

Grow More Vegetables Citywide

Bronx Green-Up's *Grow More Vegetables Certificate Series* is a free edible gardening course designed to teach the best organic techniques for growing vegetables safely and effectively, particularly in urban settings. This development of this online course material (outlines 1-5 and course handouts available online at http://www.nybg.org/green_up/tips.php) was made possible by The New York Community Trust.

Grow More Vegetables Certificate Series	5: Organic Growing Techniques II
Total Time:	2 hours
Learning Objectives	In this class, students will: • define integrated pest management (IPM) and understand it as a multifaceted approach to crop health. • understand the difference between IPM and organic food production. • identify good practices that help prevent pests and diseases from arising in the garden. • discuss methods of treating a pest outbreak or plant disease once it has been identified.
Materials	Handouts: <i>Organic Pest Control</i>; <i>Make Your Own Spray Tea</i> Pest identification guides
Quiz 15-20 min	Quiz Review of Organic Growing Techniques I Introduction • Healthy plants with a good intake of nutrients are less likely to become diseased or infested by insects than stressed plants. Remember that the key to plant nutrient availability is in healthy

Bronx Green-Up, the community gardening outreach program of The New York Botanical Garden, provides horticultural advice, technical assistance, and training to local gardeners, urban farmers, school groups, and other organizations interested in improving neighborhoods through greening projects. At the heart of Bronx Green-Up are the community gardens, school gardens, and urban farms of the Bronx. For additional information, contact Bronx Green-Up at 718.817.8026 or bronxgreenup@nybg.org, or visit www.nybg.org/green_up

5 min	soil, which stores and releases nutrients, feeding plants. • In fact, about 90 percent of insect attacks occur on already distressed plants, according to author John Jeavons¹, and poor-quality soil is usually the source of the problem. Did you prepare your soil properly? Did you use enough compost? What is the soil pH? • Remember, too, that not all insects are bad—only a small percentage of insect species cause severe problems to vegetable plants. Others are beneficial pollinators or pest predators. • If you see signs of damage, try to identify the insect and notice how many there are to determine if you actually have an infestation. The damage done by insects often affects a small percentage of your crop. • Growing plants in their proper environmental conditions is important. Cool weather crops should be grown in spring or fall. Tomatoes need full sun. Some crops need more water than others. Beets and carrots prefer not to be transplanted, so it is better to direct seed.
10 min	Background The use of pesticides increased tenfold from 1945 to 1989. But all those chemicals didn't necessarily help increase crop production. Crop losses from insect damage actually increased over the same period, from 7 to 13%, partly because some pests have developed a resistance to pesticides over the past few decades.² In 1962 Rachel Carson published <i>Silent Spring</i>, bringing awareness of the dangers of certain pesticides, especially DDT. We have known for many years since that the use of pesticides raises environmental and human health concerns. • Pesticides affect more than just the bad bugs in the garden. They may disrupt natural habitats by destroying beneficial insects and can also harm fish and birds. • Pest populations can become resistant to pesticides over time. • Pesticides kill soil organisms. • Pesticide residues may remain on our food, posing a danger to humans and animals, especially children. Pesticides and herbicides may leach into our groundwater. Chemical fertilizers Similarly, there are concerns with the overuse of chemical fertilizers. You can think of their use with this analogy: if humans subsisted solely on vitamins, their diet would lack fiber, carbohydrates, and fat, creating an

12 min

imbalance. Fertilizers deliver a rush of synthetic nutrients to plants all at once.

- Chemical fertilizers provide nutrients to plants for only a short time. The soil can only take up so much in the way of minerals, and the rest are washed away.
- Over time, the natural processes of erosion, movement of water, and plant growth use up whatever organic matter was available to the soil.
- If you use only chemical fertilizers, you are not replenishing the necessary organic matter that microorganisms need to survive. Fewer of these beneficial organisms slow humus production and increase erosion.
- Chemicals make the soil more and more acidic, promoting salt buildup (salinization) and an area in which growth becomes difficult.
- In addition, fertilizer production and application to plants is dependent upon fossil fuel use, from the factory to the field.

The 1970s brought the environmental movement and a revival of organic gardening. This is when **Integrated Pest Management (IPM)** was brought into national consciousness.

IPM defined: Integrated Pest Management is an integrated approach to pest problems that uses many techniques to keep plants healthy, and only using pesticides as a last resort. IPM utilizes a series of pest management evaluation methods, decisions, and controls.

IPM programs focus on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment.

Organic food production, the focus of this course, uses many of the same strategies as IPM, but limits the use of pesticides to those that are produced from natural sources, as opposed to synthetic chemicals.

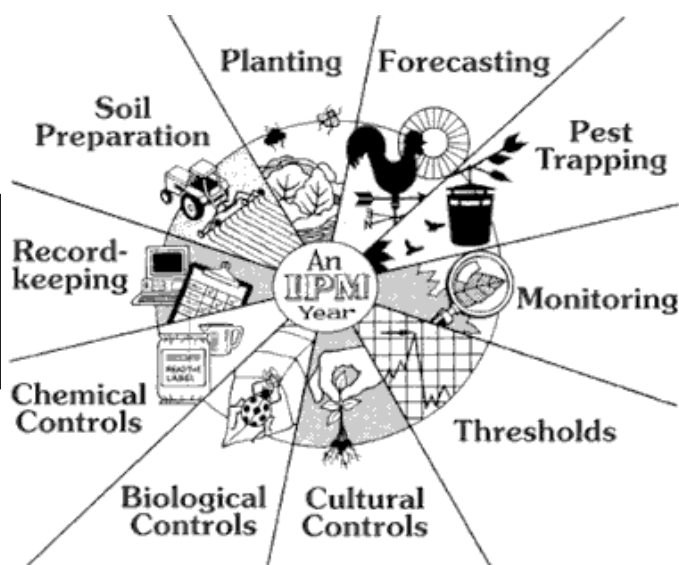
Organic pesticides may still have health and environmental risks and should still be used carefully. IPM techniques are also useful in reducing these risks in organic production.

Below is a visual of IPM strategies, created by Cornell University.³

You can learn more at this Web site:

<http://www.ipminstitute.org/faq.htm>.

Note: We will be discussing organic controls instead of chemical controls in this class.



Here are some ways to practice IPM:

Identification:

- Distinguish weed and insect pests from beneficial ones. Also, recognize pests and diseases common to our region.
- The Northeast Vegetable and Strawberry Pest Identification Guide is a helpful resource, or get an ID handbook: <http://extension.umass.edu/vegetable/publications/northeast-vegetable-and-strawberry-pest-identification-guide>
- Gather and study information about the site, plants, and potential pests and problems so you begin to know what to expect.

Path of Least Toxicity:

The entire garden should be viewed as an ecosystem. Gardeners have the ability to alter that ecosystem and also a responsibility to protect our habitat and natural resources. Choose the least toxic ways to manage pests and reduce pesticide use. Pests will continue to exist. It is more reasonable to manage pest populations below a damaging level. You might even plant a little extra for the insect world to eat.

- Change attitudes about the “perfect” fruit or vegetable.
- Alter garden practices that may be harmful (such as mowing, excessive tilling, overfertilizing, or overwatering).
- **Physically control** small populations of some insects, diseases, and weeds through actions like handpicking, creating barriers or

10 min	traps, applying water-based sprays, or creating dry conditions. <i>We will look into these a bit later.</i> • Use biological controls against pests. Biological controls utilize natural enemies in the insect world (like predatory wasps, for example) to suppress pest populations. <i>We will cover this later on.</i> • Treat only the plants that require treatment. • Apply materials when they will be most effective (i.e. not before a rainstorm). Monitoring for Pests: • Tools to Use: Hand lens, pruners, clipboard and white paper, sample bags or containers for insects, trowel, flashlight, camera, site map, ID handbook • General Plant Appearance: Is this how the plant looks normally? Regularly inspect your garden to familiarize yourself with your plants. • How to Inspect: Look under leaves and in crotches. Look for signs of droppings. Check the soil around the plant for signs. Know what you are looking for. • How often: At least every two weeks, but the more often, the better, especially in spring. Record-keeping is essential to the success of IPM. Records are critical to evaluating the success or failure of the treatment you choose. Your records can also help you predict the timing of future pest activity. Here are some tips: • Record characteristics of the pest in order to ID • Record dates of infestations to be prepared the following year • Make notes of successful companion plantings and the effectiveness of methods you have used • Here is a link to some IPM record-keeping resources, from Texas A&M Agrilife Extension: http://schoolipm.tamu.edu/forms/ipm-inspection-monitoring-and-sighting-logs/ <u>Prevention: First Steps to Pest Control¹</u> Preventive measures are really the best way to control for diseases and many of these methods are foundational to organic gardening. These are generally good garden practices to use whether or not there are pests, and so they are called cultural controls. (Some of these we have discussed in earlier classes.) • Start with the soil. As we learned in Class 3, healthy soil, rich in organic matter and biologically active, leads to healthy plants. • Choose the right plant for the site. Try to grow plants that are
--	---

Add-on activity:
Create a class list of vegetable varieties that people have had success with.

well-suited to the soil type, moisture level, sun exposure, and other environmental conditions of your garden.

- **Choose resistant or hardy varieties.** Many crops have been bred over time to be improved in some way. Choose varieties that are resistant to the most common pests and diseases in your area. Some varieties can withstand drought or other adverse weather conditions.
 - Your seed catalogs will give a good description of varieties. For example, some vegetable varieties have good resistance to pest nematodes, microscopic roundworms that live in the soil and in plant tissue. They feed on plant roots and tissue (bulbs, leaves, stems, and are particularly fond of garlic and onion). Some varieties are also resistant to powdery mildew, a fungal disease that affects a wide range of plants.
- **Plant at the right time.** Some vegetables like cooler weather, such as radishes and many leafy greens. Know the best time to plant certain plants, so they may thrive in such conditions.
- **Inspect the garden as often as possible,** especially in spring, to detect early trouble with pests.
- **Provide sufficient water;** plants that are water-stressed are more susceptible to pests and disease. Try not to wet the leaves when you are watering, as this can encourage some fungal diseases. For example, you might make dams around each plant such as tomatoes; that way you can fill each dam with the hose, ensuring each plant is receiving enough water. If you do use an overhead sprinkler, do so in the morning or late afternoon, so the leaves will dry before the cooler evening temperatures set in. Overhead watering is also good for seed beds and when plants are young.
- **Properly prune and train,** especially fruiting shrubs and trees, to create better air and sunlight conditions, increasing production. Training when plants are young and annual maintenance pruning keeps trees healthy and within bounds for harvest.
- **Clean up the garden.** Gather up spent and harvested plants and add them to the compost pile. Insects and disease may overwinter in the debris. Always discard diseased plants in the trash, rather than adding them to the compost pile. This will help prevent the spread of disease.

Promote diversity.⁴ Encouraging a diverse community in your garden is an essential step to having a healthy garden. The methods outlined below, most which we have also discussed in the last class, are also cultural controls.

- **Rotate your crops.** Rotate the vegetables you plant around your

10 min

garden each year or after each new sowing. Plants in the same families tend to be susceptible to the same pests, so when rotating, don't plant any plant from the same family in the same place as before.

- The brassica family, which includes cabbage, cauliflower, broccoli, kale, and Brussels Sprouts, are all attacked by similar pests.
- **Avoid monocropping.** A **monocrop** is the planting of a whole bed or field with just one crop. As you might guess, this way of growing makes the risk of crop loss high. Many insect pests are attracted to certain plants, so they will attack a whole row if they can easily move from one plant to another. If a whole field of corn becomes infested with the corn borer, for example, then the entire area is vulnerable to widespread attack because that pest has found its ideal habitat.
- **Use diverse cropping,** an alternative way of planting vegetables. The idea is that a greater variety of plants in one area will confuse pests and even attract predatory and beneficial insects. You can plant a diversity of crops in your garden bed, or intermix your crop plants with flowering plants. Interplanting or companion planting with flowers or vegetables of a different variety can help you avoid an explosion of pest populations. Also, mix plants of different shapes and sizes to avoid shading out plants and to save space.
- **Plant a cover crop** to enrich the soil after a harvest. You can try intercropping one with one of your vegetable crops. For example, intercropping clover with long-season row crop will have several benefits, as the clover can act as a mulch, suppressing weeds, while also fixing nitrogen in the soil area. (White clover, *Trifolium repens*, is a perennial, low-growing clover that tolerates shade and is useful in many situations.)
- **Plant perennials nearby.** Use older plants, often perennials, with a well-developed aroma and high concentration of essential oils. This helps to confuse or distract pests from your crops. Perennial herbs such as lavender have shown to be successful. Testing several herbs will help you see which ones are effective.
- **Plant flowering plants to attract beneficials.** By providing flowering plants that provide pollen and nectar, you can attract beneficial insects, many natural predators, into your garden, helping to keep pests under control. Plants that will attract beneficials include: sunflowers, dill, and cilantro and native plants such as goldenrods, asters, and mountain mint (be sure to contain goldenrods, and some asters and mints, as they may spread vigorously).
- **Plant to repel insect pests.** Some pest insects may be discouraged by certain plants.

5 min	- Whiteflies may be combated with marigolds and flowering tobacco. The strong-smelling marigold deters the whitefly while flowering tobacco has a sticky substance on the underside of its leaves where insects get trapped and die. - Ants are deterred by spearmint, tansy, and pennyroyal. - Pest nematodes and some other root pests are combated by the Mexican marigold (<i>Tagetes minuta</i>). The French marigold (<i>Tagetes patula</i>) eliminates some plant-destroying nematodes, too. (Note that there are beneficial nematodes as well.) - Aphids are repelled by spearmint, stinging nettle, nasturtium, and garlic. - Tomato worms are distracted by borage. Borage has edible blue flowers that also attract bees. • Encourage birds. Birds are very effective insect predators. Plant trees and shrubs (many natives are good choices) for food and shelter and provide fresh water year-round to encourage birds to visit your garden. Mulching is also a cultural control that can keep down weeds and moderate temperature extremes at the soil surface. Mulch is a layer of material, preferably organic matter, placed on the soil surface to conserve moisture, hold down weeds, and ultimately improve soil structure and fertility. • A mulched plant is exposed to less extreme temperatures. Unmulched roots can be damaged by sudden thaws and frosts. Mulch keeps the soil warmer in winter and cooler in summer. • Some mulches are rich in minerals and over time, rain works them into the soil to feed the roots of plants. Therefore, mulch fertilizes the soil while it sits on the surface, and also over time as it decays. • Mulching reduces weed growth and saves the gardener time spent weeding. • Less moisture will evaporate if the soil is covered by mulch on hot, dry days. • Mulching prevents erosion from wind and heavy rains. • Plants that sprawl along the ground, like squashes or cucumbers, can stay dry and clean by not touching the soil. The mulch helps prevent mildew, mold, and rot. When not to use mulch: • If seedlings are planted in a mulch soil, do not mulch immediately. The addition of organic matter may keep the soil at a high humidity, which can encourage damping off of young
---	--

15 min	plants (damping off is a disease caused by a fungus inhabiting moist, poorly ventilated soil.) Allow plants to become established before mulching. • Leave several inches clear of mulch around perennial plants to discourage crown-rot, another fungus. If there have been heavy rains, wait to mulch until the soil is no longer waterlogged. • Do not mulch wet, low-lying soils, or at least use a very light, dry material. BREAK Physical Controls are steps you can take once you have identified a specific pest problem. These methods remove the pest directly, create a barrier to keep the pest from the plant, lure pests into traps or make the environment inhospitable for the pest. Before you take a course of action, be sure to properly identify the problem. • Handpicking often works best on the slowest insects, like those still inside eggs or in the larval stage. This is a guaranteed organic method of insect control. Example: You might see a white cabbage moth flying around your cabbage, kale, or collards. If you can't catch it by hand, look out for the cabbage worm, which is greenish in color and blends right in with the cabbage. Look for holes in the leaves or dark green droppings as a sign. • Drown insects you catch in a container of soapy water. You can then dispose of them in your compost pile. • Traps: You can create places for pests to gather. Slugs will gather under a board; cucumber beetles will congregate under wilted squash vines; earwigs will go into a tube of rolled newspaper. Be sure to regularly check these traps. Other traps: - Aphids, thrips, and whiteflies are attracted to yellow. Cover a painted yellow sign with Tanglefoot (yellow sticky paper) and place at foliage level. - Slug traps – slugs are attracted to alcohol or a dish of sugar water and yeast. • Barriers: Rowcovers let sunlight and water reach plants, but not insects. These are made of thin, lightweight polyester or polypropylene, also known by the trade names Reemay or Agribon. For plants that require cross-pollination, you will need to remove the rowcovers a few hours per day. Other barriers include collars to prevent cutworms from eating plant stems, root maggot shields, tree wraps, and fruit bags.
---	---

	• Spray of water: A strong spray from a hose will knock off aphids and spider mites. • Remove all signs of pest damage. Cut out damaged portions of the leaves and gently spray off droppings with the hose. By doing this, if you missed a pest, you will see new signs of damage and will be able to take action. • Solarize the soil. This practice uses the sun's heat to kill a range of soilborne pests, such as soilborne fungal and bacterial plant pathogens, pest nematodes, or overgrowth of persistent weeds. The downside is that you take the area out of production for at least a month, but it is a simple and effective process. The steps are basically to level the area you wish to solarize, remove plant debris, wet soil thoroughly, anchor transparent plastic sheet (1–3 ml. thick), and leave on 4–6 weeks in the summer months. <u>Biological Controls</u> reduce pest populations through the use of natural enemies and typically involves an active human role. We now know that insect species are also suppressed by naturally occurring organisms (like pest predators) and environmental factors, with no human input. Natural enemies of insect pests, also known as biological control agents, include predatory or parasitic insects or mites, and pathogens. Biological control of weeds includes insects and pathogens. Biological control agents of plant diseases are most often referred to as antagonists. Biological controls include the practices we spoke about earlier, attracting beneficial animals and insects to help with pest control. Some beneficial insects are also sold commercially in mass quantities. A popular biological control product is BT, the bacterium <i>Bacillus thuringiensis</i>, which is used for a broad range of caterpillar pests. <u>Organic Controls</u> Organic controls is a broad category that refers to products that kill or deter pests. Following are a few examples: • Botanical Pesticides/Insecticides Before synthetic pesticides, pesticides were made from certain plants. These plants are now grown commercially to produce botanical pesticides that may be used in organic production. Although these pesticides (or insecticides) will break down quickly in the environment, most kill a wide variety of insects, including beneficials, and are toxic to wildlife when first applied. It is important to still use carefully and to follow use instructions. Some examples are:
--	--

	- Pyrethrum daisies contain several compounds that are used in insecticides. The dried flower heads are called pyrethrum and the extracted compounds, pyrethrins. Pyrethrins are highly irritating to insects and rapidly degrade when exposed to light or moisture. They do not persist in the environment and are moderately toxic to mammals. (Pyrethroids are more toxic, synthetic versions.) - Neem is an insecticide derived from the seeds of the neem tree. Sprays are used on the leaves to deter feeding by insects. Neem also affects the hormones of insects, inhibiting them from molting and laying eggs. Plants also take up neem extracts into their plant tissues, which helps control certain pests like leafminers, that are usually not affected by plant sprays. Many leaf-chewing beetles and caterpillars can be controlled with neem insecticides, as well as aphids, white flies, and loopers. Research indicates that it may also stop development of plant diseases. Neem biodegrades quickly and in small doses is non-toxic to mammals. • Insecticidal Soap Sprays are diluted sprays that work by damaging the cell membranes of soft-bodied insects and mites. The effects are quick, killing some insects within minutes of exposure. The soaps can kill beneficial insects as well, so use only in problem areas. The sprays work on contact, providing no later effects. Good spray coverage is necessary, and you will need to reapply after a rain event. Note: it is always good to test the spray on a few leaves before covering larger areas, as some plants, like beans, pea shoots, and nasturtiums can be damaged. - Commercial soap sprays are available, or you can make your own, mixing 1 teaspoon to several tablespoons of pure, vegetable-based soap (adjusting strength as needed—best to start with a lower concentration) per gallon of water. • Homemade Insect Spray This spray gives protection against cabbage worms, caterpillars, tomato hornworms, aphids, and other pests.⁵ Water is the carrier, soap makes the spray stick, and the plant juices are the active fighting ingredients. Ingredients: 6 cloves garlic, crushed 1 onion, minced 1 tablespoon dried hot pepper (powder works well) 1 teaspoon vegetable-based soap (do not use detergent)
--	--

Activity 15 min in groups; 5 min for each group to present	1 gallon hot water Preparation: - Blend garlic, onion, pepper, and soap in hot water and let the mixture sit for a day or two. - Strain before using as a spray. • Compost Tea can help fight fungal diseases like powdery mildew and Botrytis blight. To make compost tea: - Place 1 gallon of well-aged compost in a 5-gallon bucket and fill with water. - Set in a warm place for three days. - Filter the mixture through a screen or cloth (such as burlap or cheesecloth) and return the solids to your compost pile. - Place the liquid in a small sprayer or watering can. - Pinch off any heavily diseased leaves before applying the tea to the rest of the plant. - For best results, use the treatment in the evening, when leaves are likely to remain damp for several hours. - Sometimes a single treatment will not stop the disease. Check the plants every 3–4 days and repeat the application if necessary. Note: Resources like the book <i>Teaming with Microbes</i> tout the use of “actively aerated” compost teas for greatest effectiveness at boosting soil fertility. You can still make this type of tea at home, though it will require an aquarium pump to keep aerobic bacteria alive. Beginner Pest ID Exercise <i>In groups of 4, collect information about the pest listed on your index card using the pest identification guides. (Instructor: you can provide index cards with some common pests, such as the ones below.)</i> <i>Find out which vegetable plants or plant families your pest attacks.</i> <i>Find out how to control for the pest organically.</i> <i>Choose a notetaker and one person to report back to the class.</i> Some common garden pests and diseases: Aphids come in a range of colors, from green to whitish to red. They suck sap, causing leaves to yellow, pucker, and distort. Control methods: • Hose off with a strong spray of water. • Ladybugs and predatory wasps are available from mail-order catalogs, but are recommended for more enclosed environments. Spider mites are tiny pests that suck sap and can devastate or kill plants
---	--

	in a short time. Affected leaves show tiny cream to white flecks and soon curl and die. Very fine webs are sometimes visible. Control methods: • The mites like hot, dry conditions and dislike moisture, so regular misting at the sign of damage will help keep populations down. • Predatory mite <i>Phytoseilus persimilis</i> kills the spider mite at any life stage. Scale insects feed by sucking sap and produce much sticky honeydew in the process. They also build raised, rounded, waxy hoodlike structures on the lower surfaces of leaves and plant stems and in leaf axils. Scale insects can be very difficult to control. Control methods: • Prune out badly infested areas, or use soapy water and a soft brush to gently rub off scales. Cutworms totally destroy an entire plant per night and will eat almost anything in the garden. After eating the stem, it burrows into the soil right next to the plant to sleep until the following night. Control methods: • When you see a plant toppled, dig into the soil around the plant, about ½ inch deep. You should see the cutworm. It can grow quite big—about half the length of your little finger. • Place cutworm collars around your plants, made from cardboard or plastic (empty plastic milk gallon containers work well cut into a cylinder). Slugs and Snails will also eat almost anything. They particularly like young plants and soft leaves. They leave silvery, slimy trails behind them for detection, as well as holes in the leaves. They rest in the daytime in cool, dark places such as under boards or mulch. Control methods: • Go out at dusk or dawn with a flashlight, hand pick them off plants, and drop them into salt water. • You may also gather up many slugs after a rain, when they may have washed up around the garden. • Create a trap using an old tuna can. Fill it with beer or milk. • Place old cabbage leaves or grapefruit rinds around and look for snails/slugs underneath. Powdery mildew is a fungal disease that can attack a wide range of plants. The symptoms are a white, powdery fungal growth, coating the upper (and occasionally lower) surfaces of leaves. In some cases, flowers, buds, stems, and even thorns may become infected. Infected leaves often fall early.
--	---

	Control methods: • Plants that are dry at the roots are often affected, so regular and adequate watering is helpful. • A thick mulch will help to hold in moisture and reduce the severity of the disease. • Pruning or thinning can increase air circulation and improve light penetration, allowing wet leaves to dry faster following rain, watering, or morning dew. (Fungal spores germinate best in wet and warm conditions.) • Remove infected growth as much as possible.
--	--

¹ Jeavons, John. (2006). *How to Grow More Vegetables: (And Fruits, Nuts, Berries, Grains, and Other Crops) Than You Ever Thought Possible on Less Land Than You Can Imagine* (7th Edition). Berkeley, Ca: Ten Speed Press.

² Pimentel, D. (2009). Pesticides and Pest Control (page 89). *Integrated Pest Management: Volume 1: Innovation-Development Process*. Rajinder Peshin and A. K. Dhawan, editors. Springer Science + Business Media.

³ The IPM Institute of North America, Inc. (February 2014). *Frequently Asked Questions*. Retrieved from <http://www.ipminstitute.org/faq.htm>

⁴ Ruttle, Jack (1994). Cultural and Physical Controls. *Natural Insect Control: The Ecological Gardener's Guide to Foiling Pests*. Brooklyn Botanic Garden, Inc.

⁴ Bradley, F. M. and Ellis, B.W. Eds. (1996). *The Organic Gardener's Handbook of Natural Insect and Disease Control*. Emmaus, Pa: Rodale Press.

⁵ Reprinted with permission from *Organic Gardening* magazine.