nitrogen to the soil |
| **Petunia** | Protects beans; beneficial throughout garden |
| **Pigweed** | Brings nutrients to topsoil; beneficial growing with potatoes, onions, and corn; keep well thinned |
| **Potato** | Horseradish, beans, corn, cabbage, marigold, limas, eggplant (as trap crop for potato beetle) |
| **Pot marigold** | Helps tomato, but plant throughout garden as deterrent to asparagus beetle, tomato worm, and many other garden pests |
| **Pumpkin** | Corn |
| **Radish** | Peas, nasturtium, lettuce, cucumbers; a general aid in repelling insects |
| **Rosemary** | Carrots, beans, cabbage, sage; deters cabbage moth, bean beetles, and carrot fly |
| **Rue** | Roses and raspberries; deters Japanese beetle; keep it away from basil |
| **Sage** | Rosemary, carrots, cabbage, peas, beans; deters some insects |
| **Southernwood** | Cabbage; plant here and there in garden |
| **Soybeans** | Grows with anything, helps everything |
| **Spinach** | Strawberries |
| **Squash** | Nasturtium, corn |
| **Strawberries** | Bush beans, spinach, borage, lettuce (as a border) |
| **Summer savory** | Beans, onions; deters bean beetles |

## TABLE A2.3

### Companion Plants

| PLANT | COMPANIONS AND EFFECTS |
|---|---|
| **Sunflower** | Cucumbers |
| **Tansy** | Plant under fruit trees; deters pests of roses and raspberries; deters flying insects; also Japanese beetles, striped cucumber beetles, squash bugs, deters ants |
| **Tarragon** | Good throughout garden |
| **Thyme** | Here and there in garden; deters cabbage worm |
| **Tomato** | Chives, onion, parsley, asparagus, marigold, nasturtium, carrot, limas |
| **Turnip** | Peas |
| **Valerian** | Good anywhere in garden |
| **Wormwood** | As a border, keeps animals from the garden |
| **Yarrow** | Plant along borders, near paths, near aromatic herbs; enhances essential oil production of herbs |

and experiments by scientists. The scientific investigations have sometimes revealed that the empirical observations were biased or not carefully made or that erroneous conclusions had been drawn, but frequently, sound scientific bases for these observations have been uncovered.

Further insights into how plants inhibit or enhance the growth of others and into the nature of their resistance to disease or insect-repelling mechanisms continue to be discovered. Observations of such phenomena in the past have led organic gardeners and others to the practice of *companion planting,* which involves the interplanting of various crops and certain other plants in such a way that each species derives some benefit from the arrangement. The following companion planting list, based primarily on empirical information, appeared in the February 1977 issue of *Organic Gardening and Farming* magazine. It is included here with the permission of Rodale Press, Inc.

Table A2.3 is a list of combinations of vegetables, herbs, flowers, and weeds that are mutually beneficial, according to current reports of organic gardeners and to companion-planting traditions.

## SOME SOURCES OF HERB PLANTS AND SEEDS

China Herb Co., 428 Soledad, Salinas, CA 93901
Cottage Herbs, P.O. Box 100, Troy, ID 83871
De Giorgi Co., 6011 N St., Omaha, NE 68117
Fragrant Fields, Dongola, IL 62926
Herbs-Liscious, 1702 S. Sixth St., Marshalltown, IA 50158
Hsu's Ginseng Enterprises, P.O. Box 509, Wausau, WI 54402
Jude Herbs, Box 56360, Huntington Station, NY 11746
Otto Richter and Sons, Box 260, Goodwood, Ontario, LOC 1A0
PG Nursery, R18, Box 470, Bedford, IN 47421
Putney Nursery, Putney, VT 05346
Rawlinson Garden Seed, 269 College Rd., Truro, Nova Scotia B2N 2P6
Sanctuary Seeds, 2388 West Fourth Avenue, Vancouver, British Columbia V6K 1P1
Sea Island Savory Herbs, 5920 Chisolm, John's Island, SC 29455
Shoestring Seeds, P.O. Box 2261, Martinsville, VA 24113
Story House Herb Farm, Route 7, Box 246, Murray, KY 42071
Sunnybrook Farms Nursery, Box 6, Chesterland, OH 44026
Sunshine Herbs and Flowers, Rt. 1, Box 234, Comer, GA 30629
Thompson and Morgan, Inc., P.O. Box 1308, Jackson, NJ 08527
The Thyme Garden, 20546-0 Alsea Hwy., Alsea, OR 97324
Wildwood Herbal, P.O. Box 746, Albemarle, NC 28002
Willhite Seed Company, Box 23, Poolville, TX 76076

## ADDITIONAL READING


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