Chapter Four

Your Bountiful Vegetable Garden

Introduction

The way you set up the garden—your whole system—can help discourage disease, weed, and insect pests. These sound cultural practices include:

- The layout of your garden beds
- Preparation and care of the soil
- Promotion of biodiversity, including natural enemies
- Watering techniques
- Crop rotation

This integrated aspect of IPM really matters in the vegetable garden, where all your efforts come together for improved harvests and reduced pest problems.

**Garden plans and layout matter.** Robust plants can compete with weeds, stand up to the weather, and have better resistance to diseases and insect pests. Such plants start with healthy soil. Choose a site with the right pH range, decent drainage, and soil structure for your crops. It’s possible to amend soil and change pH before and after you plant, by adding organic matter and nutrients as needed. Watch out for compaction: dense, hard soil. Your layout—rows, types of beds, cover crops, plant combinations—can be designed to lessen compaction and protect soil health as well as promote air circulation.

People tend to lay out their garden just like the year before, planting in single rows with a path of bare soil between. In this situation, your feet, rototiller, and wheelbarrow compacts the soil. Even a heavy rain condenses soil.

**Promote healthy soil.** All plants need nutrients from soil, or fertilizer when soil nutrients are lacking. Plants grown in deficient soil won’t thrive, especially heavy feeders. Common clues such as tip burn, chlorosis, and dying leaves can indicate nutrient deficiencies. What to do? Contact your county Cooperative Extension office to learn how to do a soil pH test. Fertilizer could help for immediate, short-term correction, but look for ways to improve your soil necessary in the long run. Our Chapter Two, *Garden Basics*, provides the details.

In this chapter:

- Common Abiotic, Disease and Insect Problems of Vegetables by Plant Family
- IPM Solutions for Cultural (Abiotic) Problems
- IPM Solutions for Disease Problems of Vegetables
- IPM Solutions for Insect and Arthropod Problems of Vegetables

Photo: Ana Blazic Pavlovic, Shutterstock.com.
Wide row planting—anywhere from 2 ½ to 4 feet across—is an efficient use of space and keeps traffic away from plant roots when used with narrow aisles. When you plant in wide rows, you can combine properly spaced crops or mulch to cover more soil, thereby reducing space for weeds.

Raise planting beds higher than the path to promote drainage and give root crops the deep soil they need. Try one of these methods:

1. Turn over the soil. Next, rake soil out of pathways to form level mounds 4 – 6 inches high; 8 inches for carrots. Be sure aisles are wide enough for your wheelbarrow. Dig in some aged compost—know its source to reduce introduction of invasive worms and weedseeds. Keep the bed well-mulched and you’ll rarely need to till it again.

2. Place cement blocks or boards on edge—don’t use pressure-treated wood which contains impurities you don’t want near a food crop—around the outside of your mound; rake the dirt level. A 3-foot-wide bed lets you reach whole groups of plants comfortably. You can buy raised-bed kits, too. Your most important decision here is the source of your additional soil.

Keep soil covered. Weeds confiscate any patch of bare soil, so keep soil mulched with well-rotted mulch or shaded under quick growing cover crops to deter them. This also conserves moisture. Wide-row, intensive planting means spacing plants closely, often in a zigzag pattern, so their leaves touch or overlap at maturity.

Another option is the practice of inter-planting which puts two or more crops together in one bed. Combine short-season or

<table>
<thead>
<tr>
<th>Nutritional Needs of Vegetables</th>
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<tbody>
<tr>
<td><strong>HEAVY</strong></td>
</tr>
<tr>
<td>broccoli</td>
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<tr>
<td>cauliflower</td>
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<tr>
<td>cabbage</td>
</tr>
<tr>
<td>corn</td>
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<tr>
<td>potato</td>
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<tr>
<td>tomato</td>
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root crops with long-season or leafy crops, or with cover crops. Intensive planting and inter-planting also help keep the soil cool—important for some crops. But keep in mind ... closely planted crops can be more disease-prone. If your garden rarely catches a breeze or you get lots of cool, wet weather, intensive planting might not be for you.

**Plan ahead for garden supplies.** Do you want to prevent cukes, squash, or melons from sprawling over a large weedy area? Buy or create mulch, and lay it down before the vines spread. Mulch over cardboard works well; anchored heavy-duty black plastic or weighted-down sheets of newspaper are other options. Planting pole beans or peas? Build them a trellis, fence, or a teepee first. They’ll provide great shade for lettuce or other leafy greens. Growing tomatoes? Get your stakes and twine or cages ready ahead of time and place them long before they’re needed.

Shorten time to harvest with row covers (helps avoid pests, too), heat caps, cold frames, or heat trappers. And don’t forget other pest prevention barriers—seedling collars and fencing.

**Help wanted!** Beneficial insects, spiders, toads, frogs, and birds are volunteers in your war against pests. Provide food, water, and a place to hide and they will come. Insectary plantings or bio-strips include nectar- and pollen-rich plants that feed and shelter the natural enemies of garden pests. Mix flowers and herbs in with your vegetables to deter pests, but think twice about planting flowering bulbs that could get confused with onions or garlic. Companion gardening has been around for centuries because it works. Provide water at ground level and in birdbaths, but be sure to monitor anything that might become mosquito breeding grounds.

Diseases, and some insect pests, overwinter in soil. Crop rotation—planting in different parts of your garden as one season follows the next—helps keep diseases from spreading or insects from building up. Pay attention to crops that share pests. This is especially important with soilborne diseases. It’s no good

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**Consider the benefits of companion planting:**

- Some attract natural enemies like beneficial insects or birds
- Some provide shade or a place to climb. (Pole beans climb up corn stalks; a wall of climbing peas shades spinach.)
- Some share below-ground or above-ground space efficiently. Carrots give onions the airspace they need. Beets or turnips provide a little shade for lettuce. (Great for small gardens.)
- Some cool soil and deter weeds (alyssum around broccoli: squash with corn).
- Naturally pest-repellent plants that confuse the enemy: try chives around roses or beans with potatoes. Some veggies finish and vacate their spaces just when others need it. Another advantage to this method: There's almost no room for weeds!
to rotate away from one host and into another. We list susceptible crops by disease later in this chapter.

A small garden might not provide the luxury of mapping and scheduling, but rotating your crops improves soil nutrition. Corn and tomatoes, for example, use a lot of nutrients, especially nitrogen. Next time, plant peas and beans where the corn was. Come fall, cut and compost the tops and turn in the roots to ramp up the nitrogen in your soil.

Try using a garden journal to map where your crops are, or sketch out a rotation plan for the next couple of years. Keep it flexible so you can react quickly to changing conditions. Be willing to tweak your plan if, say, part of the garden becomes compacted, weeds invade the squash, or a soilborne disease hammers one of your beds.

Some crops are good for starting a new garden. Case in point—potatoes can grow in poor soil; digging their trenches and hills will break up compacted soil. When they’re done, the soil will be a little more suitable for the next crop. But beware digging up a grassy spot for potatoes, because it may hold wireworms and grubs. Destroy any you find.

Consider the source! Buy from garden centers or nurseries with good reputations. Labels should note the plant name and cultivar or variety. Inspect plants for disease or insects, and don’t buy stressed, leggy, or overgrown plants in crowded packs or containers. Be sure freebies and on-sale plants are healthy.

In gardening as in sports, the best offense is a good defense. Find resistant varieties. A plant that shrugs off pests is a plant breeder’s stock in trade. New cultivars are introduced all the time, so check seed catalogs and

There’s a science to crop rotation

... but rather than stress over it in a home garden, just try to avoid consecutive years of the same plant family, and alternate heavy feeders and light feeders. “Fallow” areas, incorporating cover crops rather than a vegetable crop, reduce insect and disease pests.

- Buckwheat is a great summer cover crop. Plant in June, then till under in fall
- Oats and field peas (seed mix 1 part oats to 2 parts field peas) can be a spring or fall cover crop. Plant in early April and till by early June, or plant in August and till under in spring.
- Annual ryegrass sowed thickly reduces weeds and is an easy cover crop for home gardens.
- Crop rotation reduces pests like white grubs, corn rootworm, potato beetle, clubroot, verticillium wilt, white mold (Sclerotinia), bacterial spot, bacterial speck and root-knot nematodes. Fusarium wilt, on the other hand, is tough to reduce.
garden centers each season. Seed packets and plant labels should offer codes to pest resistance, as seen below.

Just as with so-called water-resistant items, no guarantees come with disease or insect resistance. There’s also the chance that one key trait—resistance to powdery mildew, say—comes at a loss of size or taste. And resistance doesn’t last forever because, as with influenza, pathogens evolve new strains.

Contact your county’s Cooperative Extension office, or consult the Cornell Gardening website which offers an updated list of recommended cultivars each year.

**Don’t grow trouble for yourself.** Part of IPM is deciding what not to grow. If some bug is notorious on beans in your area, maybe you shouldn’t grow them. If you have heavy clay soil, think twice about carrots, unless you’re willing to do some extra work. If you’re too busy to prepare your beds early, don’t try to grow spring cabbage and spinach. If your soil pH is above 6.0, choose scab-resistant potato varieties; if pH is above 6.8, seek ways to lower it or don’t bother with spuds. (The problem—the lower your pH is, the less well most other crops grow.)

### What do those codes on the seed packet mean?

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>BCMV</td>
<td>Bean Common Mosaic Virus BV1 and NY15 tolerant</td>
</tr>
<tr>
<td>BLS</td>
<td>Bacterial leaf spot resistant to strains 1, 2, and 3</td>
</tr>
<tr>
<td>F</td>
<td>Fusarium resistant or tolerant; F1 or F2: Fusarium wilt races 1 and 2</td>
</tr>
<tr>
<td>LBR</td>
<td>Late Blight Resistant</td>
</tr>
<tr>
<td>M</td>
<td>Zucchini yellows mosaic and watermelon virus resistant</td>
</tr>
<tr>
<td>MR</td>
<td>Mosaic resistant</td>
</tr>
<tr>
<td>N</td>
<td>Root knot nematode resistant or tolerant</td>
</tr>
<tr>
<td>P</td>
<td>Phytophthora resistant or tolerant</td>
</tr>
<tr>
<td>PM</td>
<td>Powdery Mildew resistant or tolerant</td>
</tr>
<tr>
<td>R</td>
<td>Rust resistant</td>
</tr>
<tr>
<td>SMR</td>
<td>Scab, mosaic resistant</td>
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<tr>
<td>SR</td>
<td>Scab resistant (potatoes)</td>
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<tr>
<td>T</td>
<td>Tolerance to tobacco mosaic TMV, ToMV: Tomato or tobacco mosaic viruses</td>
</tr>
<tr>
<td>Th</td>
<td>Thrips resistant</td>
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<tr>
<td>V</td>
<td>Verticillium resistant or tolerant V1 or 2: races 1 and 2</td>
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<tr>
<td>YR</td>
<td>Yellows resistant</td>
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</tbody>
</table>

Check the Fine Print

Look on seed packets for “certified disease-free.” Yes, you can hot-water treat your seeds, but it’s waaaay easier to let the seed company do it. Hot-water treatments of crucifers (cabbage-family crops) are particularly important.

All of the information you need is found on the back of the packet. Plan ahead, starting in winter when those great seed catalogs show up!

Photo: osukidsgarden, Oklahoma State Univ., osukidsgarden.wordpress.com/horticulture-lesson-plans/

**Code Pink!**

Many seeds are treated with fungicides so they won’t rot before they sprout. Seeds are dyed pink, green, or blue to remind you to use care. Read packet instructions before handling them.
The Northeast has a short growing season. The **Days to Harvest** information on labels or seed packets help you choose the most suitable varieties of corn, pumpkins, melons, and tomatoes. Small-fruited varieties of standard vegetables generally mature faster. So if your growing season is really short, go for cherry tomatoes instead of beefsteak.

**Write it down.** It makes sense to record what went wrong and what went right … but too few of us do. Start a garden journal, keeping a section just for problems and solutions. Record pest damage, its severity, your diagnosis, what you did and when you did it. You’ll be better prepared next year.

**Keep an eye to the weather.** The better you know your climate and weather patterns, the better choices you’ll make. Some plants are cool-season crops. Others are tender crops—frost-sensitive plants that could be damaged by weather extremes; many require warm soil.

Cool season crops, such as spinach, lettuce, peas, broccoli, cabbage, and cauliflower, need cool soil and midrange temperatures. When summer heat strikes, they bolt—go to seed really fast—and get bitter and tough. Plant them early, or in late summer to grow through the fall.

Tomatoes, peppers, cucumbers, corn, and squash are frost-sensitive. They suffer if it gets too cold, or hot. Tomato blossoms are especially prone to cold and heat damage. Are your tomatoes cracking; are their shoulders white; are they cat-faced? Don’t blame the bugs—weather extremes did it. So check the last frost date for your region before you plant. If the weatherman predicts a late frost, be ready to cover tender plants with bed sheets, row covers, or hot caps. Is the soil warm enough? And, how will you know? Take its temperature!

An additional tool is the pest forecasting power of NEWA, the Network for Environment and Weather Applications. NEWA is a website with live weather conditions across the northeast and linked into pest forecasting using knowledge of conditions relating to the life cycles of insect and disease pests. You’ve heard us mention GDD, growing degree days. NEWA supports and advances integrated pest management (IPM) and best management practices for agricultural and green industries.

**Careful timing** when you sow your garden cuts your losses. Planting cabbage and broccoli in late spring, when soil temperatures have risen, avoids cabbage maggots, which avoid warm soil. Or skip the spring crop and just grow them in the fall. Plant onions and carrots late (after June 1st in much of the northeast) to avoid onion maggot flies and carrot rust flies. Timing is particular to each area and changes with the weather, so check with local experts and keep records of your own planting times and pest problems.

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**Taking Your Soil’s Temperature**

Soil thermometers are slender, 6 or 7 inch inexpensive probes with a thermometer on the end. Get them at garden centers. Insert 2 inches deep for early-season crops or those with small seeds. Insert 4 inches deep for warm-season veggies. Take the temperature at the same time (mid-day is best) for a few days running, then average it out.

Or do it the old fashioned way: go out on a mild morning in late spring, pull back some mulch or soil in your garden, and place your hand flat on it. If it feels like the air does on your skin, or a touch warmer, you can plant those tender crops.

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**Man the Barricades**

**Collars:** Cutworms girdle seedling stems at the soil level. To block them early on, cut the bottom off paper cups or tuna cans, gently slip this ‘collar’ over your plants, and then push the collar edges into the soil. To deter cabbage maggot flies from laying eggs, take a 4 inch x 4 inch piece of cardboard, tarpaper, or carpet and cut a slit from one side into the center. There, create a hole large enough to fit around the stem without choking it. Slip this barrier around stem of cabbage-family plants, laying it flat on the soil.

**Row covers:** Lightweight spun fabric, such as Agrifleece, comes in a range of weights and sizes that let light and rain through. Some fabrics retain heat, extending the season, while others provide shade for plants during hot days. As a barricade, they all reduce insects so long as pests aren’t already there when you lay the row cover down. Make a tunnel by placing the cover on flexible arches called hoops, then bury the sides or hold them down with boards. Or just lay a wide piece of it over your beds and anchor it with rocks: a floating row cover. Fabric covers work well against cabbageworm, squash vine borers, aphids, cucumber beetles, flea beetles, and other pests of cole crops (broccoli, cabbage, cauliflower, and Brussels sprouts) and vine crops (squash, cucumbers, pumpkins, and melons).

Put row covers on right after you plant. Lift one side now and then to get at weeds, then rebury the edge. Remove when the weather gets hot or plants are established enough to withstand pests. Some plants need insects to pollinate them, so remove covers at flowering stage. Except for squash vine borer, their most vulnerable time has passed. Scout often, because row covers don’t prevent insects already in the soil from munching your plants!
Bird nets, deer fence, wire screens, chicken wire: Rabbits love nibbling tender vegetables! Lay netting or lightweight wire or vinyl window screen (both sold in rolls) over small leafy crops like young lettuce to discourage them. If crows destroy your corn crop each year, here's a serious battle plan: plant in trenches 4 – 6 inches deep; cover with an inch or two of soil. Lay pieces of gutter guard (a wire or plastic mesh product three or four feet long and several inches wide) lengthwise over the trench. Slowly fill the trench with soil as the corn grows. When the corn touches the mesh, remove it. By now the corn is well rooted and the crows will go elsewhere.

Do neighborhood cats think your planting bed is a good litter box? Fence them out or lay chicken wire or window screen—both easy to cut with scissors—on the soil between beds or plants to discourage the digging of little paws. Cardboard, and gutter guard between plants, works well too.

Fencing: A big topic! Keeping out deer requires an 8-foot high woven wire or electric fence, or small, sturdy wire cages around lettuce, beans, peas, broccoli, and other favorites. Deterring woodchucks means bending the bottom ten inches of cage-style fencing outward, then burying it a foot deep. Juvenile woodchucks and bunnies can squeeze through small gaps, so a skirt of 1-inch chicken wire will complete the barrier.

Smell and taste, though invisible, are barrier repellants. Products such as Hinder and Deer-Off work, though neither is foolproof. Read the label for safe usage.

Keep it clean. Tidy up the garden to prevent diseases and deter insect pests. Put all diseased or infected plants in the trash. Don't compost them. Watch your garden or compost heap for volunteer seedlings from last year's crop. Err on the safe side and remove weeds that could host disease or insect pests, and then wash your hands and gloves, and in some cases, your clothing.

As each new season begins, and any time you encounter diseased plants, wash or disinfect your boots, pots, tools, gloves, wooden stakes, and propagating equipment. Disinfect with rubbing alcohol or a solution of one part household bleach to nine parts water; let soak for 15 minutes, rinse, and let dry. Strongly dilute such solutions with water and safely dispose through a drain, or where it won't pose a risk to plants, pets or wildlife.

Watch that water. Think before you water. Do the plants need it? If your beds are mulched, they might not need that 1 to 1½ inch of water per week that some guides call for. Most of you aren't going to be out there with a rain gauge, so slip your trowel in about 2 inches down and see if the soil feels moist. If it isn't, go for the hose. Don't let last week's rain shower fool you. A few showers here and there in a hot summer usually aren't enough.
Most experts suggest occasional deep watering over daily shallow watering, but do so early in the day so plants dry before nightfall. Many diseases thrive in humidity, or are spread by the splashing or pooling of rain or a sprinkler. They spread, too, when you (or your pets) walk through a damp garden. Be careful not to brush up against wet plants after rain or watering. Drip irrigation is best but also a financial investment. If you water with a hose, target the soil, not the leaves.

Give them shade (or warmth). Your vegetable garden needs the sunniest part of your yard, but a surprising number of veggies could stand a little shade, especially during the hottest summer days. Besides shade cloth, crates, baskets, upturned pots, or old window screens propped up on blocks can help.

When summer warmth is slow to arrive, those row covers are good at trapping heat. Heavy-duty black plastic warms the soil. Clear plastic works even faster but doesn’t stop weeds. (If you leave plastic in place between rows, be sure to water at base of plants.)

**Plant Cover Crops**

Cover crops, also called green manure, offer advantages for all kinds of gardens. Grains (buckwheat, oats, winter rye), grasses (annual rye, Sudan grass) or legumes (peas, beans, alfalfa, clover) make up cover-cropping systems that range from simple to complex, with an art and science to each. Their benefits:

- **Cover crops add high-quality organic matter to your soil,** whether grown between food crops or for a whole year.
- **Many cover crops provide food for pollinating insects and natural enemies.**
- **Like mulches, cover crops help retain soil moisture and slow down erosion.**

While some plant debris helps overwintering beneficial insects, always be sure to remove plant debris carrying disease or insect pests. Learn to recognize symptoms to reduce reinfection the following season. Photo: Meg McGrath, Cornell University.
• Some cover crops, including rape and alfalfa, have deep roots that break up the soil, improve drainage, and increase microbial life and bring important minerals closer to the surface.

• Cover crops can help suppress some soilborne pathogens.

• Legume cover crops such as peas, beans, clover, and alfalfa pull nitrogen from the air. It attaches to their roots, and when the plants are turned under or left to die, that nitrogen stays in the soil to nourish other plants. (Even trees can be legumes: black locust and Kentucky coffee tree among them.)

• Last, but hardly least—

Cover crops reduce weeds. Farmers use cover crops to improve soil texture and block weeds, and you can too. Few systems beat a season of buckwheat-rye or just buckwheat. There is a significant benefit to new vegetable (and flower) gardens if you can plant cover crops a year or more in advance. Note: you can use this method early in spring or after harvesting a spring garden crop.

Step 1: Loosen early spring soil and water to moisten or wait for a good rain. A day or two later, sow buckwheat thickly, casting seeds by hand. Ideally they’ll land about ½ inch apart. Let the buckwheat grow until it flowers.

Step 2: Before it goes to seed, mow high and turn it under with a shovel or tiller, or just till if you have a good rototiller. Don’t till thoroughly; just turn over. Now, choose more buckwheat for a second crop or use annual ryegrass. (Make sure it’s annual.) If you chose buckwheat, let it grow until it flowers and repeat the cut-and-turn-under process.

Step 3: If your second buckwheat planting flowers by late August and you have a month or more until a killing frost, plant annual ryegrass. It dies back after a killing frost, leaving a weed-excluding mat behind. Turn it under in spring. If you have less time, plant winter rye. It’ll grow until frost and resume growing in the spring. Turn under a couple weeks before planting. But don’t let it get so tall you can’t mow or till it.

Because these crops grow so thickly and cover the ground so quickly, they crowd out weeds and suppress the seedbank as long as you cut the buckwheat after it flowers and before it goes to seed.

To till, or not to till. If you have Canada thistle, Johnson grass, mugwort, nut grass, bindweed, or other noxious weeds that spread by underground runners, think twice about tilling. You’ll break their roots into bits and spread them all over the place. Better to cover the whole area with plastic—lap the edges and watch for weeds that sneak through the cracks—a year in advance of planting will get rid of most. Here is a time to consider spot-application herbicide use. But be aware. These weeds are sneaky on the rebound, and will require diligence to eradicate.

Spacing plants adequately can help prevent diseases from taking hold. We know this flies in the face of our counsel on intensive planting. As you gain experience with your site, you’ll know which plants need elbowroom or what areas of your garden tend toward dampness.

Diseases can spread rapidly when conditions are right. Beans rot. Squash plants get powdery mildew. Closely planted crops take longer to dry out when it’s rainy or humid. If a crop is prone to these diseases, plant it in the breeziest part of your garden, or give it lots of room. Thin plants to increase air circulation. Prune or pinch the crowded leaves of squash plants. The same for suckers or cramped branches of tomatoes. Staking squash, cucumbers, peppers, or tomatoes helps air circulate.
Common Abiotic, Disease and Insect Problems of Vegetables by Plant Family

A Quick View of Vegetable Plant Families

Since culture is intrinsic to plant health, we first offer basic growing advice, then the common abiotic, disease and insect concerns for each family. Later we provide IPM solutions.

Asparagus family (Asparagaceae)

Bean or Legume Family (Leguminosae or Fabaceae): peas, beans.

Cabbage family, Cole Crops, Brassicas, Crucifers (Brassicaceae): arugula, broccoli, Brussels sprout, cabbage, cauliflower, Chinese cabbage, collard, horseradish, kale, kohlrabi, leafy mustards, radish, rutabaga, turnip.

Celery, Carrot family (Apiaceae or Umbelliferae),

Corn, Grass family (Poaceae)

Gourd family, Vine Crops, Cucurbits (Cucurbitaceae): cucumber, gourd, muskmelon pumpkin, summer and winter squash, watermelon.

Leafy Greens: Swiss chard and table beet (Amaranthaceae), lettuce (Asteraceae), spinach (Amaranthaceae), mesclun (mixed salad greens).

Onion Family, Alliums (Alliaceae): chives, garlic, leek, onion, and shallot.

Rhubarb, Buckwheat family (Polygonaceae)

Root Crops: beet (Amaranthaceae), carrot and parsnip (Apiaceae or Umbelliferae), radish (Brassicaceae).

Tomato family, Nightshades (Solanaceae): eggplant, pepper, potato, tomato.

Herbs, several families.
Asparagus

This desirable perennial takes three years or more before it produces a good crop, but with care, you’ll have it for decades. Asparagus needs at least five hours of direct sun daily; light soil with good drainage, fertile with pH: 6.0 – 6.7. It thrives in raised beds because it needs deeply worked soil, 12 – 18 inches (or deeper). Buy roots or crowns at the garden center or via mail order and plant 10 inches apart in furrows 10 inches deep— mound the soil in the trench and fan the roots out over it. Cover tops of crowns with six inches of soil, gradually adding to garden level as it grows. Let the spears go to seed the first three years to become well-established, productive plants for later seasons. Plant four to six weeks before last spring frost or when dry enough to dig. Water well the first year. Weeds will likely be your biggest complaint, so weed well before—they show up early, so be prepared—and after the harvest season. Once you allow ferns to open, it will be difficult to keep caught up.

### Possible Cultural (Abiotic) Problems of Asparagus

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>CAUSE</th>
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<tbody>
<tr>
<td>spears too small</td>
<td>not enough fertilizer, poor drainage, plants not mature yet</td>
</tr>
<tr>
<td>crooked spears</td>
<td>wind or hail damage, wounding during cultivation or weeding</td>
</tr>
<tr>
<td>soft stems</td>
<td>freezing</td>
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### Possible Disease and Insect Problems of Asparagus

<table>
<thead>
<tr>
<th>DISEASES</th>
<th>INSECTS, MITES, SLUGS, ETC.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fusarium crown rot and root (<em>Fusarium</em> spp.)</td>
<td>asparagus beetle, striped asparagus beetle</td>
</tr>
<tr>
<td>asparagus rust (<em>Puccinia asparagi</em>)</td>
<td></td>
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<tr>
<td><strong>Occasional pests of asparagus:</strong> Japanese beetle, spear rot (<em>Phytophthora</em> spp.)</td>
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Bean or Legume Family

Beans and Peas

Our friends here help trap, or fix, nitrogen into the soil. That’s good! To prepare a bed for heavy feeders like tomatoes or corn next year, plant beans right after peas in the same bed this year.

Peas are hardy and like it cool, they’ll even germinate in soils over 40ºF, so you can plant them in late March to mid April in most of the Northeast. Some varieties stop producing when it gets into the 70ºs, though watering when it’s hot helps them stay cool. For fall harvest, use shade cloth and mulch for late summer plantings.

Beans, on the other hand, like warm weather. Frost kills them, so for best results, wait until soil reaches 70ºF.

If you don’t mulch, peas and beans need ½ – 1 inch of water per week. For even better yields, dig in compost before you plant. When the season is over, compost the tops, leaving the nitrogen-fixing roots in the soil.

Support climbing peas and beans on poles, fences, or trellises. Grow plants that like a little shade—lettuce, cauliflower, spinach—on the north side of your trellis.

### Possible Cultural (Abiotic) Problems of Legumes

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<tr>
<th>VEGETABLE</th>
<th>PROBLEM</th>
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</tr>
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<tbody>
<tr>
<td>BEANS</td>
<td>baldhead (growing points broken, dead)</td>
<td>mechanical damage to seed</td>
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<td></td>
<td>poor germination</td>
<td>cold, wet soil</td>
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<td></td>
<td>sunscald</td>
<td>ozone (O₃) and other air pollutants</td>
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<td>PEAS</td>
<td>sudden death</td>
<td>hot weather</td>
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<tr>
<td></td>
<td>poor yields in fall</td>
<td>soil too warm</td>
</tr>
<tr>
<td></td>
<td>walnut wilt</td>
<td>planted near walnut tree, roots grow close to walnut roots and take up toxins</td>
</tr>
</tbody>
</table>

### Possible Disease and Insect Problems of Legumes

<table>
<thead>
<tr>
<th>VEGETABLE</th>
<th>DISEASES</th>
<th>INSECTS, MITES, SLUGS, ETC</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEAN</td>
<td>Botrytis gray mold (Botrytis cinerea)</td>
<td>seedcorn maggot</td>
</tr>
<tr>
<td></td>
<td>bean rust (Uromyces appendiculatus)</td>
<td>aphids</td>
</tr>
<tr>
<td></td>
<td>white mold (Sclerotinia sclerotiorum)</td>
<td>Mexican bean beetle, Japanese beetle</td>
</tr>
<tr>
<td></td>
<td>BCMV (bean common mosaic virus) and other viral diseases</td>
<td>potato leafhopper</td>
</tr>
<tr>
<td></td>
<td>bacterial blight/common blight (Xanthomonas campestris, X. axonopodis)</td>
<td>two-spotted spider mite</td>
</tr>
<tr>
<td></td>
<td>bacterial brown spot, halo blight (Pseudomonas syringae)</td>
<td></td>
</tr>
<tr>
<td><strong>Occasional pests of bean:</strong></td>
<td>Phytophthora blight (Phytophthora capsici), Fusarium wilt (Fusarium oxysporum), damping off (Rhizoctonia spp.), root rot (Fusarium spp.) anthracnose (Colletotrichum lindemuthianum), European corn borer, other viruses</td>
<td></td>
</tr>
<tr>
<td>PEAS</td>
<td>root rot (Pythium spp., Rhizoctonia spp., Fusarium spp., Thielaviopsis spp.)</td>
<td>seedcorn maggot</td>
</tr>
<tr>
<td></td>
<td>powdery mildew (Erysiphe pisi)</td>
<td>aphids</td>
</tr>
<tr>
<td></td>
<td>pea seed decay, damping off (Rhizoctonia solani, Pythium spp., Fusarium spp., and Aphanomyces euteiches)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fusarium wilt (Fusarium oxysporum)</td>
<td></td>
</tr>
<tr>
<td><strong>Occasional pests of pea:</strong></td>
<td>Botrytis gray mold (Botrytis cinerea), cutworm, slugs, pea weevil, stinkbug, ascochtya leaf spot</td>
<td></td>
</tr>
</tbody>
</table>
Cabbage Family, Cole Crops, Brassicas, Crucifers

Broccoli, Brussels Sprouts, Cabbage, Cauliflower, Chinese Cabbage, Collard, Kale, Kohlrabi, Radish, and Turnip

Note: Arugula is in this family but look for it under leafy greens.

Here’s a family that grows well in spring and fall when it’s cool, and can even survive frost, though cauliflower can handle only light frost. Put in transplants 4 – 6 weeks before last expected spring frost; earlier if by seed. The best timing for each crop varies, so check the seed packet. Cauliflower is the most cold-sensitive: plant no sooner than 2 – 3 weeks before last spring frost. All prefer rich soil, and do best when soil and air temps stay around 60°F—it’s the extremes that are the problem. If your broccoli buttons, it stayed too cold too long. If it bolts, it got too hot. Fall plantings for late harvest are less risky; kale is especially hardy and sometimes overwinters. Plant seeds in midsummer—determine best planting time by checking date to maturity on the seed packet, then count back from the first average frost date for your area.

Crucifers need at least five hours of sun per day but don’t like the heat. Keep them cool by planting in part shade, or drape a shade cloth over them. Row covers deter early-season pests, but remove them before weather heats up. Remember that interplanting helps soil stay cool. Soil should be pH of 6.0 – 7.5. If you don’t mulch, they need 1 – 1½ inch of water each week. Check under the mulch to be sure soil stays moist.

<table>
<thead>
<tr>
<th>VEGETABLE</th>
<th>PROBLEM</th>
<th>CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BROCCOLI</td>
<td>no heads</td>
<td>calcium, not enough water, or high temperature</td>
</tr>
<tr>
<td></td>
<td>purplish</td>
<td>phosphorus deficiency</td>
</tr>
<tr>
<td></td>
<td>buttoning (nubby little heads)</td>
<td>too hot or soil below 50°F.</td>
</tr>
<tr>
<td></td>
<td>bolting (plants suddenly go to seed)</td>
<td>heat wave</td>
</tr>
<tr>
<td></td>
<td>hollow stems</td>
<td>too much nitrogen</td>
</tr>
<tr>
<td></td>
<td>small heads</td>
<td>planted too closely or compacted soil</td>
</tr>
<tr>
<td>BRUSSELS SPROUTS, CABBAGE, TURNIP</td>
<td>cankers, internal rot</td>
<td>soil too dry or wet makes boron unavailable; pH too high</td>
</tr>
<tr>
<td>CABBAGE</td>
<td>walnut wilt</td>
<td>planted near walnut tree, roots grow close to walnut roots and take up toxins</td>
</tr>
<tr>
<td>CAULIFLOWER</td>
<td>buttoning (nubby little heads)</td>
<td>too hot or soil below 50°F.</td>
</tr>
<tr>
<td></td>
<td>yellow heads</td>
<td>too much sun (wrap heads in opaque cover)</td>
</tr>
<tr>
<td></td>
<td>bronzed leaf borders or brown spots</td>
<td>potassium deficiency</td>
</tr>
<tr>
<td>VEGETABLE</td>
<td>DISEASES</td>
<td>INSECTS, MITES, SLUGS, ETC.</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>BROCCOLI</td>
<td>clubroot (<em>Plasmodiophora brassicae</em>)</td>
<td>cabbage aphid</td>
</tr>
<tr>
<td></td>
<td>black rot (<em>Xanthomonas campestris</em>)</td>
<td>cabbage root maggot</td>
</tr>
<tr>
<td></td>
<td>cabbageworm</td>
<td>flea beetle</td>
</tr>
<tr>
<td></td>
<td>slugs</td>
<td></td>
</tr>
<tr>
<td>Occasional pests of broccoli:</td>
<td>fungal blackleg (<em>Phoma lingam</em>), downy mildew (<em>Peronospora parasitica</em>), Alternaria leaf spot (<em>Alternaria brassicicola</em>), Fusarium yellows (<em>Fusarium oxysporum</em>), root rot (<em>Rhizoctonia</em> spp., <em>Pythium</em> spp.), white mold (<em>Sclerotinia sclerotiorum</em>)</td>
<td></td>
</tr>
<tr>
<td>CAULIFLOWER</td>
<td>clubroot (<em>Plasmodiophora brassicae</em>)</td>
<td>cabbage aphid</td>
</tr>
<tr>
<td></td>
<td>Black rot (<em>Xanthomonas campestris</em>)</td>
<td>cabbage root maggot</td>
</tr>
<tr>
<td></td>
<td>flea beetle</td>
<td>cabbageworm</td>
</tr>
<tr>
<td></td>
<td>slugs</td>
<td></td>
</tr>
<tr>
<td>Occasional pests of cauliflower:</td>
<td>downy mildew (<em>Peronospora parasitica</em>), Alternaria leaf spot, root rot (<em>Rhizoctonia</em> spp., <em>Pythium</em> spp.), black leg (<em>Phoma lingam</em>), white mold (<em>Sclerotinia sclerotiorum</em>), cabbage yellows (<em>Fusarium oxysporum</em>), cutworm, cabbage looper, harlequin bug, Swede midge, thrips, diamondback moth</td>
<td></td>
</tr>
<tr>
<td>BRUSSELS SPROUTS</td>
<td>clubroot (<em>Plasmodiophora brassicae</em>)</td>
<td>cabbage aphid</td>
</tr>
<tr>
<td></td>
<td>cabbage root maggot</td>
<td>cabbageworm</td>
</tr>
<tr>
<td></td>
<td>flea beetle</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cutworm</td>
<td></td>
</tr>
<tr>
<td>Occasional pests of Brussels sprouts:</td>
<td>cabbage looper, slugs</td>
<td></td>
</tr>
<tr>
<td>KALE</td>
<td>Kale has few common pests but may occasionally be susceptible to: cabbage aphids, cabbage root maggot, cabbageworm, flea beetle, cabbage looper, slugs, clubroot</td>
<td></td>
</tr>
<tr>
<td>CABBAGE</td>
<td>clubroot (<em>Plasmodiophora brassicae</em>)</td>
<td>flea beetle</td>
</tr>
<tr>
<td></td>
<td>Black rot (<em>Xanthomonas campestris</em>)</td>
<td>cabbage aphids</td>
</tr>
<tr>
<td></td>
<td>cabbage root maggot</td>
<td>cutworm</td>
</tr>
<tr>
<td></td>
<td>cabbageworm</td>
<td></td>
</tr>
<tr>
<td>Occasional pests of cabbage:</td>
<td>fungal blackleg (<em>Phoma lingam</em>), cabbage yellows/<em>Fusarium oxysporum</em>, cabbage looper, slugs, root rot (<em>Rhizoctonia</em> spp., <em>Pythium</em> spp.)</td>
<td></td>
</tr>
<tr>
<td>RADISH, TURNIP</td>
<td>Cabbage root maggot</td>
<td></td>
</tr>
</tbody>
</table>
Celery needs at least five hours of direct sun daily. It survives frost but prefers air to be 60° – 70°F. Celery is not easy to grow and needs rich, fertile, consistently moist soil—1½ inch per week if not mulched.

**Possible Cultural (Abiotic) Problems of Celery**

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>cracked stems</td>
<td>boron deficiency</td>
</tr>
<tr>
<td>weak, thin stalks</td>
<td>phosphorus deficiency; wet, cold soil</td>
</tr>
<tr>
<td>tough, stringy</td>
<td>too much heat or not enough water</td>
</tr>
<tr>
<td>black heart (black water-soaked areas on inner “heart” lvs)</td>
<td>calcium deficiency</td>
</tr>
</tbody>
</table>

**Possible Disease and Insect Problems of Celery**

<table>
<thead>
<tr>
<th>DISEASES</th>
<th>INSECTS, MITES, SLUGS, ETC.</th>
</tr>
</thead>
<tbody>
<tr>
<td>aster yellows (a phytoplasma)</td>
<td>aphids</td>
</tr>
<tr>
<td>Fusarium yellows (<em>Fusarium oxysporum</em>)</td>
<td>aster leafhopper</td>
</tr>
<tr>
<td>early blight (<em>Cercospora apiicola</em>)</td>
<td></td>
</tr>
<tr>
<td>late blight (<em>Septoria apiicola</em>)</td>
<td></td>
</tr>
<tr>
<td>cucumber mosaic virus (CMV)</td>
<td></td>
</tr>
</tbody>
</table>

Green celery. Photo: Suzies Farm, c1.staticflickr.com/9/8044/8144868173_13aa2177f5_o.jpg, CC BY-NC-ND 2.0
Sweet Corn

Sweet corn needs full sun and warm temperatures, including warm soil at planting time (70°F). Plant in blocks of four or five rows, rather than long single rows for good pollination. It also needs moisture, and high soil nitrogen and phosphorus, and can’t compete with weeds so consider ways you can reduce weed growth and keep plants moist.

Though weeds are serious competition, consider companion crops. Plant buckwheat between rows to suppress weeds when corn is a foot tall or try the traditional “three sisters:” corn, squash or pumpkins, and pole beans. The vines weave among the corn plants, shading out weeds, keeping the ground moist, and helping prevent erosion. The beans that climb the cornstalks leave nitrogen in the soil. True, your yields might be a little less, but you’ll have outsmarted the weeds.

Corn roots grow close to the surface and are easily damaged, so be careful with your hoe.

### Possible Cultural (Abiotic) Problems of Sweet Corn

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>stunted plants, pale or yellowish leaves</td>
<td>nitrogen deficiency</td>
</tr>
<tr>
<td>yellow leaves</td>
<td>phosphorus deficiency</td>
</tr>
<tr>
<td>uneven ears, barren stalks</td>
<td>not pollinated</td>
</tr>
</tbody>
</table>

### Possible Disease and Insect Problems of Sweet Corn

<table>
<thead>
<tr>
<th>DISEASES</th>
<th>INSECTS, SLUGS, MITES, ETC.</th>
</tr>
</thead>
<tbody>
<tr>
<td>common smut (Ustilago maydis)</td>
<td>European corn borer</td>
</tr>
<tr>
<td>rust (Puccinia sorghii)</td>
<td>corn earworm</td>
</tr>
<tr>
<td>northern corn leaf blight (NCLB) (Exserohilum turcicum)</td>
<td>seedcorn maggot</td>
</tr>
</tbody>
</table>

**Occasional pests of corn:** stinkbug, armyworm in newly tilled soil, maize dwarf mosaic virus (MDMV) and other virus (and the aphids that spread them)
**Gourd Family, Vine Crops, Cucurbits**

**Cucumber, Gourd, Muskmelon (Cantaloupe), Watermelon, Pumpkin, Summer and Winter Squash**

Most need a long growing season but don’t set outside or plant until the soil reaches 70°F and nights are 60°F or above. Cucurbits need fertile soil; consider mixing in compost or aged manure at time of planting and mulch to keep soil moist. (If you don’t mulch, they need 1 – 1½ inches of water per week.) Row covers block pests, but always remove covers when flowers appear, or they won’t get pollinated and you won’t get a crop. Provide space to sprawl or fences to climb on. To prevent rotting, prop fruits on tins or stones if ground is wet. Black plastic warms soil and keeps weeds out.

---

### Possible Cultural (Abiotic) Problems of Cucurbits

<table>
<thead>
<tr>
<th>VEGETABLE</th>
<th>PROBLEM</th>
<th>CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>poor fruit set or blossoms drop off</td>
<td>flowers not pollinated (usually in cool weather), extreme heat or cold during blossoming</td>
</tr>
</tbody>
</table>

---

### Possible Disease and Insect Problems of Cucurbits

<table>
<thead>
<tr>
<th>VEGETABLE</th>
<th>DISEASES</th>
<th>INSECTS, MITES, SLUGS, ETC.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SUMMER SQUASH</strong></td>
<td><strong>powdery mildew</strong> (<em>Podosphaera xanthii, Sphaerotheca fuliginea</em>)</td>
<td>squash bug</td>
</tr>
<tr>
<td></td>
<td>bacterial wilt (<em>Erwinia tracheiphila</em>)</td>
<td>squash vine borer</td>
</tr>
<tr>
<td></td>
<td>CMV, mosaic and ringspot viruses</td>
<td>striped/spotted cucumber beetle</td>
</tr>
<tr>
<td></td>
<td>gummy stem blight/black rot (<em>Didymella bryoniae and Phoma cucurbitacearum</em>)</td>
<td>squash beetle</td>
</tr>
<tr>
<td></td>
<td>Phytophthora blight (<em>Phytophthora capsici</em>)</td>
<td></td>
</tr>
</tbody>
</table>

**Occasional pests of summer squash:** downy mildew (*Pseudoperonospora cubensis*), scab (*Cladosporium cucumerinum*), Choanephora fruit blight (*Choanephora cucurbitarum*), Septoria leaf spot (*Septoria cucurbitacearum*), Anthracnose (*Colletotrichum orbiculare*), white mold (*Sclerotinia sclerotiorum*), spider mites, seedcorn maggot.
### Possible Disease and Insect Problems of Cucurbits

<table>
<thead>
<tr>
<th>VEGETABLE</th>
<th>DISEASES</th>
<th>INSECTS, MITES, SLUGS, ETC.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WINTER SQUASH</strong></td>
<td>gummy stem blight/black rot (<em>Didymella bryoniae</em> and <em>Phoma cucurbitacearum</em>)</td>
<td>squash bug</td>
</tr>
<tr>
<td></td>
<td>powdery mildew (<em>Sphaerotheca fuliginea</em> or <em>Podosphaera xanthii</em>)</td>
<td>striped/spotted cucumber beetle</td>
</tr>
<tr>
<td></td>
<td>bacterial wilt (<em>Erwinia tracheiphila</em>)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phytophthora blight (<em>Phytophthora capsici</em>)</td>
<td></td>
</tr>
<tr>
<td><strong>CUCUMBER</strong></td>
<td>scab (<em>Cladosporium cucumerinum</em>)</td>
<td>striped/spotted cucumber beetle</td>
</tr>
<tr>
<td></td>
<td>bacterial wilt (<em>Erwinia tracheiphila</em>)</td>
<td>aphids</td>
</tr>
<tr>
<td></td>
<td>cucumber mosaic virus (CMV) and other virus</td>
<td>squash vine borer</td>
</tr>
<tr>
<td></td>
<td>gummy stem blight/black rot (<em>Didymella bryoniae</em> and <em>Phoma cucurbitacearum</em>)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>powdery mildew (<em>Sphaerotheca fuliginea</em> or <em>Podosphaera xanthii</em>)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phytophthora blight (<em>Phytophthora capsici</em>)</td>
<td></td>
</tr>
<tr>
<td><strong>MELON</strong></td>
<td>gummy stem blight/black rot (<em>Didymella bryoniae</em> and <em>Phoma cucurbitacearum</em>)</td>
<td>striped/spotted cucumber beetle</td>
</tr>
<tr>
<td></td>
<td>fungal leaf spot, Septoria blight (<em>Septoria cucurbitacearum</em>)</td>
<td>squash beetle</td>
</tr>
<tr>
<td></td>
<td>powdery mildew (<em>Sphaerotheca fuliginea</em> or <em>Podosphaera xanthii</em>)</td>
<td>squash vine borer</td>
</tr>
<tr>
<td></td>
<td>downy mildew (<em>Pseudoperonospora cubensis</em>)</td>
<td>aphids</td>
</tr>
<tr>
<td></td>
<td>Phytophthora blight (<em>Phytophthora capsici</em>)</td>
<td>squash bug</td>
</tr>
<tr>
<td><strong>PUMPKIN (AND GOURD)</strong></td>
<td>powdery mildew (<em>Sphaerotheca fuliginea</em>)</td>
<td>squash bug</td>
</tr>
<tr>
<td></td>
<td>downy mildew (<em>Pseudoperonospora cubensis</em>)</td>
<td>squash beetle</td>
</tr>
<tr>
<td></td>
<td>bacterial wilt (<em>Erwinia tracheiphila</em>)</td>
<td>squash vine borer</td>
</tr>
<tr>
<td></td>
<td>gummy stem blight/black rot (<em>Didymella bryoniae</em> and <em>Phoma cucurbitacearum</em>)</td>
<td>aphids</td>
</tr>
<tr>
<td></td>
<td>Phytophthora blight (<em>Phytophthora capsici</em>)</td>
<td>striped/spotted cucumber beetle</td>
</tr>
<tr>
<td><strong>Occasional pests of winter squash</strong>:</td>
<td>angular leaf spot/bacterial leaf spot (<em>Pseudomonas syringae</em>, <em>Xanthomonas</em> spp.), white mold (<em>Sclerotinia sclerotiorum</em>), downy mildew (<em>Pseudoperonospora cubensis</em>), scab (<em>Cladosporium cucumerinum</em>), mosaic and ringspot viruses, squash vine borer.</td>
<td></td>
</tr>
<tr>
<td><strong>Occasional pests of cucumber</strong>:</td>
<td>downy mildew (<em>Pseudoperonospora cubensis</em>), Anthracnose (<em>Collectotrichum orgiculare</em>), bacterial leaf spot/angular leaf spot (<em>Pseudomonas</em> spp., <em>Xanthomonas</em> spp.), squash beetle, stink bugs, squash bug, crown rot (<em>Fusarium</em> spp.), damping off and root rot (<em>Pythium</em> spp.).</td>
<td></td>
</tr>
<tr>
<td><strong>Occasional pests of melon</strong>:</td>
<td>White mold (<em>Sclerotinia sclerotiorum</em>), Fusarium wilt (<em>Fusarium oxysporum</em>), bacterial wilt (<em>Erwinia tracheiphila</em>), scab (<em>Cladosporium cucumerinum</em>), mosaic and ringspot viruses, crown rot (<em>Fusarium</em> spp.), damping off and root rot (<em>Pythium</em> spp.).</td>
<td></td>
</tr>
<tr>
<td><strong>Occasional pests of pumpkin</strong>:</td>
<td>mosaic and ringspot viruses, angular leaf spot (<em>Pseudomonas syringae</em>), Fusarium crown rot/foot rot (<em>Fusarium solani</em>), white mold (<em>Sclerotinia sclerotiorum</em>), damping off (<em>Pythium</em> spp.).</td>
<td></td>
</tr>
</tbody>
</table>
Leafy Greens

Beet Greens, Chard, Spinach, Leaf or Head Lettuce, Mesclun (Mixed Salad Greens), and Arugula

Leafy green vegetables like cool weather best. Chard and spinach can survive a heavy frost, so plant seeds 2 – 4 weeks before the last frost date in spring, or up to 2 weeks after the first frost date in the fall. Cold frames or row covers keep greens going into early winter. Head lettuce is tricky to grow—most home gardeners don’t bother.

Sow seeds when it’s below 65°F. Leafy greens thrive when soil is below 70°F, and the daytime air is below 75°F. In a heat wave they bolt—shooting up flower stalks, setting seed quickly, and turning tough and bitter.

Leafy greens enjoy partial shade from other plants. If it’s hot, protect them with mulch, shade cloth, or crates propped up on one side. Mulch keeps the soil moist and cool. Plant where cooling winds caress them.
### Possible Cultural (Abiotic) Problems of Leafy Greens

<table>
<thead>
<tr>
<th>VEGETABLE</th>
<th>PROBLEMS</th>
<th>CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL</td>
<td>Plants bolt (go to seed early)</td>
<td>Weather too hot</td>
</tr>
</tbody>
</table>

### Possible Disease and Insect Problems of Leafy Greens

<table>
<thead>
<tr>
<th>VEGETABLE</th>
<th>DISEASE</th>
<th>INSECTS, MITES, SLUGS, ETC.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SPINACH</strong></td>
<td></td>
<td>spinach leafminer</td>
</tr>
<tr>
<td><strong>Occasional pests of spinach:</strong> Anthracnose (<em>Colletotrichum spinaciae</em>), cutworms, slugs, flea beetles, CMV, damping off (<em>Pythium</em> spp.), Cercospora leaf spot (<em>Cercospora beticola</em>).</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BEET GREENS</strong></td>
<td>Cercospora leaf spot (<em>Cercospora beticola</em>)</td>
<td>stink bug</td>
</tr>
<tr>
<td></td>
<td></td>
<td>spinach leafminer</td>
</tr>
<tr>
<td><strong>Occasional pests of beets (also see beet root pests):</strong> damping off (<em>Pythium</em> spp.), downy mildew (<em>Peronospora farinosa</em>), armyworm, aphids, flea beetle</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SWISS CHARD</strong></td>
<td>Cercospora leaf spot (<em>Cercospora beticola</em>)</td>
<td>aphids</td>
</tr>
<tr>
<td></td>
<td>downy mildew (<em>Peronospora farinosa</em>)</td>
<td>spinach leafminer</td>
</tr>
<tr>
<td><strong>ARUGULA</strong></td>
<td></td>
<td>flea beetle</td>
</tr>
<tr>
<td><strong>Occasional pests of arugula:</strong> damping off (<em>Pythium</em> spp.), downy mildew (<em>Peronospora farinosa</em>), bacterial leaf spot (<em>Pseudomonas syringae</em>).</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LETTUCE</strong></td>
<td>mosaic viruses (LMV, CMV)</td>
<td>cabbage looper</td>
</tr>
<tr>
<td></td>
<td></td>
<td>gray garden slug</td>
</tr>
<tr>
<td></td>
<td></td>
<td>aster leafhopper</td>
</tr>
<tr>
<td></td>
<td></td>
<td>cutworm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>slugs</td>
</tr>
<tr>
<td><strong>Occasional pests of lettuce:</strong> aster yellows, white mold/lettuce drop (<em>Sclerotinia sclerotiorum</em>), tarnished plant bug, bottom rot/damping off (<em>Rhizoctonia solani</em>).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Onion Family, Alliums

Garlic, Leek, Onion, Shallot, and Chives

Alliums grow best in full sun; they tolerate a little shade and can even tolerate a light frost but they prefer soil temperatures between 65°F – 75°F, especially if those soils are highly fertile, loose, with a pH of 6.2 – 6.8. Onions from seed need a long growing season—buy sets (often shelved near seeds at your garden center) or transplants. Put in 2 – 4 weeks before last frost date as a general rule; check the variety description on the package or bin for specifics. On large production farms, onions draw a lot of pests, but the home gardener may have none of them. Be aware, however, that alliums have thin leaves and don’t compete well with weeds.

Transplants of the allium family sometimes carry disease. As for the rest, use transplants for leeks, and plant garlic cloves in the fall, from mid-September until the soil freezes. Shallots are easy, hardy; grown from sets, they produce a cluster of small bulbs; grown from seed, they produce one bulb. Chives make lovely clumps (pretty flowers go well in salads) in perennial borders and persist for years without any fuss.
### Possible Cultural (Abiotic) Problems of Alliums

<table>
<thead>
<tr>
<th>VEGETABLE</th>
<th>PROBLEM</th>
<th>CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEEK</td>
<td>tough stems</td>
<td>dry soil or inadequate hilling</td>
</tr>
<tr>
<td>ONION</td>
<td>no bulbs</td>
<td>weather was too cold or wrong variety for your region</td>
</tr>
<tr>
<td></td>
<td>forms seed stalks early</td>
<td>wrong variety for your region</td>
</tr>
<tr>
<td>SHALLOT</td>
<td>look scrawny</td>
<td>poor or dry soil</td>
</tr>
</tbody>
</table>

### Possible Disease and Insect Problems of Alliums

<table>
<thead>
<tr>
<th>VEGETABLE</th>
<th>DISEASE</th>
<th>INSECTS, MITES, SLUGS, ETC.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ONION</td>
<td>Botrytis leaf blight <em>(Botrytis squamosa)</em></td>
<td>onion maggot</td>
</tr>
<tr>
<td></td>
<td>purple blotch <em>(Alternaria porri)</em></td>
<td>onion thrips</td>
</tr>
<tr>
<td></td>
<td>Fusarium rot/basal rot <em>(Fusarium oxysporum)</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Botrytis neck rot <em>(Botrytis allii)</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>downy mildew <em>(Pernospora destructor)</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bacterial soft rot <em>(Erwinia carotovora)</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Occasional pests of onion:</strong> slippery skin and sour skin <em>(Burkholderia gladioli, B. cepacia)</em>, white rot <em>(Sclerotinia cepivirum)</em>, pink root <em>(Phoma terrestris)</em>, leek moth, seedcorn maggot, cutworm, onion smut <em>(Urocystis cepulae)</em>, damping off <em>(Pythium spp.)</em></td>
<td></td>
</tr>
<tr>
<td>LEEK</td>
<td>purple blotch <em>(Alternaria porri)</em></td>
<td>onion maggot</td>
</tr>
<tr>
<td></td>
<td>Botrytis leaf blight <em>(Botrytis squamosa)</em></td>
<td>onion thrips</td>
</tr>
<tr>
<td></td>
<td>smut <em>(Urocystis cepulae)</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Botrytis flower blight <em>(Botrytis allii)</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Occasional pests of leek:</strong> leek moth</td>
<td></td>
</tr>
<tr>
<td>GARLIC</td>
<td><strong>Occasional pests of garlic:</strong> purple blotch <em>(Alternaria porri)</em>, botrytis leaf or flower blight <em>(Botrytis spp.)</em>, smut <em>(Urocystis cepulae)</em>, Penicillium decay <em>(Penicillium gladioli)</em></td>
<td></td>
</tr>
</tbody>
</table>
Rhubarb

Rhubarb needs at least five hours of direct sun daily. Survives frost but prefers air to be 60º – 70ºF. If you can get it established in rich, fertile, consistently moist soil—1½ inch per week if not mulched, you’ll have an old-fashioned favorite for yourself and your neighbors each summer.

### Possible Disease and Insect Problems of Rhubarb

<table>
<thead>
<tr>
<th>DISEASES</th>
<th>INSECTS, MITES, SLUGS, ETC.</th>
</tr>
</thead>
<tbody>
<tr>
<td>crown rot (<em>Phytophthora</em> spp.)</td>
<td></td>
</tr>
<tr>
<td><strong>Occasional pests of rhubarb:</strong></td>
<td></td>
</tr>
<tr>
<td>fungal leaf spot (<em>Ascochyta rhei</em> and others), rhubarb curculio</td>
<td></td>
</tr>
</tbody>
</table>

### Possible Cultural (Abiotic) Problems of Rhubarb

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>plants begin to fail, produce less</td>
<td>• over harvesting left too few leaves for the plant to build energy for the next year (don’t harvest more than two-thirds of the stalks).</td>
</tr>
<tr>
<td></td>
<td>• aging crown can benefit from division (remove full crown early in spring, divide and re-plant promptly).</td>
</tr>
<tr>
<td></td>
<td>• site may not be draining properly</td>
</tr>
</tbody>
</table>

Healthy rhubarb is showy addition to your garden and a fun addition to spring and summer baking. Photo: Gerard’s World, c1.staticflickr.com/1/135/327593987_23eaf425f2_o.jpg, CC BY-NC-ND 2.0

Rhubarb custard tart. Photo: Helen Penjam, c1.staticflickr.com/5/4215/34964924414_f770f0c6c8_o.jpg, CC BY 2.0
Root Crops

Beet, Carrot, Parsnip (see Crucifers for Turnip and Radish)

Root crops are often grown together because they have similar needs. They also tend to share pests. They are considered hardy and you may plant seeds 2 – 4 weeks before the last frost, if the season has been sunny and warmer; hold off if it’s been cold and nasty. They grow well when soil temperatures range between 60º – 75ºF and air is 50º – 75ºF. Soil shouldn’t dry out but be consistently moist until the roots are well-established.

Beets prefer full sun. Carrots and parsnips need at least 5 hours of direct sun daily, and do fine with a little shade. Carrots and parsnips have long taproots and fibrous roots that grow deep. If your soil is heavy, choose short, stocky cultivars. Gardener’s trick: Plant radishes next to carrots to break up the soil. Harvest the radishes before the carrots need the room.

Help your carrots grow deep straight roots.

If your soil is heavy or dense, your carrots will do better in a raised bed. Sow carrots on top of the soil and cover with ¼ inch of organic matter. Since raised beds drain easily and dry out before other parts of the garden, water your carrots whenever the soil is dry on the surface.

Even with great soil, you can encourage your carrots to grow even deeper. Sow seeds on top of the soil and cover with ¼ inch of organic matter. Keep them moist while they sprout. When they’re one inch tall, stop watering them and let them wilt. The roots will grow downward, seeking water. Once the seedlings have wilted, start watering them again. They’ll need about an inch of water per week.

Possible Cultural (Abiotic) Problems of Root Crops

<table>
<thead>
<tr>
<th>VEGETABLE</th>
<th>PROBLEM</th>
<th>CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>All root crops</td>
<td>misshapen roots</td>
<td>overcrowding or lumpy soil</td>
</tr>
<tr>
<td></td>
<td>hairy roots</td>
<td>too much fertilizer; too much nitrogen-rich fertilizer; fresh manure</td>
</tr>
<tr>
<td></td>
<td>splitting</td>
<td>dry period followed by heavy rain</td>
</tr>
<tr>
<td>Parsnip</td>
<td>cankers, internal rot</td>
<td>soil too dry or wet makes boron unavailable; pH too high</td>
</tr>
</tbody>
</table>

Possible Disease and Insect Problems of Root Crops

<table>
<thead>
<tr>
<th>VEGETABLE</th>
<th>DISEASES</th>
<th>INSECTS, MITES, SLUGS, ETC.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beet</td>
<td>common scab <em>(Streptomyces scabies)</em></td>
<td>cutworm</td>
</tr>
<tr>
<td></td>
<td>damping off <em>(Rhizoctonia solani)</em></td>
<td></td>
</tr>
<tr>
<td>Carrot</td>
<td>Cercospora leaf blight <em>(Cercospora carotae)</em></td>
<td>aster leafhopper</td>
</tr>
<tr>
<td></td>
<td>leaf blight <em>(Alternaria dauci)</em></td>
<td>carrot rust fly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>carrot weevil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>slugs</td>
</tr>
<tr>
<td>Parsnip</td>
<td>Alternaria leaf blight <em>(Alternaria dauci)</em></td>
<td>aster leafhopper</td>
</tr>
<tr>
<td></td>
<td>Cercospora leaf blight</td>
<td>carrot weevil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>carrot rust fly</td>
</tr>
</tbody>
</table>
Tomato Family, Nightshades

Eggplant, Pepper, Potato, and Tomato

Nightshades are warm season crops and can easily be killed by frost, though potatoes can send up new shoots from their tubers. Nightshades generally need a long season to mature, full sun, good drainage, and plenty of water. Dry spells or lots of rain while blossoming can cause blossom end rot. To thrive, they require nights above 55°F and soil over 60° - 70°F is better. Cold weather or rapid shifts in temperature can cause growth defects. For an early start, warm the soil with hot caps, “wall o’ water” plant protectors, or row covers placed around or over plants and heavy-duty black plastic on the ground.

Solanaceae need fertile soil, 6.0 – 7.0 pH, except for potatoes which prefer acidic soils with a 5.0 – 6.5 pH, and they tolerate poor soil. Potatoes grow below ground first, so they can be planted 3 – 6 weeks before your last expected frost date if soil is about 50°F. The choice depends on you and spring weather. If you gamble and plant early you might get the first crop that’s big enough to withstand Colorado potato beetle attack, but heavy rains could rot them out. If you plant late, you won’t have potatoes until fall (you’ll need a fast-maturing variety)—but you might evade most Colorado potato beetles.

### Possible Cultural (Abiotic) Problems of the Tomato Family

<table>
<thead>
<tr>
<th>VEGETABLE</th>
<th>PROBLEM</th>
<th>CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL</td>
<td>pale, yellowing leaves</td>
<td>nitrogen deficiency</td>
</tr>
<tr>
<td></td>
<td>reddish-purple leaves</td>
<td>phosphorus deficiency</td>
</tr>
<tr>
<td></td>
<td>poor growth; wrinkled, spotted, or off-color leaves</td>
<td>potassium (nutrient) deficiency</td>
</tr>
<tr>
<td></td>
<td>leaf spots or distortion</td>
<td>herbicide drift</td>
</tr>
<tr>
<td>TOMATOES</td>
<td>catfacing: scarred, spiderweb pattern on blossom end of fruit</td>
<td>cold weather during blossoming</td>
</tr>
<tr>
<td></td>
<td>blossom end rot</td>
<td>localized calcium deficiency in developing fruit; too wet or dry during flowering</td>
</tr>
<tr>
<td></td>
<td>walnut wilt</td>
<td>planted near walnut tree; roots grow close to walnut roots, take up toxins</td>
</tr>
<tr>
<td>POTATOES</td>
<td>undersized</td>
<td>calcium deficiency</td>
</tr>
<tr>
<td></td>
<td>black heart</td>
<td>calcium deficiency</td>
</tr>
<tr>
<td></td>
<td>hollow heart (or star-shaped cavity)</td>
<td>potatoes grew too fast; uneven; too much fertilizer, water</td>
</tr>
<tr>
<td></td>
<td>green shoulders</td>
<td>too much light on tubers; improper hilling</td>
</tr>
<tr>
<td></td>
<td>Walnut wilt</td>
<td>Planted near walnut tree. Roots grow close to walnut roots; take up toxins</td>
</tr>
<tr>
<td>PEPPER</td>
<td>all foliage, no fruit</td>
<td>too much nitrogen fertilizer</td>
</tr>
<tr>
<td></td>
<td>poor fruit set</td>
<td>magnesium deficiency; weather too cool (below 55°F) or hot (above 90°F) while blossoming</td>
</tr>
<tr>
<td></td>
<td>sunscald</td>
<td>foliage not dense enough to shade fruit; too much hot sunshine</td>
</tr>
<tr>
<td>EGGPLANT</td>
<td>tough, bitter fruit</td>
<td>harvested too late; fruit oversized</td>
</tr>
</tbody>
</table>
### Possible Disease and Insect Problems of the Tomato Family

<table>
<thead>
<tr>
<th>VEGETABLE</th>
<th>DISEASES</th>
<th>INSECTS, MITES, SLUGS, ETC.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOMATO</strong></td>
<td>Anthracnose, black dot (<em>Colletotrichum coccodes</em>)</td>
<td>Colorado potato beetle</td>
</tr>
<tr>
<td></td>
<td>Verticillium wilt (<em>Verticillium albo-atrum, Verticillium dahliae</em>)</td>
<td>cutworm</td>
</tr>
<tr>
<td></td>
<td>early blight/Alternaria (<em>Alternaria solani</em>)</td>
<td>aphids</td>
</tr>
<tr>
<td></td>
<td>bacterial spot (<em>Xanthomonas campestris, X. euvesicatoria</em>)</td>
<td>flea beetle</td>
</tr>
<tr>
<td></td>
<td>late blight (<em>Phytophthora infestans</em>)</td>
<td>tomato hornworm</td>
</tr>
<tr>
<td></td>
<td>Septoria leaf spot (<em>Septoria lycopersici</em>)</td>
<td>stink bug, brown marmorated stink bug</td>
</tr>
<tr>
<td></td>
<td>bacterial canker (<em>Clavibacter michiganensis</em>)</td>
<td></td>
</tr>
<tr>
<td><strong>Occasional pests of tomato:</strong> Fusarium wilt (<em>Fusarium oxysporum</em>), whiteflies, bacterial speck (<em>Pseudomonas syringae</em>), Botrytis gray mold, root rot (<em>Phytophthora spp.</em>), damping off (<em>Rhizoctonia solani</em>), root-knot nematode, white mold (<em>Sclerotinia sclerotiorum</em>), tomato fruitworm, tarnished plant bug, European corn borer, western flower thrips, slugs, two-spotted spider mite, TMV and ToMV (mosaic viruses)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>POTATO</strong></td>
<td>early blight (<em>Alternaria solani</em>)</td>
<td>Colorado potato beetle</td>
</tr>
<tr>
<td></td>
<td>late blight (<em>Phytophthora infestans</em>)</td>
<td>aphids</td>
</tr>
<tr>
<td></td>
<td>common scab, acid scab (<em>Streptomyces scabies, S. acidiscabies</em>)</td>
<td>potato leafhopper</td>
</tr>
<tr>
<td></td>
<td>potato leaf roll virus (PLRV), potato virus Y (PVY) and other viruses</td>
<td>slugs</td>
</tr>
<tr>
<td></td>
<td>Anthracnose, black dot (<em>Colletotrichum coccodes</em>)</td>
<td>flea beetle</td>
</tr>
<tr>
<td><strong>Occasional pests of potato:</strong> Fusarium wilt (<em>Fusarium spp.</em>), black scurf/Rhizoctonia canker (<em>Rhizoctonia solani</em>), pink rot (<em>Phytophthora erythroseptica</em>), root-knot nematodes, bacterial soft rot (<em>Pectobacterium carotovorum</em>), Botrytis vine rot (<em>Botrytis cinerea</em>), white grubs, wireworm, European corn borer, two-spotted spider mite</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PEPPER</strong></td>
<td>bacterial spot (<em>Xanthomonas campestris</em>)</td>
<td>aphids</td>
</tr>
<tr>
<td></td>
<td>gray mold (<em>Botrytis cinerea</em>)</td>
<td>stink bug, brown marmorated stink bug</td>
</tr>
<tr>
<td></td>
<td>cucumber mosaic virus (CMV)</td>
<td>European corn borer</td>
</tr>
<tr>
<td><strong>Occasional pests of pepper:</strong> damping off and seed rot (<em>Phytophthora spp.</em>, <em>Pythium spp.</em>, <em>Rhizoctonia solani</em>), Fusarium wilt (<em>Fusarium oxysporum</em>), Phytophthora blight (<em>Phytophthora capsici</em>), viruses including TMV ToMV, flea beetle, two-spotted spider mite, slugs, tarnished plant bug, root-knot nematode</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>EGGPLANT</strong></td>
<td>Verticillium wilt (<em>Verticillium dahliae</em>)</td>
<td>Colorado potato beetle</td>
</tr>
<tr>
<td></td>
<td>aphids</td>
<td></td>
</tr>
<tr>
<td></td>
<td>flea beetle</td>
<td></td>
</tr>
<tr>
<td><strong>Occasional pests of eggplant:</strong> black dot (<em>Colletotrichum coccodes</em>), root-knot nematode, white mold (<em>Sclerotinia sclerotiorum</em>), Phytophthora blight or Crown rot (<em>Phytophthora capsici</em>), Damping off (<em>Phytophthora capsici</em>), early blight (<em>Alternaria solani</em>), cutworm, two-spotted spider mite</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tomatoes. Photo: world of jan, c2.staticflickr.com/8/7300/10398483774_d7e7254e72_o.jpg, CC BY-NC 2.0
Herbs are certainly not a family group, but we've grouped them together for other reasons. Herbs are one of the first and easiest ‘crops’ to grow and lend themselves to container gardens, deck boxes and window sills.

Herbs are generally plants with aromatic properties used for cooking, scent (there’s the aromatic part), medicinal supplements, or just for their looks. They can be annuals, biennials or perennials. Over seventy plants can be called herbs. Many cooking herbs come from the Mediterranean, therefore preferring heat and sun, and disliking wet feet.

Choose a sunny indoor window sill—preferably a south, west or south west spot—or a well-draining patio container or spot in your garden. You can easily find young transplants in spring. Many start from seed outdoors as well, once the soil has warmed up.

Generally, try to match plants to your soil. Few herbs survive wet-feet. Some, like basil, mint and parsley like moist soil. Those like rosemary, thyme, sage, marjoram and oregano prefer soil that dries out between watering.

Indoor window sill gardens rarely give the amount of light needed to prevent kitchen herbs from becoming leggy, but it’s an enjoyable venture. Especially when you can snip some leaves, rinse and add to your recipe.

Remember to use potting soil in container gardens as most garden soil dries out too quickly in pots. Herbs that receive fertilizer may flower too early or too often, so don’t rush to fertilize unless your container grown plants are looking yellow. Also, given a choice, use larger pots rather than smaller—you’ll have larger plants.

Harvest often. Snip older stems with a scissors or knife. Pinch back top growth on ‘bushy’ plants like basil. Removing flower buds encourages thicker growth.

Mints of all types have reputations. While you may plant a mint in a container, be aware that flowers and seeds may still spread.

For containers, or areas in a garden, choose ‘like-minded’ plants based on their watering needs. Don’t place lavender and cilantro next to each other.

Our chart shows the most likely pest problems of herbs. For the most part, they are easy-care plants with a nice payback if you provide sun, well-drained soil, and take the time to weed and pinch back as needed.
### Possible Problems of Different Types of Herbs

<table>
<thead>
<tr>
<th>PLANT</th>
<th>DISEASES</th>
<th>INSECTS, MITES, SLUGS, ETC.</th>
<th>OCCASIONAL PESTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basil</td>
<td>damping off, downy mildew</td>
<td>Japanese beetle, aphids</td>
<td>Cercospora leaf spot, cutworm, flea beetle, Fusarium wilt, botrytis, bacterial leaf spot (<em>Pseudomonas</em>)</td>
</tr>
<tr>
<td>Chives</td>
<td></td>
<td>aphids</td>
<td>onion maggot, pink rot (<em>Phoma</em>), thrips</td>
</tr>
<tr>
<td>Cilantro</td>
<td></td>
<td>aphids</td>
<td>aphids, bacterial leaf spot (<em>Pseudomonas</em>), cutworm, damping off (<em>Pythium</em>, <em>Rhizoctonia</em>), powdery mildew</td>
</tr>
<tr>
<td>Lavender</td>
<td></td>
<td>aphids</td>
<td>fungal diseases where wet soil doesn’t drain well (<em>Phytophthora</em>, <em>Pythium</em>, <em>Rhizoctonia</em>)</td>
</tr>
<tr>
<td>Lemon Balm</td>
<td>powder mildew</td>
<td>peach aphids, two-spotted spider mites</td>
<td>cutworm, root rots</td>
</tr>
<tr>
<td>Oregano</td>
<td></td>
<td>peach aphids, two-spotted spider mites</td>
<td>Xanthomonas bacterial leaf spot, flea beetle, peach aphid, cutworm, powdery mildew</td>
</tr>
<tr>
<td>Parsley</td>
<td>damping off (<em>Pythium</em>, <em>Rhizoctonia</em>), leaf spot (<em>Alternaria</em>, <em>Cercospora</em>)</td>
<td>two-spotted spider mite</td>
<td>Xanthomonas bacterial leaf spot, flea beetle, peach aphid, cutworm, powdery mildew</td>
</tr>
<tr>
<td>Peppermint</td>
<td>botrytis, mint rust (<em>Puccinia</em>)</td>
<td>two-spotted spider mite</td>
<td>aphids, cutworm</td>
</tr>
<tr>
<td>Rosemary</td>
<td>botrytis, powdery mildew, root rots</td>
<td>aphids, spider mites, scale, crown gall (<em>Agrobacterium</em>)</td>
<td></td>
</tr>
<tr>
<td>Sage</td>
<td>spider mites, spittle bug</td>
<td>slug, root rot, wilts, crown gall (<em>Agrobacterium</em>)</td>
<td></td>
</tr>
<tr>
<td>Tarragon</td>
<td>rust (<em>Puccinia</em>)</td>
<td>two-spotted spider mite</td>
<td>root rots</td>
</tr>
<tr>
<td>Thyme</td>
<td></td>
<td></td>
<td>fungal leaf spot (<em>Ascochyta</em>, <em>Alternaria</em>, and others), crown rot (<em>Phytophthora</em>)</td>
</tr>
</tbody>
</table>

Sharing with a friend? Herbs such as cilantro and parsley are also favorites of the swallowtail butterfly, but hatched larvae can quickly devastate a plant. If you love both herbs and butterflies, we suggest you plant twice as much and share. Swallowtail caterpillar on dill. Photo: zoosnow from Pixabay.
IPM Solutions for Cultural (Abiotic) Problems

Planting in the wrong site, improper care, or elements beyond your control (think of drought or endless rain) can make for pest problems down the road. So we address these cultural and abiotic conditions first.

• Choose well-drained sites. Raised beds help in poorly drained areas.

• Most veggies want sun, but some like a little shade or will produce later in their season if they get some.

• Know which plants are frost or heat tolerant. (If you plant your spinach or lettuce too late—they will bolt.)

• Vegetables grow stronger if well nourished. Amend your soil as needed with organic matter such as compost or well-aged manure.

• Transplant during cool, cloudy weather or provide shade to new transplants (and plants taken off a window sill and moved outdoors).

• Water early in the day, directing your hose at the base of plants. Or use drip irrigation. Don’t overwater.

• Provide good air circulation. Give plants some elbowroom—thin as needed.

• Watch out for soil compaction from foot traffic. Try to keep your pathways well defined. Wide rows help.

• Consider nutrient deficiencies in poor soil. Add aged organic matter.

Nutrient Deficiencies

Blackheart

Key hosts: Celery, potato.

What it is and what it does: In celery, blackheart has to do with the balance of calcium in the growing plant and may occur under conditions of inconsistent water, high temperatures, and high levels of nitrogen. Note water-soaked tips on young center leaves, drooping leaves, and petioles becoming brown. Calcium in the soil doesn’t suffice to meet plant needs and deficiency develops.

In potato, blackheart is due to an oxygen deficiency which occurs with flooding or hot spells. Note a dark or purple blotch when you slice a tuber open. It’s most common in storage when tubers aren’t stored correctly.

IPM solutions: Encourage steady celery plant growth with well-balanced fertilizing and regular watering. Harvest potatoes before it gets (and stays) too hot: over 90°F. Don’t store in closed containers or deep piles that lack adequate ventilation.

Store Right or They’ll Rot

Keep potatoes in open bins. Don’t pile too deep. They need oxygen to make it through the winter. Keep them dark and cool, but don’t let them freeze.
Blossom End Rot

Key hosts: Tomato, eggplant and pepper.

What it is and what it does: Dark and leathery spots show up on the bottoms of tomatoes; sunken, water-soaked brown spots that shrivel and become leathery ruin the bottoms of peppers. Watch for it in mid to late summer—on the bottom (the blossom end) of the fruit. Blossom end rot is not a disease but a lack of calcium during the blossom stage. This may not be your soil’s fault, but rather too little or much rain, or cold soil, which prevents plants from absorbing calcium at the critical time.

IPM solutions: Fruits that develop later on the same plant most likely will be fine. Delay planting tomato-family crops until the soil is warm and dry. If droughty, water young plants often and well, letting soil drain between watering. Don’t damage roots when you hoe out weeds. Don’t cultivate during dry spells—that dries plants out more. Go easy on nitrogen fertilizer—it interferes with calcium uptake.

Too Much or Too Little Sun

Green Shoulders

Key host: Potato

What it is and what it does: Tubers turn green if exposed to sunlight because soil is too shallow, or they’re stored where light strikes them. The green tissue does contain a toxin called solanine, but you’re unlikely to eat enough to be harmed.

IPM solutions: Plant tubers deeply, and cover well at hillling. Keep storage place dark.

Allelopathic Concerns

Walnut Wilt

Key hosts: Tomatoes, peppers, potatoes, eggplant, and asparagus are most susceptible; also cabbage and peas; tolerant plants include beans, beet, carrot, corn, melon, onion, parsnips.

What it is and what it does: Walnut, butternut, and hickory roots produce the toxin juglone during active growth, as do stems, leaves, and husks. Plants suddenly wilt and die. Cut the stem to see browning vascular tissue, just beneath outer layers of main stem. (Mildly susceptible plants lose vigor, become stunted; might not flower.) Host plant roots must come close to walnut roots to be damaged by this allelopathic substance, though poor drainage plays a role where roots don’t actually touch. Won’t spread to unsusceptible plants.

Plants That Play Nice

Allelopathic plants (and many exist) might seem like the lone killers of the plant world, sneaking too close to garden plants and zapping them behind your back. It’s nature’s original form of chemical warfare.

But allelopathy isn’t all bad. Some of these plants—even certain fescue or rye grasses you might grow in your lawn—are nature’s weedkillers, inhibiting the growth of various annual weeds, while cover crops of sorghum are reported to reduce crabgrass by up to 98 percent.

How can you use allelopathy to your advantage? Search online for keywords like “allelopathic plants” and go from there.
**Solar Power!**

You have a powerful pest-management tool available to you in your garden. It's completely nontoxic, easy to use, and best of all, free. It's the sun. But it has its downsides too. It kills all microorganisms and many beneficial insects, and in the northeast...climate makes this technique weather-dependent. Use it only when it's really important—as in the case of a diagnosed nematode pest. It can also help kill weed seeds.

The other problem: summers could be too cool or cloudy in the Northeast to take the best advantage of it. But even so, it could help slow down problem pests and weeds.

**To solarize your soil:**

At the end of June, prepare the bed. Pull up weeds and old crops. Rake the surface smooth, taking out stones.

Water with a sprinkler overnight. Humidity helps the process.

Dig a trench around the bed 8” deep.

Lay a clear plastic sheet over the area, overlapping the trench. Use two layers to help it heat up. Thin layers work better but tear more easily. Fill in the trench, weighing down the plastic. Pull it as tight as possible. Leave for 6 weeks.

The clear plastic traps the sun’s heat—hot enough to kill insects, plant diseases, nematodes, harmful fungi, and weed seeds. Next season, your crops may take up nutrients more quickly and won’t have to compete with weeds, growing faster and stronger.

**IPM solutions:** Don’t plant wilt-prone plants near walnut trees or mulch them with fresh walnut leaves. (Experts disagree about composted leaves: be sure they break down completely; don’t use on susceptible plants.)

**Know the Signs of Nutrient Deficiency**

You won’t usually need to worry about nutrient deficiencies, a type of abiotic problem. But if you’ve eliminated other cultural and abiotic factors as well as insect or disease pests, then consider these possibilities:

**Boron** deficiency causes vascular system breakdown. Leaves appear chlorotic (pale or yellowish due to insufficient chloroform); new growth may look puckery like little rosettes or whorls of leaves; stems roughened with sunken, necrotic areas. Some stems become hollow while some roots crack or get cankered. Leaves crinkle, become brittle and break easily. Young leaves wilt even when plants have enough water.

With low **calcium**, leaves curl and look distorted; mature leaves curl under and tips look chlorotic; plants wilt. Note tip browning in lettuce and blossom-end rot in tomatoes and peppers. Your soil could have plenty of water, but a combination of too much or little rain—along with hot weather—prevents calcium transport.

**Chloride** deficient plants wilt, and their tips look stubby. Leaves could become mottled; pale between leaf veins. Young leaves wilt. Where advanced, upper surfaces of mature leaves turn bronze.

Without **copper**, leaves become limp, curled, and pale. Note netlike pattern—green veins surrounding bleached, grayish-white areas—on newly matured leaves. Sometimes you’ll see sunken, necrotic spots.

**Iron** deficiency is common because it is dependent on soil pH and moisture. High pH keeps plants from absorbing iron. Young leaves turn pale, followed by older leaves, until entire plant looks bleached. Pale areas develop necrotic spots.

Low **magnesium** levels cause mottled chlorotic areas between veins. Later the whole leaf may turn yellowish-green. Leaves pucker or curl; tops of puckers turn pale, then necrotic. Where severe, mature leaves completely roll up and new leaves are dull green. Note: this can resemble potassium deficiency.

Inadequate **manganese** resembles iron deficiency. Young leaves are the first to become pale with netted veins. Next, they turn gray or metallic-looking, with dark freckles and necrotic spots along the veins—best viewed against light.
Molybdenum is difficult to pronounce and essential to humans and plants. Leaves become pale between veins—similar to nitrogen deficiency but without the typical reddish tone. Leaves show mottled spots and often cup upward. When advanced, leaves turn orange.

Nitrogen is numero uno. Young leaves are pale and stay small, while veins of older leaves turn whitish-green. Tissue between veins and leaf tips often looks light red or reddish-brown. Leaves are unnaturally narrow; plants short and spindly. Older leaves wilt with the slightest water deficiency; die quickly. Plants recover quickly when properly fertilized, and many plants use quite a bit therefore needing recurring applications.

Potassium is another of the macronutrients, (the K in NPK). Leaf tips look burned and turn pale or become scorched-looking while veins stay green. On some plants, the first sign of low potassium is white speckling on leaves.

Phosphorus is a difficult one to pinpoint because symptoms resemble many other problems. Often, leaves are a darker green than on the same plant with enough phosphorus. Mature leaves sometimes cup downward, or turn pale on tips and between veins. Plants could be dwarfed or stunted; stems or leaf undersides sometimes show purple—blue-grey where extreme. Older leaves can become dull green, slightly twisted, or show brown netting. Conduct a soil test to determine if the soil needs phosphorous. While phosphorus has long been a part of standard fertilizer, it is not always needed and can contribute to algae blooms in waterways.

A lack of sulfur resembles nitrogen deficiency, turning leaves pale or bleached. Both young and old leaves turn uniformly yellow. Stems, petioles, and leaf undersides can turn pinkish. Shoot tips show brown patches at base of mature leaves and sometimes leaves twist or become erect and brittle.

Zinc deficiency causes yellowing in young leaves and pitted areas on leaves show between veins. When advanced, tissue dries and crinkles but veins stay green—similar to recovering iron deficiency. Leaves tend to stay small.

Soil solarization can reduce nematode and disease pressure, but is dependent on temperatures and amount of sunshine. Photo: Amara Dunn, NYSIPM Program
When your plants get enough sunshine and rain, when you've weeded and mulched (and the soil is right for them), plants thrive. When they're stressed by drought or endless rain; by too much heat or cold; if the site is wrong or they just don't get enough care, they get sick and cave in to pests. But long spells of high humidity can make even healthy plants disease-prone.

The IPM techniques we've shown you in Chapter Two, *Garden Basics*, help keep your plants stress-free and often disease-free. But when bad things happen to good plants, use this guide to identify what's ailing them.

These IPM solutions are good for nearly every case. Where they aren't, we tell you. Where less-common remedies help, we say so. If we say “no cure,” there's no point in spraying, so don't look for a pesticide at the garden center.

- Seek disease-resistant cultivars. Your local cooperative extension has the latest plant variety recommendations.
- Inspect transplants for signs of disease before you buy them.
- Water early in the day, directing your hose at the base of plants. Or use drip irrigation.
- Let leaves dry before working in the garden.
- Provide good air circulation. Cage, tie, or stake tomatoes. Grow squash, melons, and peas on trellises or netting. Give plants some elbowroom.
- Provide good drainage—critical for many soil diseases. Raised beds help in poorly drained sites.
- Rotate crops.
- Compost has some fungus-deterring properties. But composting infected plants or their fruits may not kill all pathogens—don’t put infected plant material into compost if you plan to use it in your vegetable garden.
- Remove diseased stems, leaves, or fruit right away and destroy (burn, or double bag and dispose of in trash). We’ll suggest when professional diagnostic help is especially worth getting.
- Clean garden well in fall—many pathogens overwinter in plant debris. Fall tilling helps bury debris that’s hard to remove by hand. It encourages more thorough decay before the next crop is planted.
- Consider fungicides or other pesticides if severe—but learn more about them first. Be sure you learn how to read labels for toxicity and carefully follow directions for your specific

Confused by Common Names?

So are we! But seriously, it's common for different diseases to have the same common name. After all, what could be more descriptive than “fruit rot”? So that moniker has been hung on several quite different diseases. Not only that, but these diseases can affect different parts on different hosts—and when they do, they show quite different symptoms or signs. For example, what's fruit rot on one plant could be crown rot on another.

Sometimes, if their symptoms or remedies are similar enough, grouping diseases by common name makes sense—even if they’re caused by really different pathogens, such as bacteria or fungi. Other times it just makes for confusion.

When we group diseases in one case but split them in another, we’re not being inconsistent; we’re just trying to make the best order we can of a complex microcosm.
crop. Always remember that the label is the law. Also know what to do and who to call in a case of accidental pesticide poisoning. (Keep a sticker on your fridge.)

- The right diagnosis is key to choosing the right fungicide. Seek help from your county’s Cooperative Extension specialists or a diagnostician at your state’s land grant college. Each state has its own standards, and product labeling changes frequently when these standards change. Be sure you are looking at the current product listings for your state.

- Weed out volunteer crop seedlings, especially if that crop was diseased last year.

- Keep the perimeter of garden area weed-free. Weeds often serve as reservoirs of diseases and insects that vector pathogens.

**Blights**

**Bacterial Canker (Clavibacter michiganensis)**

**Key hosts:** Tomato

**What it is and what it does:** This disease is a true systemic bacterial disease that displays a discolored vascular system (xylem) inside the stem. Often seed-borne in tomato, bacterial canker can survive on wooden trays and stakes, and in soil on dried tomato debris. Once established on plants, the pathogen spreads by splashing water, contaminated tools, and your hands. Watch for wilting and curling on leaf margins on lower leaves. As disease moves up plant, leaves wither and die. Stems show brown streaks internally, become dry and pithy inside. On the tomato fruit, you’ll see white dots, birds-eye spots, or rough, scabby lesions surrounded by a white halo. Eventually, plants become stunted or die.

**IPM solutions:** Don’t save seeds from infected plants; purchase only certified seed. There is no cure, but if you catch it when it’s a superficial infection on a few plants, promptly pull and destroy those plants (burn, or double bag and dispose) to reduce a major infection. Consider copper-based products could help protect remaining plants. Rotate crops out for at least three years.

**What Is a Blight?**

Blight is a serious disease, known by their sudden, dramatic, in-your-face symptoms. Leaves become necrotic and die. Growing tips give up the ghost. Entire fields of commercial crops can be stricken overnight. When weather—mostly too much rain—stresses plants and makes blights likely, watch your garden closely.

If you get blight, pull and destroy blighted plants and their neighbors right away. Double bag them and dispose of the bag. Use a sanitizing solution on your tools, and gloves. Learn which crops are most at risk.

Blight in the tomato and potato patch usually means late blight (*Phytophthora infestans*), while among vine crops, peppers, eggplants, and beans, blight means *Phytophthora capsici*. Think of them as cousins. *Phytophthora* comes from the Greek (phyto = plant and phthora = destroyer). Late blight’s species name, *infestans*, drives home how devastating a disease this is.

**Troubled by Late Blight Lately?**

You are not alone. Gardeners in the entire Northeast got slammed in 2009. But two tomato varieties, Mountain Magic and Plum Regal, were completely late blight-free—and they perform well in the Northeast. Mountain Magic is a cherry hybrid tomato with high sugar and a disease package that includes late-blight resistance, tolerance for early blight, and resistance to Verticillium wilt and Fusarium wilt. It rivals an heirloom in taste. Plum Regal is a plum hybrid with the same disease package.
Bacterial Blight, Common Blight
(*Xanthomonas campestris, Xanthomonas axonopodis*)

**Key hosts:** Beans

**What it is and what it does:** This bacterial disease can be seed-borne, or move by wind and rain to enter leaf pores or wounds during long spells of humid weather. It can survive on weeds, volunteer plants and overwinter in plant debris. Symptoms on leaves are small, irregular lesions which increase in size creating larger, yellowed areas. Symptoms often begin along leaf margins. *Xanthomonas* may cause flower blossom drop, but primarily affects immature fruit with small water-soaked spots. These raise up, enlarging until the center darkens and sink to become scabby. On beans, this disease thrives on humid days with temperatures over 80°F.

**IPM solutions:** Buy certified seeds. Rogue infected plants (and those nearby) right away, and get rid of weeds. Don’t plant the same crop there again for 2 years or more. There is no cure for bacterial-infected plants, but some copper-based products protect uninfected plants if disease pressure isn’t severe; this practice needs to be done at first sign of disease. Consider your watering schedule to reduce humidity at plant level.

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Botrytis Gray Mold, Botrytis Vine Rot
(*Botrytis cinerea*)

**Key hosts:** Bean, pea, tomato, pepper, potato

**What it is and what it does:** This might be the most widespread and endemic fungal diseases you’ll face. It overwinters in soil and on plant debris, and thrives during cool periods and humid spells, moving by air, rain, fog and anything else passing by. Flowers are easily infected as they senesce; spores then infect stems—they wilt—and fruit shows water-soaked spots; these enlarge quickly, looking like they were cooked. Gray mold quickly covers the damage.

**IPM solutions:** Avoid working in wet gardens, and remove plant debris each fall. Watch for early signs of disease when weather stays cool, with long periods of high humidity. Petunias are susceptible and can give you a heads-up. Roughly handled transplants are particularly susceptible. Promptly remove and destroy any diseased plant parts. Consider fungicides to battle major plant loss.

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**Ba-a-ad Bacteria**

Though bacteria are hard to control, you can help prevent disease or slow its spread by keeping tools and your garden clean, and by avoiding injury: they enter pruning nicks and other wounds. Whether it’s galls, wilts, leaf spots and specks, blights, soft rots, scabs, or cankers they cause—you don’t want them in your garden.
Botrytis Rot, Bulb Rot, Neck Rot, Botrytis Leaf Blight (*Botrytis* spp.)

**Key hosts:** Onion, garlic, leek, other alliums

**What it is and what it does:** This fungi is a late-season disease encouraged by wet weather, splashing rain or sprinklers. At harvest it may be latent, and then develop during storage. The disease overwinters on infected bulbs, and makes crops prone to secondary infections of bacterial soft rot. Watch carefully for its first symptom—a softening around the neck followed quickly by a gray mold.

**IPM solutions:** Eliminate cull piles and don’t compost diseased bulbs. Rogue infected plants. Harvest only when onions are mature and allow the necks to continue drying down completely before storing. Store in a cool, dry place (33-40°F and 70-75% humidity) and check often and remove bad bulbs.

Cercospora Blight, Cercospora Leaf Spot, Early Blight of Celery (*Cercospora* spp.)

**Key hosts:** Carrot, celery, parsnip, beet greens, Swiss chard, spinach, other leafy greens.

**What it is and what it does:** This fungal disease overwinters in plant debris, and is carried short distances by wind. It thrives early in the season when dry weather alternates with warm, wet or humid weather (including dew and frequent watering). In July, the disease can progress rapidly.

Carrot and parsnip first show spots along leaf margins as well as curling leaves. Spots inside leaf edges are small, roughly circular; tan or gray to brown with dead centers. Lesions grow, spread; leaflets wither and die. Celery seedlings show circular yellow or tan spots with darker edges. When these turn brown and grow together, the leaves die and sunken lesions appear on the stalks.

**IPM solutions:** Be careful about your seed source. Planting in raised beds reduce drainage problems. Don’t crowd plants if you’ve previously fought Cercospora. Promptly rogue infected plants, and rotate crops (avoid planting in the same site—including any host—for 2-3 years after infection). Consider heat-treating seeds.
**Choanephora Fruit Rot, Choanephora Blight (Choanephora cucurbitarum)**

**Key hosts:** Cucurbits

**What it is and what it does:** Fungal spores enter most often from blossom end and grow quickly where fruit rests on moist soil. You may miss seeing the pale, circular spots but within 24 hours an fuzzy fungal growth can appear, turn black and cover half the fruit.

**IPM solutions:** Rotate if this has been a problem in the past, and reduce contact of fruit with wet soil. Fungicide may be impractical because this disease can occur each time new fruits blossom.

**Downy Mildew (Peronospora spp., Pernospora destructor, Pseudoperonospora cubensis, Bremia lactucae)**

**Key hosts:** Broccoli, cauliflower, cucumber, melon, pumpkin, squash, onion, beets, chard, arugula and others

**What it is and what it does:** Downy mildew was once considered a fungal disease but think of it as a microbe disease, an oomycete, that only survives on its host (which makes it an obligate parasite). Symptoms on most plants are similar, but downy mildew is host family-specific. Downy mildew on cucumbers can't infect basil—but watch other cucurbits.

Large blocky yellow spots appear on the top of leaves, enlarge and turn brown. On the underside of leaves, those spots appear watery but upon closer inspection, they are actually a dark mold-like covering that disperses the disease. Downy mildew prefers damp, cool conditions and spreads quickly, destroying leaves. Although it doesn’t overwinter on dead tissue, it can spread from transplants, and on rain blowing up from the south. Watch for symptoms in July.

**IPM solutions:** Plant resistant varieties, be careful of your source for transplants, and watch disease forecast models such as NEWA.

**Late Blight (Phytophthora infestans)**

**Key hosts:** Potato, tomato

**What it is and what it does:** Late blight is a nasty pathogen with the capability of taking all your tomato or potato plants out in a matter of days. Phytophthora is not a fungus but it acts like one—think of it as a water mold. The official reference is oomycete. It is an obligate parasite, meaning it needs a host

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**Downy or Powdery?**

Downy mildew and powdery mildew sound alike but they don’t act alike. Downy is not a fungus; powdery mildew is. Downy shows up as yellow spots on leaves; leaves only! On the underside you’ll see dampness and dark areas that are actually tiny mold-like residue. Powdery mildew becomes a fuzzy white covering on top of leaves and fruit.

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Downy mildew on cantaloupe. Photo: blogs.cornell.edu/livegpath/gallery/cucurbits/downy-mildew-o-cucurbits-early-symptoms/.

Downy mildew on spinach. Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org.
plant to live. However, Phytophthora—known to live in soil for years—can exist in a dormant state in soil water by living off stored energy until it finds suitable plant material to live on. This includes other members of the nightshade family, such as weeds, and can overwinter in plant material in compost piles. Once phytophthora finds a host, it reproduces easily. A lesion on a plant stem can release 100,000 to 300,000 sporangia a day, so a field can be infected from rain, fog or wind and destroy a crop in a matter of days. This is the disease that produced the Irish potato famine in the 19th century. You may not be too worried about it, but that disease can kill crops miles from your home if you don’t destroy it. Commercial growers with millions of dollars at stake rightly fear that nearby home gardeners won’t recognize and deal with late blight.

Phytophthora thrives during moist weather and foggy spells with temperatures of 40º – 60ºF at night and 70º – 80ºF during the day. New strains, increasingly fungicide-resistant, have emerged in the Northeast in recent years.

Potatoes first show purplish or dark brown lesions on the leaf stalk or stem, then on lower leaves. These blacken; pale halos sometimes surround them. In tomatoes, note dark, water-soaked patches on mature leaves; as spots expand, a white, downy growth covers them. Fruits show dark, leathery spots.

Plants or an entire crop suddenly wilt and collapse. Be on the alert for a stinky smell.

**IPM Solutions:** Use only certified seed-potatoes from a reputable source. Buy a small “hoop house” to grow vulnerable crops inside. Don’t move around the wet garden. If you get a positive diagnosis, destroy all diseased and nearby plants through deep burial (tissues will rot) or freezing. Composting is not reliable unless it heats up and cooks. Putting them in the garbage—unless you know how it is handled—could help move the fungus around. Fungicides are recommended. Contact your local cooperative extension office for the latest treatment suggestions.

**Phytophthora Blight (Phytophthora capsici, Phytophthora spp.)**

**Key hosts:** Pepper, eggplant, summer squash, winter squash, melon, pumpkin, cucumber, potato, beans and others

**What it is and what it does:** This fungus-like organism is an oomycete, or try water mold instead. It is soilborne, but its spores can splash plant-to-plant in rain or overhead sprinklers, or run in puddled water at plant bases. It can overwinter in soil, or in infected plant material. Early season infestations attacks roots, causing root and crown rot that will bring sudden wilt
Obligate parasite diseases?
Downy mildew and Phytophthora blights are both oomycetes, a fungal-like pathogen that need hosts to survive. Downy mildew only survives on living plant material, so it rarely overwinters in the northeast garden. Phytophthora survives in soil water using energy it has stored up from its time on live roots, and becomes viable again when new plant cells are found—and it's not hard to do. They were considered fungal diseases for a long time, and for most purposes, managing them as fungal diseases works.

during hot days after heavy rain. Wilted leaves stay green; could seem to recover; then collapse or turn brown and die. Crowns or vines show often-slimy dark layer or slimy, watersoaked lesions. Later infestations make fruits mushy and soft; slimy white spores show on undersides. Watch for dark lesions moving up stems; spores splash into canopy, causing lesions on leaves and fruit.

IPM solutions: No cure once infected. Remove and destroy debris—don't compost. Rotate three to four years. Good drainage and air circulation are key. Water early in day. Mulch to keep soil from splashing up in rain and keep fruits off soil. Consider preventive fungicides.

Smut (Corn) (Ustilago zaeae, Ustilago maydis)

Key host: Sweet corn

What it is and what it does: This unusual fungus overwinters in soil and crop debris and spreads in hot dry weather by wind. However, spores need a soak in a nice spot of water or dew to become active. It can also be seedborne. Smut grows quickly into a disfiguring growth, mainly on ears, but also cornhusks, tassels, and leaf nodes. Note white galls that expand, then burst, forming masses of black spores. Plants can become infected at any time but are less susceptible once ears have formed.

IPM solutions: Seek less susceptible varieties. Scout often and pick and dispose of galls (don't bury) before they burst. (Mushroom connoisseurs consider immature galls a delicacy, especially the Mexican dish cuitlacoche.) Rotating doesn't help; neither do pesticides.

Smut (Onion) (Urocystis cepulae, Urocystis magica)

Key hosts: Onions, leeks, garlic

What it is and what it does: This patient fungus is destructive and long lasting in the soil. Urocystis can attack any allium and is a major disease on onion farms. What first looks like dark, dirty streaks, become long dark blisters (pustules) containing powdery black spores within leaves. Most infected seedlings die; smut can become systemic in surviving plants; bulbs are weak and don't store well. Look for leaves falling over early. The bulb may split. Smut enters tender leaves and can grow into the tissue and become a mass of black spore. Seedlings are most susceptible. Spores don't generally infect older plants because of their thicker leaves.

IPM solutions: Choose smut-free sets or seedling onions for transplanting since they are immune to infection. Consider fungicidal seed treatments. Destroy diseased plants as soon as you find them, and be vigilant with transplants the following year.
Galls

Nematodes, Root-Knot Nematode, Root-Lesion Nematode (*Meloidogyne hapla, Pratylenchus penetrans*)

**Key host:** Most plants.

**What they are and what they do:** Tiny organisms called nematodes are found in the water surrounding soil particles, but most are far too small to see without magnification. The majority are helpful to soil, but some damage plant roots. Moving soil, digging, or rototilling can disperse them, but they generally don’t spread more than a few feet on their own. Some secrete a chemical that makes galls or knots on roots, while others make roots susceptible to invasion by pathogens or vector viruses. Nematodes seem to be worse in sandy soil.

Galls (or cysts) on potato and tomato roots can be the swollen bodies of certain female nematodes. Root-knot nematodes, especially on legumes, can be confused with nitrogen-fixing nodules. Infected plants become weakened or stunted; some (depending on the nematode) might die. A female can lay hundreds of eggs at a time, so by the end of the season … that’s a lot of nematodes feeding on a plant’s roots. While nematodes causing root knots or galls are easier to identify, others can be harder to diagnose. If you see knot-like bumps on roots or your plants croak and you can’t tell why—get a diagnosis. These pest nematodes can be hard to eradicate, but your nearby Cooperative Extension office can help or refer you to a nematode specialist at your land-grant college.

**IPM solutions:** Add compost, plant cover crops and mulch to increase the microbial life in your soil—bacteria, fungi, and other organisms help control nematodes. Some crop varieties are more resistant to nematodes, but may still suffer damage. If root-knot nematodes are confirmed, flag the suspected area. Consider soil solarization (with plastic mulch) but be aware it kills beneficial organisms as well. Some cover crops like millet or canola, or plants like broccoli and cauliflower reduce nematodes. An infested spot can be tilled often to keep weed-free, reducing root habitat.

**Note:** Clean tiller tines, and tools before using them in the rest of your garden.
Leaf Mosaics and Virus Diseases

Aster Yellows (*Candidatus Phytoplasma asteris*)

**Key hosts:** Lettuce, carrot, celery

**What it is and what it does:** Some diseases called yellows are a fungal disease, but many more, like aster yellows, are phytoplasma diseases—a virus-like disease, but not a true virus. This phytoplasma is spread by leafhoppers, entering a plant’s vascular system through the insect’s mouthparts. Yellows can overwinter in living tissue of perennial weeds along a garden’s edge. Young leaves become yellow, flowers can be distorted, and plant growth is bushy. New leaves will often be much smaller than normal.

**IPM solutions:** Seek resistant varieties and keep garden weeded—many weeds harbor the disease, including shrubby weeds in borders and hedgerows. Remove and destroy (don’t compost) infected plants.

Bean Common Mosaic Virus, (BCMV)

**Key hosts:** Bean

**What it is and what it does:** This particular virus thrives during cool periods and humid spells. It can be seedborne, and transmitted by aphids from weeds to new plants. Leaves pucker and grow extra-long, before becoming mottled, blistered, or malformed. Look for yellow streaks across leaf veins.

**IPM solutions:** There’s no cure for virus-infected beans. Rogue infected plants, and their neighbors, remove weeds and nearby areas. Try hosing off aphids.

Cucumber Mosaic Virus (CMV)

**Key hosts:** Celery, cucumber, spinach, lettuce, pepper, bean, melon, pumpkin, summer squash, winter squash

**What it is and what it does:** This virus can overwinter in many common weeds, and is usually carried to new plantings by green peach aphids early in the season. On vine crops, new leaves are dwarfed, mottled or distorted. On lettuce, plants become stunted and patchy yellow; head lettuce doesn’t head properly. On peppers plants, leaves become badly mottled and the older leaves may show necrotic rings or oak-leaf patterns. Pepper fruits show conspicuous yellow spots or concentric rings and are often malformed.

**IPM solutions:** Eliminate nearby weed hosts that may act as virus reservoir. Learn to identify green peach aphids and hose them off aggressively. Always look for CMV resistant cultivars.
Lettuce Mosaic Virus, (LMV)

**Key hosts:** Lettuce and others

**What it is and what it does:** LMV can affect all types of lettuce, and probably spreads by infected seeds, although it can linger in host weeds as well. Plants show symptoms of stunting and puckering. It is spread by feeding damage of aphids. Spinach can also be infected.

**IPM solutions:** Buy only certified seed. You may harvest and eat lettuce with this virus, but destroy any plant residue, and keep weeds down in that area. There is no cure for this virus.

Maize Dwarf Mosaic Virus (MDMV) and others

**Key host:** Corn

**What it is and what it does:** MDMV is a mosaic virus affecting many grass and grain species; it’s thought to survive in perennial weed grasses like johnsongrass. Mosaic viruses exhibit as irregular patterns of light and dark green in leaf tissue. Plant quality is reduced, ears are stunted. Virus diseases ae spread by aphids; aphids may migrate carrying the disease, or vector it from locally infected plants. Two other corn virus diseases—BYDV, a luteovirus and CYDV, a polerovirus—show up as purpling or yellowing along the entire leaf margin; they are less common but also spread by aphids.

**IPM solutions:** Avoid low, wet areas. Look for resistant varieties as there are no treatment options. Controlling aphids is one option, and keeping weeds cut is helpful.

Potato Virus Y (PVY)

**Key host:** Potato

**What it is and what it does:** Potato leafroll virus is spread only by aphid feeding into the phloem. Look for rolling leaves, yellowing or a leather feel to leaves. Disease can affect the tuber—it will continue to worsen in storage. Potato Virus Y spreads with insect feeding and by tools or machinery. PVY shows up as dead spots on leaves and tubers. Some varieties, like Yukon Gold, are susceptible.

**IPM solutions:** Virus diseases can be hard to pin down, and with vectors like aphids, prompt action may save some of your crop. Contact your cooperative extension office. Keep weeds down, and don’t plant near other solanaceous plants. Choose virus resistant varieties, and always purchase certified seed. Keep tools clean and reduce ‘mechanical’ damage.
Tobacco Mosaic Virus (TMV), Tomato Mosaic Virus (ToMV)

Key hosts: Tomato, pepper, broccoli

What it is and what it does: These two viruses have similar symptoms and treatments. The virus can last an unusually long time in plant debris and organic matter in soil, and can be spread in many ways—quite often by gardening activities. Surprisingly, this is not spread by sucking insects. Damage and symptoms vary widely due to the virus strain, soil or air temperature, and the plant variety’s resistance. Look for mottled areas of light and dark green leaves. Plants may be stunted or yellowed, and some leaves become malformed—a symptom known as fernleaf. Fruit may have brown spots on the outside, uneven ripening, and gray or brown flesh inside (called brownwall).

IPM solutions: Chose resistant varieties. Smokers, wash your hands before going into the garden; don’t smoke or chew tobacco while there or brush among plants, and be aware even clothing can spread this disease. Disinfect tools, door handles, workbenches. Keep the garden weed-free. There’s no cure for infected plants, but relentless fall cleanup helps. Crop rotation offers little protection in this case.

Leaf Spots

might be the biggest collections of vegetable concerns we have, and can be caused by a large number of factors: fungal disease, bacterial disease, viral disease, insects, weather and nutrient deficiencies. The other major headache for growers are plant failures that fall under root, crown or stem rots: crown rot, damping off, root rot, bottom rot and more. Each common name can have a list of causes! Even the experts don’t guess. Follow clues and do your best!

Alternaria Leaf Spot (Alternaria brassicicola);

Key hosts: Cabbage, cauliflower, broccoli and other cole crops

Early Blight (Alternaria Solani);

Key hosts: Tomato, potato, eggplant

Alternaria Leaf Blight (Alternaria dauci)

Key hosts: Leaves of carrot and parsnip

What it is and what it does: The alternaria fungus overwinters in plant debris, and can be carried short distances by wind. Like most fungus, it thrives early in the season when warm, wet or humid weather alternates with dry. Likes warmth, dew, frequent watering. Watch lower leaves for dark, irregularly sized and shaped lesions. Potato and tomato show spots on mature leaves; rings circle the spots like targets. Tomato fruit, stems, and branches show mushy lesions; fruit cracks at the stem. Potato tubers get puckered lesions, then decay.

Note: Late blight is a much more serious disease of tomato and potato.
**IPM Solutions:** Destroy infected plants. Rotate garden layout, using space that has proved disease free for at least two years.

**Note:** the Alternarias that infect tomatoes and potatoes are different than the rest in our list—you can rotate them with other families of early blight-susceptible crops. Learn how to heat treat seeds or buy certified seeds, and transplants from a reputable nursery.

**Angular Leaf Spot, Bacterial Leaf Spot (Pseudomonas syringae)**

**Key hosts:** Cucumbers and other cucurbits, arugula

**What it is and what it does:** The bacterium overwinters on plant material and in seeds, and becomes active in temperatures of 75°- 82°F with high humidity. Though it is called leaf spot, it attacks all part of the plant. Leaves show small, angular spots with a water-soaked appearance. They later turn brown. In high humidity, spots appear milky—this is bacterial ooze which dries into a white crust. These spots can occur on stems as well. On the cucumber fruit, the spots are more circular (veins on the leaves tend to cause the angular shapes) and may crack open.

**IPM solutions:** Avoid using uncertified seeds, and look for resistant plant varieties. Avoid working in wet gardens, and don’t water from overhead. Rotate all cucurbits out of that area of the garden for at least two seasons. Some copper-based products help uninfected plants, at first hint of bacterial spots, if disease pressure isn’t severe. There is no cure.

**Anthracnose, Black Dot (Colletotrichum spp.)**

**Key hosts:** Bean, cucumber, summer squash, spinach, potato, tomato

**What it is and what it does:** Anthracnose is a common fungal disease that thrives and spreads during rainy weather. It is widespread on plant debris and soil, and can survive three or more years. Symptoms include irregular yellow or brown spots on leaves, stems, or fruit. The spots darken, expand, and often run together to cover entire leaves. On some hosts, dark lesions show along leaf veins; also look for sunken, stretched-out brown marks on leaves or other tissues. Sometimes, if you use a loupe, you might see pinkish ooze (containing spore masses) in the center of the spot, especially on fruit.

In vine crops: spots on fruit may look water-soaked or sunken. On tomato: small, round sunken spots on fruit enlarge as decay spreads internally. This is primarily a “ripe fruit” disease in tomato, but fungus can also infect leaves, stems and roots for both tomato and potato. Potato tubers look “dirty” even after...
washing. Beans may have reddish-brown or slimy pink spots. Note: this can be seedborne in all but lettuce and spinach.

**IPM solutions:** Purchase disease-free seed, and potato tubers. Water at the base of the plants; don’t use sprinklers. Trellises help get tomato fruit off the ground. Some copper-based fungicides slow the spread to other plants. Remove all loose plant debris after harvest and till under remaining debris. Different species infect different hosts: rotate your crops.

**Ascochyta Leaf Spot (Ascochyta rhei);**

**Key host:** Rhubarb

**Ascochyta Leaf Spot (Ascochyta pisi)**

**Key host:** Peas

**What it is and what it does:** As-ko-kite-ah is a fungal disease that overwinters in plant debris and shows up during cool, wet springs. Symptoms are small, yellow-green areas on leaves; these spots have white centers with a reddish ring that becomes gray as the area dies. Leaf damage reduces yield.

**IPM solutions:** Remove diseased leaf material and discard far from the garden. Harvesting of asparagus stalks can continue unless damage is major. Two-to-three year rotation of pea plantings is helpful. Plowing under pea crop debris immediately after harvest reduces spread.

**Bacterial Brown Spot, Halo Blight (Pseudomonas syringae)**

**Key host:** Beans, legume family

**What it is and what it does:** Like other bacterial diseases, this one starts out looking like water-soaked spots on leaves. The spots turn brown but have a yellow border that gives it the name halo blight. It thrives in temperatures under 80°F (unlike the bacterial disease Xanthomonas) and will eventually move into the bean pods. There it causes lesions and ooze. Beans (seeds) can become discolored and shriveled inside the pod.

**IPM solutions:** Reduce plant debris in garden; it’s best to remove any bean crop residue after harvest if you suspect disease. Don’t compost—it’s unlikely to create enough heat to destroy bacterial organisms. Use resistant cultivars and only plant certified bean seed.
Bacterial Spot (*Xanthomonas* spp.);

**Key hosts:** Tomato, pepper

Bacterial Leaf Spot (*Xanthomonas* spp.); also see Bacterial Leaf Spot of Cucurbits, (*Pseudomonas*)

**Key hosts:** Pumpkin, winter squash

**What it is and what it does:** This bacterial disease can be seedborne, or move by wind and rain to enter leaf pores or wounds during long spells of humid weather. It can survive on weeds, volunteer plants and overwinter in plant debris. Symptoms on leaves are small, irregular lesions which increase in size creating larger, yellowed areas. Symptoms often begin along leaf margins. *Xanthomonas* may cause flower blossom drop, but primarily affects immature fruit with small water-soaked spots. These raise up, enlarging until the center darkens and sink to become scabby. On beans, this disease thrives on humid days with temperatures over 80°F.

**IPM solutions:** Buy certified seeds. Rogue infected plants (and those nearby) right away, and get rid of weeds. Don’t plant the same crop there again for 2 years or more. There is no cure for bacterial-infected plants, but some copper-based products protect uninfected plants if disease pressure isn’t severe; this practice needs to be done at first sign of disease. Consider your watering schedule to reduce humidity at plant level.

Bacterial Speck (*Pseudomonas syringae*)

**Key hosts:** Tomato, arugula

**What it is and what it does:** A bacterial disease may be introduced to your garden on purchased or saved seed, and then spread during cool, moist weather in wind and rain. Small black spots (specks) are seen and often have a faint yellow halo effect. Leaves may curl. Spots on fruit raise up, but remain small, and, unlike *Xanthomonas* bacterial spot, they don’t become scaly.

**IPM solutions:** As with any bacterial disease, choose only certified seeds. Rogue infected plants (and those nearby) right away. Keep area weeded, and rotate crops—don’t plant susceptible crops two years or more. Some copper-based products help uninfected plants, at first hint of bacterial spots, if disease pressure isn’t severe. There is no cure.
Black Rot, Gummy Stem Blight (*Didymella bryoniae, Phoma cucurbitacearum*)

**Key hosts:** Summer squash, winter squash, melon, pumpkin, cucumber

**What it is and what it does:** This fungal disease has two names depending on its form during reproduction. Like most, it spreads by wind or moisture in humidity and prefers temperatures between 61°F and 75°F. Can be seedborne or remain viable on plant debris from the previous year. Creates a variety of symptoms in the field and in storage, as both a leaf disease and a fruit rot. It may begin along the edges of leaves as reddish brown lesions that expand into the leaf’s center, killing it. Disease progresses to black rot or cracked, gummy (or dry) scarring. Damage from cucumber beetles and aphids increase susceptibility.

**IPM solutions:** Use only disease-free seed, and rotate cucurbits a minimum of two years from that planting spot. After harvest, promptly plow under or remove plant debris. If certified seed is used, and these cultural practices follows, you can reduce the chance of losing crops.

Black Rot (*Xanthomonas campestris*)

**Key hosts:** Broccoli, cabbage, cauliflowers & other crucifers only

**What it is and what it does:** Bacteria is everywhere, and this particular strain causes a nasty, stinky problem in crucifers during wet weather. It can overwinter in plant debris (including some weeds) and in infected seed. Symptoms include: seedlings yellow and die; plants don’t make heads; mature plants get triangle-shaped yellow areas at leaf edges, pointing to center; browning leaves drop; developing heads rot. Stems, veins, and roots may blacken and rot, becoming putrid.

**IPM solutions:** There’s no cure for infected plants, so use bacteria-resistant varieties, certified seed or transplants only. Rotate crops at least two years, and avoid cover crops from same family—rape, for example. Fungicides could keep black rot from worsening, but tissue will still be infected and could continue to decline. Treat seed with hot water if you think it could be infected. Consult cooperative extension office for recommended varieties.
Northern Corn Leaf Blight (NCLB)  
(*Exserohilum turcicum*)

**Key host:** Corn

**What it is and what it does:** This fungal disease has surged over the last decade due to the increase in no-till farming. While many home gardens don’t use this practice, spores from NCLB can travel by wind or move from infected debris to cause infection anytime there is prolonged leaf wetness (6-18 hours) and temperatures between 64°- 81°F (pretty typical weather in a northeast summer). Look for gray-green, or tan leaf spots—often explained as cigar-shaped (long and narrow), and 1-6 inches long. Spore overwinters on corn debris.

**IPM solutions:** If you have any chance of NCLB on a prior year's crop, destroy debris or bury it promptly after harvest. Scout for symptoms about a week after a rainy day, if NCLB is a threat in your neighborhood. Choose resistant varieties—they may show faint symptoms on leaves but no spore will be produced.

Purple Blotch (*Alternaria porri*)

**Key hosts:** Onion, leek, garlic

**What it is and what it does:** A fungal pathogen found in crop debris and soil. It produces spores during warm, wet springtime conditions which move via wind and rain. Small water-soaked elliptical spots enlarge into purple, then brown patches, slowly damaging leaves. Ultimately crops are undersized due to wilted leaves. In onions, bulbs may succumb in storage.

**IPM solutions:** Rotate crops out of possible infected soil for 2-3 years. Bury deep or destroy plant material; do not compost or create cull piles. Do not work in the garden when vegetation is wet, but removed diseased plants carefully during dry weather. Avoid crowding and removed weeds. Consider fungicides during prolonged wet weather.

Septoria Leaf Spot, Septoria Blight, Late Blight and Leaf Blight of Celery,  
(*Septoria cucurbitacearum, Septoria spp.*)

**Key hosts:** Celery, squash, melon, tomato and others

**What it is and what it does:** Septoria is a fungal disease that overwinters in plant debris and becomes active in cool (temps in the 60’s) and wet or humid conditions. Spores are carried by top watering, wind-blown rain, and by gardeners and animals moving among wet plants. Spores can infect throughout the season. Septoria is mostly host-specific; for example, tomatoes can be affected by disease from other nightshades, including...
weed species, but unlikely to be susceptible to Septoria from cucurbits. It is seedborne in celery, lettuce, and parsley.

This is a major disease on tomatoes, where symptoms can show up anywhere on young plants, but are generally restricted to the leaves on older plants. Look for small, water-soaked circular brown lesions which expand with beige or white centers and brown margins. Dark brown or black pimply dots (pycnidia, the fruiting bodies) often appear inside those centers, visible with the naked eye or a loupe.

On cucurbits, *Septoria cucurbitacearum* infects but rarely kills foliage. Instead, fruits of pumpkin and winter squash (acorn and butternut) show raised white spots (measles) with a brown border which can reduce their market value. Pycnidia/black spots may fill older spots. Fruit rot is unlikely unless another disease has entered through a lesion. The disease can flare up again in the fall, but once harvested, septoria doesn’t cause rot in storage. On muskmelon, it can sometimes confused with gummy stem blight (bacterial black rot).

On celery (lettuce or parsley also), note yellowish speckling; turns tan or yellowish-gray with time. Margins could be darker and will eventually rot. If seeds are infected, seedlings die soon after sprouting.

**IPM solutions:** Seek disease-free seed. Weed often—it helps keep the microclimate less damp. Use a minimum 2-year rotation. Don’t compost diseased plants. Consider mulch that will reduce splashing.

**Rots: Root, Stem, Crown & Fruit**

**Bacterial Soft Rot (Pectobacterium carotovorum, previously Erwinia carotovorum)**

**Key hosts:** Potato, pepper, tomato, onion

**What it is and what it does:** This soil dwelling bacteria survives in soil water and enters plant stems, roots or fruit through lenticels and wounds made by mechanical means (tools, machinery) or insect feeding. On onion, it shows up as pale, wilted leaves (youngest leaves first), and obvious softness in bulb. Potato, tomato and pepper stems become black in some sections—those areas break off easily into a slimy mess. On harvested fruit, look for translucent skin with dark area below; on potato you’ll see dark spots. This rot can continue after harvest, and cause a nasty odor.
**IPM solutions:** Don’t plant in poorly draining soil. Be careful to avoid nicks and damage to plants before and after planting. Use a three year rotation. Control insects like onion maggot that cause feeding injury to roots. Choose certified seed potatoes. Harvest on hot, dry days, and inspect your harvest for storage; remove anything with a hint of disease.

**Blackleg, Phoma Leaf Spot, Dry Rot** *(Phoma lingam)*

**Key hosts:** Broccoli, cabbage, other crucifers

**What it is and what it does:** Humid, rainy weather is a fungi’s friend. Phoma can be carried on seed or transplants and spreads in many ways: splashing water from rain or sprinklers, wind, contaminated tools, diseased plant debris and visitors to the garden. Look for leaf spots that are pale brown, tan, or almost white with many tiny black fruiting bodies. Main stems could show large, sunken, brown-to-black cankers sporting black fruiting bodies. Stems deteriorate and become girdled, stunted and wilted. The stem’s woody tissue blackens (blackleg), while symptoms on root crops are called dry rot.

**IPM solutions:** Purchase only disease-free seed of cabbage family crops. The fungus can survive ~4 years in seed; ~ 3 years in crop debris, so a three or four-year rotation is best. If certified seed is used, and these suggested cultural practices followed, you have significantly reduced chance of losing these crops. Cabbage family blackleg and potato black leg are not the same disease, so can be part of each other’s rotation schedule. Don’t forget ... seed can be hot-water treated.

**Black Rot, Gummy Stem Blight** *(Didymella bryoniae, Phoma cucurbitacearum)*

**Key hosts:** Summer squash, winter squash, melon, pumpkin, cucumber

**What it is and what it does:** Like most fungal diseases, it spreads by wind or moisture in humidity and prefers temperatures between 61°F and 75°F. It has two names depending on the form the spore takes during reproduction. It can be seedborne or remain viable on plant debris from the previous year. Creates a variety of symptoms in the field and in storage, as both a leaf disease and a fruit rot. On the fruit, look for circular or irregular rings that darken to brown or black. Sunken, water-soaked areas may occur. Disease progresses to black rot or cracked, gummy (or dry) scarring. Damage from cucumber beetles and aphids increase susceptibility.
IPM solutions: Use only disease-free seed, and rotate cucurbits a minimum of two years from that planting spot. After harvest, promptly plow under or remove plant debris. If certified seed is used, and these cultural practices are followed, you can reduce the chance of losing crops.

Crown Rot (*Fusarium* spp.);
Key hosts: Tomato, asparagus, cucumber, squash, pumpkin and other cucurbits

Crown Rot (*Rhizoctonia solani*);
Key hosts: Carrot

Crown Rot, Spear Rot (*Phytophthora* spp.)
Key hosts: Eggplant, pepper, rhubarb, asparagus

What it is and what it does: These pathogens are soil-borne fungus and fungus-like diseases that enter plant roots and crowns, and reduce vigor. Eventually the plant dies. These diseases affect most plants—not just vegetables—and can kill trees. In your vegetable garden, symptoms include sudden wilting and death, or a slow yellowing of leaves. Stems may show brown streaks, and seedlings may drop over or break at the soil. Established plants may break off at the crown. Look for discoloring, stem lesions and water-soaked spots. When it’s obvious a plant is not going to survive, examine the roots for rot.

IPM solutions: Your first defense is reducing standing water and promoting good drainage—before you plant. Use raised beds in these areas, or parts of your garden may have these pathogens. Be aware of how water moves through your garden, and avoid walking or digging in wet soil to reduce the chance of spreading soil-borne disease. Plant only certified stock from reputable sources and look for resistant varieties. Rotate susceptible crop and its family members away from suspected soils.

**Fusarium Crown Rot, Fusarium Root Rot, Fusarium Basal Rot (*Fusarium oxysporum, Fusarium solani*)**

Key hosts: Asparagus, onion, pumpkin, bean

What It Is And What It Does: Fusarium is a very persistent (5-7 years) fungus with a number of variations and hosts. Damage to seedlings or feeding by soil insects increases the chance of infestation through roots. Cole crops like cabbage become yellowed and wilted, mostly on one side of the plant. Lower leaves turn yellow before the upper leaves; eventually turning brown and dry. Heat increases the disease’s effects
and you may see ooze on stems. On pumpkins and melon, wilt primarily effects mature plants; look for lesions along stems and discoloration, but seedlings can fall as well (see Damping Off). On hot days, plants can suddenly collapse. Legumes like peas and beans can survive but appear sickly (see Dry Root Rot on bean). Celery symptoms are stunting, and brittle leaves.

**IPM solutions:** Choose disease-resistant varieties. Remove soil and replace with soilless mix, or consider raised beds. Fungicides won’t help. Take care to avoid root damage as you plant. Rotation helps but is not the answer. Always destroy plant residue—don’t move to any location inside the garden, or use for compost.

**Fusarium Dry Rot of Potato (Fusarium sambucinum, Fusarium solani)**

**Key host:** Seed potato

**What it is and what it does:** Fusarium is a soil-borne fungal disease that causes many vegetable problems, and is especially harsh on seed potatoes, as well as showing up after harvest as a stored potato rot. Dry rot develops at nicks or bruises of the skin where the pathogen enters to cause an internal rot, and eventual mold. Bacteria take advantage and may co-exist to cause soft rots. It is rarely a problem during the growing season, as tubers grow with little chance of damage.

**IPM solutions:** Carefully inspect seed potato and check during storage. Let seed potatoes warm to 50°F before handling in spring. Disinfect your tools, including knives you use for cutting tubers. Follow planting directions carefully. Good handling and drying of harvested potatoes reduces storage rots.

**Penicillium Decay, Clove Rot of Garlic, Blue Mold (Penicillium spp.)**

**Key host:** Garlic

**What it is and what it does:** If penicillium mold ‘blooms’ (sporulates) in your stored garlic bulbs, you will recognize that blue-green mold you’ve seen on old food. There are a couple species of penicillium that are specific to garlic and they can linger unnoticed in diseased bulbs—in the ground or on your shelf. In the field, symptoms include yellowing leaves and low quantity, but the bigger concern is for stored bulbs. Bulb skin falls off, bulbs seem to shrink. On cloves, you may see water-spots or soft spots, yet you may not suspect clove rot unless you also see active mold—this is how infected bulbs can be unintentionally planted for a new crop.
IPM solutions: Avoid trimming tops too closely. Completely dry harvested bulbs in a single layer—racks work well (3-4 weeks is common). Don’t compost infected bulbs. Use crop rotation. At planting time, don’t let ‘seed’ cloves linger after cracking them off the base—this allows new roots to dry out and gives them a poor start, as well as provides a period where they may become infected. Get them in the ground!

**Phytophthora Root Rot (Phytophthora capsici)** see Root Rot

**Key hosts:** Pepper, eggplant, summer squash, winter squash, melon, pumpkin, cucumber, potato, beans and others

**What it is and what it does:** This fungus-like organism is an oomycete, or try water mold instead. It is soilborne, but its spores can splash plant-to-plant in rain or overhead sprinklers, or run in puddled water at plant bases. It can overwinter in soil, or in infected plant material. Early season infestations attacks roots, causing root and crown rot that will bring sudden wilt during hot days after heavy rain. Wilted leaves stay green; could seem to recover; then collapse or turn brown and die. Crowns or vines show often-slimy dark layer or slimy, watersoaked lesions. Later infestations make fruits mushy and soft; slimy white spores show on undersides. Watch for dark lesions moving up stems; spores splash into canopy, causing lesions on leaves and fruit.

**IPM solutions:** No cure once infected. Remove and destroy debris—don’t compost. Rotate three to four years. Good drainage and air circulation are key. Water early in day. Mulch to keep soil from splashing up in rain and keep fruits off soil. Consider preventive fungicides.

**Pink Root (Phoma terrestris)**

**Key host:** Onion

**What it is and what it does:** Pink root is a fungal disease found in soil and able to spread through infected seed (onion sets), splashing, wet soil, and soil dust. Symptoms don’t show up until mid-season. Look for reduced size such as leaves smaller than usual. If removed from the row affected roots often break off and stay in the soil. If you pull a bulb and see pink or red roots, your garden has this common soil fungus.

**IPM solutions:** Rotate onions with unrelated crops (also avoid grains, grasses, parsnip, radish and spinach). Look for resistant onion cultivars. You can still grow onions, but they’ll need extra care and fertilizer to maintain normal size.
Pink Rot (*Phytophthora erythroseptica*)

**Key host:** Potato

**What it is and what it does:** Pink rot is another phytophthora—that nasty soil-borne water mold—which can affect potatoes in the field or later, in storage. In the field, infected tubers appear dark, dry and may feel firm, but just not quite right. Uninfected potatoes can pick up pink rot if they are wounded at harvest time; symptoms develop during storage. Cut a suspected potato in half and leave it exposed to air and infection will appear pink.

**IPM solutions:** As with any phytophthora disease, choose well-drained soil and resistant varieties. Harvest carefully and in cool, dry weather. Sort harvested potatoes well, let them dry, and consider preventive fungicides if there’s a chance of phytophthora in the soilbed.

Rhizoctonia Canker, Black Scurf (*Rhizoctonia* spp.)

**Key host:** Potato

**What it is and what it does:** Rhizoctonia is a common soil fungus that overwinters on plant debris, soil, and diseased tubers. Favored by cool, wet weather and moist, dense or clay soils, you’re wise to delay planting until soil has warmed up. Early in the season, rhizoctonia can create lesions on new growth stolons; above ground, new sprouts may be small or show disease. Later in the season, black sclerotia (the spore producing part of the disease) grow on tubers. This sclerotia is black scurf, also known as ‘the dirt that won’t wash off’. You may see leaf curl as well.

**IPM solutions:** There is no cure. You can put crops on a three-year rotation—it doesn’t stop the disease but it slows it, especially when other crops (grassy cover crops, for example) add organic matter and organisms that compete with rhizoctonia living in the soil. Raised beds and good soil tilth speed plant emergence and growth. Opt for seed treatment, and always choose certified seed. Watch for signs of black scurf on seed potatoes. Don’t plant in cool, wet soil. Harvest promptly in fall, and remove all plant material. Burn if possible, or bury far from future potato fields.

Meet the Rhizoctonia

Here’s which Rhizoctonia infects what crop:

- Rhizoctonia canker: potato
- black scurf: potato tubers
- bottom rot: lettuce
- damping off: many crops;
- root rots: crucifers and beans
- soil fruit rot: tomatoes touching the ground
- wirestem and head rot: crucifers


Pink rot on potato. Pink only shows up when exposed to air. Photo: Jordan Eggers, Oregon State University, mtvernon.wsu.edu/path_team/DiseaseGallery/potato-pink-rot-4.htm.
Root Rot, Cavity Spot of Carrot (*Pythium* spp.);

**Key hosts:** Carrot, cucumbers and other cucurbits, peas, broccoli, cabbage and other cole crops, beet

Root Rot (*Rhizoctonia solani*);

**Key hosts:** Peas, cabbage, broccoli and other cole crops

Root Rot (*Phytophthora* spp.);

**Key hosts:** Pepper, tomato

Root Rot (*Fusarium solani*);

**Key hosts:** Peas, asparagus, beans

What it is and what it does: Root rot can occur early like damping off or, later, when a plant is established and is linked to waterlogged soil and soil-borne diseases. It usually strikes seedlings before first true leaves show, but plants can also succumb later when plants simply wilt or collapse. Phytophthora is particularly troublesome because it is a water-mold and remains persistent in soil.

**IPM solutions:** Start seeds in disease-free, soilless potting mixtures or buy seedlings from trusted sources. Don’t overwater plants, work in a wet garden, or over-fertilize. Disinfect tools, boots and gloves, and consider raised beds in problem areas. Note areas in your garden where you suspect soil-born fungus issues, and be sure to rotate out to avoid placing susceptible plants in those areas.

**Sclerotinia, White Mold, Lettuce Drop, Damping Off (*Sclerotinia sclerotiorum*); White Rot on Onion (*Sclerotium cepivorum*)**

**Key hosts:** Tomato, eggplant, summer squash, winter squash, melon, pumpkin, broccoli, cauliflower, bean, lettuce, carrot, celery, onion

**What it is and what it does:** Sclerotinia is a common fungal disease with notable white mold. It thrives when spring weather is moist and temperatures are cool (60°F – 70°F; morning dew provides ideal conditions), and again in cool, moist weather of mid- to late-season. It can survive many years in soil as black sclerotia, and then germinate when digging or tilling brings them close to the soil surface. Spores can move by wind, tools and equipment, and water runoff. This fungal disease can be seed-borne or enter your garden on infected transplants, or by other hosts such as wild mustard, ragweed, and lambsquarters.
Damping off kills seedlings and transplants. Collar rot affects slightly older plants at soil line. Note bleached stems, often covered completely with white fungal growth. On older plants, lesions can show anywhere on the shoot, usually on a leaf scar or where a fallen flower lodged. The same infected plant material can cause the fruit to rot.

**IPM solutions:** White mold and white rot are serious diseases. If they get a foothold, it could be years before you can plant host crops there again—and there are a lot of them. Early detection is key. Don’t transplant diseased plants, sets, or bulbs. Watch the weather; scout often. Remove diseased plants and the soil from around their base. Weed thoroughly; many common weeds are infected. Rotate with corn, or winter rye, or other grass cover crops to slow buildup in soil.

### Slippery Skin (*Pseudomonas gladioli, Burkholderia gladioli*)

**Key host:** Onion

**What it is and what it does:** This bacterial disease causes a slow rot. One or two leaves will wilt in the center of the leaf cluster, before turning yellow and dying. The bulb will soften layer by layer (called scales), until the interior is rotted. A gentle squeeze may cause rotted material to ooze out through the neck of the onion. Slippery skin occurs in a wide variety of temperatures, but needs moisture: heavy rains, heavy dew or overhead irrigation. Bacteria generally enters with moisture through neck or wounds. Disease continues during storage.

**IPM solutions:** Be careful not to wound onions; reduce overhead irrigation if possible; don’t store bulbs until they are dry.

### Sour Skin (*Burkholderia cepacia*)

**Key host:** Onion

**What it is and what it does:** Similar to slippery skin but with different symptoms. Sour skin is a bacterial disease found in the soil. This strain only affects onion, and can only enter through wounds or when onions are topped. One or two leaves will turn brown and show watery spot near the base of the leaves. It spreads in rain or with overhead irrigation. When the bulb is rotting, leaves may break right off. Not all scales of the onion bulb are affected; it might be one layer between others that rots, and gives off a sharp, foul odor.

**IPM solutions:** Minimize overhead watering late in the season. Take care not to injure onion bulbs during harvesting, and do so in dry weather when possible. Allow onions and tops to dry thoroughly.
Rusts

**Rust (Puccinia spp.)**

**Key hosts:** Asparagus, corn

**What it is and what it does:** Rust is a fungal disease with an odd life cycle. Some species can overwinter and most can spread by wind and rain. All rust fungi are obligate parasites, meaning they need specific plant hosts at specific periods in their life cycle. Corn rust doesn’t overwinter in the Northeast and must blow in from the Midwest. Look for oval, cinnamon-colored bumps (pustules) scattered over tops and bottoms of leaves; these rupture, releasing dusty red spores. Spots turn brownish-black with spore masses. If severe, bumps could show on ears and tassels, and leaves could turn yellow and become tattered.

On beans, first note small white bumps on undersides of leaves which become pimply pustules that erupt and release reddish brown spores. Rust infects bean leaves and pods, but rarely the stems. On asparagus, spears and ferns show small orange patches or reddish brown streaks; turn black in fall (and can overwinter in the Northeast). Rust progresses fast in humid weather with temperatures over 80°F.

**IPM solutions:** Rogue volunteer seedlings; seek disease-resistant seed. In beans, remove plant debris quickly after harvest; destroy. Do a thorough fall cleanup, and rotate beans every other year. For pole beans, disinfect wooden poles with a 10 percent bleach solution. If you find rust or had rust the prior year in your asparagus, scout carefully and remove suspicious spears at soil level (destroy). Consider fungicides on ferns.

**Scab**

**Acid Scab (Streptomyces acidiscabies), Common Scab (Streptomyces scabies)**

**Key hosts:** Potato, beet

**What it is and what it does:** This bacterial disease has two strains that affect potatoes and beets: common scab and acid scab, differentiated by their responses to soil pH. Acid scab is much less common in the northeast. In either case, streptomycin can infect from the time of flowering in potato, and continue throughout the season. Scab persists in soils indefinitely on decaying plant residue or on animal manure; spread by rain, windblown soil, and infected tubers. Worse when soil is dry—scab-fighting bacteria in soil are less active during dry weather.
Symptoms range from minor superficial marks to russetting (corky patches), to deep pitting of the tuber or beetroot, and are dependent on weather, and crop history in that part of the garden. Scab doesn’t affect flavor or safety; just cut off what you don’t want to eat.

**Note:** Symptoms stop after harvest but scabby potatoes don’t store well.

**IPM solutions:** Choose scab-tolerant varieties; plant certified seed potatoes. Have your pH tested and follow recommendations for altering soil fertility and pH. You’ll want soil pH of 5.0-5.2. Well-rotted organic matter helps retain soil moisture, slowing scab onset in dry seasons. Rotating crops reduces the level of streptomycin in the soil, but won’t eliminate what’s there. Rotating with grain crops is thought to reduce disease. Chemical controls haven’t been successful.

**Scab (Cladosporium cucumerinum)**

**Key hosts:** Melon, summer and winter squash, pickling cucumber and others

**What it is and what it does:** This fungal disease is widespread and can travel far on winds, though it needs 100% relative humidity or free moisture on leaves for infection. It can overwinter on plant debris or be seedborne. On leaves, look for pale green, water-soaked areas; lesions become angular; turn gray or white, break and then leave irregularly shaped holes—often with pale circles around them. On fruit, note tiny spots that darken with age, creating sunken, dark green/brown lesions. Ooze contains spores. This disease can be confused with angular leaf spot except for the dark green lesions of scab.

**IPM solutions:** Be sure to use clean, disease-free seed. Choose resistant varieties, and plant in well-drained soils. Keep plants far enough apart to assure air circulation. Delay planting until weather has warmed, and cycle susceptible plants out for a three year rotation. If you are considering fungicide, use early rather than later, but be sure you are following directions. Efficacy is tied to weather conditions.

**Scab**

Here’s a case where a common name can really mean two different things. Scab diseases refer to how they look on a plant, but scab can be fungal or bacterial, and that’s a big difference. In context, consider the vegetable involved. Fungal scab attacks cucurbits, while bacterial scab attacks potatoes and beets.
Surface Molds

Powdery Mildew (Erisyphe spp., Sphaerotheca spp., Podosphaera spp.)

Key hosts: Pea, summer squash, winter squash, cucumber, melon, pumpkin and others

What it is and what it does: The fungi that cause powdery mildew are usually host-specific (pea powdery mildew won’t move to squash, etc). It’s a pretty common problem because it is carried by the wind, tools, plants and animals—yet it doesn’t thrive in wet weather. In fact, it spreads in drier weather, and can grow in humidity as low as 50%, though it prefers higher. Powdery mildew is common late in the season, often as a grayish-white powdery mold found on leaves that may be in the shadow of others. In cucumbers, melons, and squash, it starts as small, white moldy spots on leaves; spots run together. In peas, seeds inside pods turn gray or brown. In beans, newest leaves dwarf and curl.

IPM solutions: Rain and overhead sprinklers can disrupt mildew. Hose off plants, but only if plants can dry quickly, as wet foliage could be prone to other disease problems. Choose resistant varieties and don’t depend on fungicides alone.

Wilts and Damping Off

Bacterial Wilt (Erwinia tracheiphila)

Key hosts: Cucumber, melon, pumpkin, summer squash, winter squash

What it is and what it does: This bacterial disease is vectored by spotted and striped cucumber beetles, and overwinters in the gut of adult beetles. Crops wilt quickly while still green, and may be difficult to diagnose. On cucumbers and melons, note limp leaves before the affected vines die. On summer squash, main leaf veins stay dark green while the rest of the leaf yellows, then turns brown and dies. Symptoms on pumpkins are similar but include shortened internodes, stunted, tufted, pale yellow leaves on seedlings, or at nodes on older vines. If infected while young, plants turn brown, rot, and die, but in all cases, this can be a quick wilt and death. Cukes and melons more susceptible than pumpkins or squash

IPM solutions: There is no cure, but squash infected late in the season may produce adequate fruit. Adult beetles emerge in mid-June, so managing cucumber beetles (spotted and striped) is important. Try row covers. Consider planting really late crops and use hoops or cold frames to extend the season.
Blackleg, Bacterial Dry Rot
*Pectobacterium atrosepticum, formerly Erwinia carotovora*

**Key hosts:** Potato

**What it is and what it does:** This bacterial disease is often carried by infected seed tubers and leads to poor germination and plant stands. Soil and weather conditions at planting, as well as seed tuber handling and cutting are major factors. Symptoms show at flowering, when one or more stems suddenly wilt and stems turn inky black just above the soil line.

**IPM solutions:** Plant only blackleg-free potato tubers and do a two- or three-year rotation (don’t plant potatoes in the same place the following year). Keep seed potato/tubers dry and at room temperature, then plant when soil temperatures are about 50°F at a 5-inch depth.

**Clubroot (Plasmodiophora brassicae)**

**Key hosts:** Broccoli, Brussels sprout, cabbage, cauliflower, kale, other crucifers

**What it is and what it does:** This fungus is soilborne, surviving up to 20 years as resting spores, especially in moist, acid soil. Spreads by splashing or running water, tools, or infected transplants and plant tissue. Heads and leaves wilt and yellow. Young plants fail to grow; older plants fail to head up or complete their growth. Symptoms might not show until plants become drought-stressed. Pull up plant to see malformed, club-shaped, swollen roots. Depending on where infection begins, swellings are small to large. Swellings interfere with water uptake; swollen tissue has no protective outer layer, making it easier for bacteria to invade.

**IPM solutions:** Few, if any, varieties show resistance. Buy certified transplants. Inspect roots; if you find it, reject entire lot. Put crops on a seven year rotation and keep pH high (6.8) by applying lime regularly to slow clubroot down. Finely ground lime is more reactive than coarse granules and alters pH more quickly. Plant in raised beds if drainage is poor.
Damping Off (*Rhizoctonia* spp.);

**Key hosts:** Pepper, tomato, beans, carrot, beets, pea; for lettuce, also see Bottom Rot

Damping Off, Seed Rot (*Phytophthora* spp.);

**Key hosts:** Pepper, eggplant, tomato, potato

Damping Off (*Fusarium* spp.);

**Key hosts:** Beans, carrot

Damping Off, Seed Rot (*Pythium* spp.)

**Key hosts:** Spinach, broccoli, lettuce, arugula, cucumbers and other cucurbits, beets, onion

**What it is and what it does:** Damping off is a common plant failure in seedlings caused by various fungal and fungal-like diseases. Unlike crown rot or root rot, damping off generally refers to plant death of new seedlings. Stems become discolored, and remain stunted and die, or simply fall over close to the soil level. It can also kill seeds before or after they germinate. Damping off most often occurs when soils are wet and cool temperatures prevail.

**Note:** Damping off has also been attributed to *Botrytis* spp.

**IPM solutions:** Reduce wet soil, and stay out of the garden when it’s wet. Disinfect tools, your boots and be careful what you move from one spot to another. Use raised beds, and planting medium (starter soil) if you are growing transplants. Don’t fertilize plants until they are well-established.

Fusarium Wilt, Crown Rot (*Fusarium oxysporum*, *Fusarium solani*);

**Key hosts:** Tomato, melon, potato, pumpkin, pea, spinach, pepper, bean

Fusarium Yellows (*Fusarium oxysporum*)

**Key hosts:** Broccoli, cauliflower, cabbage, celery

**What It Is And What It Does:** Fusarium is a very persistent (5-7 years) fungus with a number of variations and hosts. Damage to seedlings or feeding by soil insects increases the chance of infestation through roots. Cole crops like cabbage become yellowed and wilted, mostly on one side of the plant. Lower leaves turn yellow before the upper leaves; eventually turning brown and dry. Heat increases the disease’s effects and you may see ooze on stems. On pumpkins and melon, wilt primarily affects mature plants; look for lesions along stems and
Phytophthora species are soil-inhabiting pathogens that are favored by wet conditions.

Although previously considered fungi, Phytophthora species are now considered to be in a separate classification called oomycetes. We also call them water molds. Phytophthora can take down a seedling or your favorite ornamental shrub.
IPM Solutions for Insects and Arthropod Problems of Vegetables

Having insect problems? Take another look at your layout, rotation, sanitation practices, plant selection, spacing, weeding, watering, and mulching. All can make your vegetable garden less inviting to pests. Consider traps, barriers, hand-picking or hosing them with a heavy spray of water (as hard a stream as possible without damaging plants), and other ways to handle the bad guys.

Which pest is which? What plants do they damage? What can you do about them? Review basic IPM. You’ll learn that keeping an eye on your garden is much easier than trying to fix a major pest problem later.

These solutions apply to nearly every case. Where they don’t, we tell you. Where less-common remedies help, we describe them.

- Insect-resistant veggies are less common than disease-resistant ones. Still, seek them out.
- Inspect transplants before you buy them—tap stems to see if tiny insects fly or fall off leaves.
- Use slow-release or organic fertilizer—or compost—to avoid the lush, quick growth (promoted by high-nitrogen fertilizers) so attractive to many pests.
- Compost improves soil texture and contributes to plant health.
- Scout routinely for pests (for the good guys, too), and track what, how many, and when, in your garden journal.
- Attract natural enemies with varied, pollen- and nectar-rich plants such as dill and cilantro (aka coriander)—with water and shelter, too.
- Plant mixed beds of different kinds of plants to confuse or repel pests.
- Handpick or do the sheet-beneath-the-plant trick. Drop pests in a can or bucket of soapy water. Some insects, like cucumber beetles, won’t sit still for you, but you can still brush them into a can of soapy water.
- Drape row covers over crops to let light and water in but keep pests out. Secure edges with stones, boards, or soil.
- Plant trap crops for insects. Set out lures and traps—our listings tell you how.
- Clean up garden debris in fall—some insects (and many diseases) overwinter in damaged leaves and stems. But leave little piles of disease-free, undamaged leaves around to provide winter homes for natural enemies.

Jumping Worms?

AKA crazy worms, these are no fun at all. They destroy good soil habitat and are extremely invasive.

Check your property’s earthworms by mixing one gallon of water with 1/3 cup of ground yellow mustard seed and pour slowly onto soil. Examine any worms that rise to the surface. Jumping worms can be identified by their whitish clitellum and odd movement.

Choose heat-treated compost to reduce pathogens and invasive worms, and always remove compost, soil and debris from personal gear, equipment and tools before moving them from one site to another, or when sharing plants.
• Rotate crops. Sometimes pests (pupae of tomato hornworm, for example) overwinter in the soil near their hosts. Rotating helps keep them from building up year to year.

• Straw or other mulch could harbor spiders and other predators of potato beetles and other pests.

• Till or cultivate—gently—to destroy overwintering sites. Remember that overtiling can wreck soil structure.

• Consider insecticides or other pesticides if severe—but learn more about them first. Be sure you learn how to read toxicity information on labels: the label is the law. Also know what to do and who to call for pesticide poisoning. The right diagnosis is key to choosing the right fungicide. Seek help from your county’s Cooperative Extension specialists or a diagnostician at your state’s land grant college. Each state has its own standards and product labeling changes frequently when these standards change. Be sure you are looking at the current product listings for your state.

Pesticides: A Complex Decision

Gardening with IPM stacks the deck against pests. But once in a while a pest can take hold and surpass your threshold of tolerance. That’s the point when you decide you need to do in the pests to save your crop. Some gardeners would rather lose a crop than use any pesticide. Others use least-risk pesticides. Still others are comfortable with any legal pesticide. It’s a complex decision. As you plan your garden, think about your threshold of tolerance. Only you can define what a severe infestation is in your garden.

Aphids

Key hosts: Bean, cucumber, eggplant, carrot, celery, beet greens, chard, tomato, corn and more

What they are and what they do: Few vegetables are exempt from aphids, because most aphid species are generalists (they like all plants). These tiny (to 1/8 inch), pear-shaped insects come in many colors: yellow, green, dusty black, red, and some have a fluffy white coating. They have sucking mouthparts that draw sap from leaves, buds, and flowers, especially on new, tender growth. Feeding can distort or stunt foliage. The sticky liquid (honeydew) they leave behind attracts ants and makes the perfect habitat for sooty mold.

IPM solutions: Use slow-release or organic fertilizers which slows the quick, lush growth aphids love. Hose them off three mornings in a row, and you’ll get rid of most. Encourage beneficial insects (aphids parasitized by wasps turn into golden-brown aphid mummies).

Beetles

Asparagus Beetle, (Crioceris asparagi), Spotted Asparagus Beetle (Crioceris duodecimpunctata)

Key hosts: Asparagus

What they are and what they do: The common asparagus beetle adult is a small but fancy metallic blue-black with blue head, four boxy yellowish spots on wing covers; ¼ inch. The
larvae are plump, wrinkled gray or olive-green, with black heads and legs. They mature at 3/8 inch. The spotted asparagus beetle adult is orange-red with six black spots on each wing cover; to ¼ inch. Their larvae are orange and 3/8 inch. They overwinter as adults and emerge to feed and lay eggs in late spring. Common asparagus beetles lay eggs in a row on spears; those hatched larvae feed on the spear. The spotted asparagus beetle lays eggs on ferns where her offspring will instead feed on asparagus berries. Larvae of both feed and grow for about two weeks, then drop to the soil to pupate. There are two generations a year; the second generation overwinters as adults. Feeding damage makes asparagus unmarketable but not necessarily inedible.

**IPM solutions:** Destroy crop residues to get rid of overwintering sites. Scout often and hand pick (drop into soapy water) or knock larvae off with a soft brush. If immature, they won’t feed again, nor survive to pupate.

**Colorado Potato Beetle (Leptinotarsa decemlineata)**

**Key hosts:** Potato, eggplant, tomato

**What they are and what they do:** Adults overwinter in debris and emerge in May from crop debris and hedgerows. These small, 3/8 inch beetles have black, lengthwise stripes on yellowish-orange wing covers; heads are the same color or darker. Clusters of yellowish eggs are deposited on the underside of leaves; larvae are reddish, hump-backed with black spots and voracious eaters; their feeding damages production of growing potato crops. Larvae pupate in soil, precipitating a second generation of adults and eggs each summer.

**IPM solutions:** Plant early potatoes as a trap crop started close to the surface. (If nightshade grows as a weed nearby, use it temporarily like a trap crop. Just don’t forget to destroy it—you don’t want it in your garden.) Scout for overwintering adults as they emerge and handpick. Interplanting crops with unrelated vegetables and flowers could confuse them. A deep straw mulch can make it harder for beetles to find the plants. Always move potatoes from year to year in crop rotation (but don’t replace with eggplant or tomato). Consider pesticides if severe.

**Spotted Cucumber Beetle (Diabrotica undecimpunctata howardi), Striped Cucumber Beetle (Acalymma vittatum)**

**Key hosts:** Summer squash, winter squash, cucumber, melon, pumpkin and others

**What they are and what they do:** Similar in appearance and with similar life cycles for the most part, we lump these two
pests together; adults of both feed on leaves and fruit, while larvae of both feed on roots and stems. Much more common in the northeast, the striped cucumber beetle overwinters in topsoil under plant debris and comes out in early spring to feed on wild host plants. The spotted cucumber beetle generally doesn’t overwinter but flies in later in the season and has a much wider variety of hosts. Both are long, pale beige or yellow, and ¼ – ½ inch in length. Their size matters little because of quantity. Adults lay eggs at the crown, larvae enter soil to feed on roots and pupate. The next generation of adults and larvae may do more damage—the larvae may feed on plant stem or fruit as well. Their feeding can also spread bacterial diseases.

**IPM solutions:** Since cucumber beetles can spread bacterial disease, dealing with them is a high priority. Row covers reduce infestations, but you must open them up for pollination of flowers. Deep straw mulch slows larvae moving among plants but provides homes for adults—and helpful predators. They won’t sit still for you, but you can knock them into a can of soapy water. Parasitic nematodes could help control larvae. Trap crops, and inter-planting helps. Rotate your cucurbits and encourage natural enemies. Scouting will help determine if you need an insecticide.

**Flea Beetles: many species**

**Key hosts:** Beet, Swiss chard, broccoli, Brussels sprouts, cabbage, kale, cauliflower, eggplant, pepper, tomato, potato, melon, others

**What they are and what they do:** Seven or eight members of this family are pests in North America—lumped in together because they are voracious, jumping beetles and able to fly. Adults are tiny (to 1/16 inch), black, blue-black, brown, or bronze; some have stripes but the majority are solid colored and shiny. Adult feeding damage is easily identified by a shot-hole pattern. Oh, and did we mention the jumping? Larval feeding on roots and stems can weaken or kill seedlings. They prefer early, tender leaves, but attack arugula, mustard greens, and turnip leaves all season long. Adults overwinter and emerge from soil to feed on early weeds until your garden plants are ready for them. Eggs are laid near the base of plants allowing larvae to enter the soil, pupate and start over with a second (or more) generation. This is one of those pests where both larvae and adults chew on multiple plants, but favor nightshades and cole crops. You may be able to ignore the feeding damage, but your crops won’t be marketable.

**IPM solutions:** Seedlings are most vulnerable. Scout often for adults. Keep row covers on until plants are mature, thus less attractive. Try to plant seeds or transplants later in the season, or

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**When is a cucumber beetle also a corn earworm?**

The larvae of the spotted and the striped cucumber beetle both feed on roots, but the spotted cucumber beetle is an opportunist and a much greater pest in the south than in the north. That’s why it’s also called the Southern corn earworm.
put out mature transplants. Trap crops include mustard greens, pac choi, radishes, or eggplant interspersed, or run along the edge of the garden also help. Crop rotation isn’t helpful. Straw mulch, a ‘green’ mulch, and sticky tape also slows down this pest. Parasitic wasps and nematodes may be a good purchase, as is the good soil organism *Beauveria bassinia*. There are insecticide options as well.

**Japanese Beetle (Popillia japonica)**

**Key hosts:** Asparagus, bean and others

**What they are and what they do:** These easily recognized metallic blue-green and coppery ½ inch beetles are sun lovers from July through September, massing and feeding on leaves of all kinds, and often leaving them skeletonized. Feeding by masses can rapidly defoliate a plant. Larvae are fat, pale gray/brown-headed C-shaped grubs that can be as long as 1⅓ inch. They feed in soil on roots, including turfgrass roots, overwintering and pupating there as well. They also show up in the soft, moist soil of gardens.

**IPM solutions:** In July, check your garden (vegetable, fruits and flowers) daily at dawn or dusk, and flick adults into soapy water buckets, or shake off onto a tarp (and then destroy). Handpicking is the most successful and safest option. Don’t use beetle lure traps. Reduce neighboring grassy areas to reduce larvae (irrigated, lush lawns welcome more larvae, too). Drought in July through September usually affects the following year’s population. Consider floating row covers, and don’t chase off birds ‘grubbing’ in your soil.

**Mexican Bean Beetle (Epilachna varivestis)**

**Key hosts:** Bean

**What they are and what they do:** This pest overwinters as an adult in plant debris. Mexican bean beetle adults are ¼-1/3 inch long, yellowish with black spots when young, and darken to a copper color as they age. They are also easily confused with helpful lady beetles. Mexican bean beetle’s spots seem to be in three obvious rows. After two weeks of feeding (most often on the underside of leaves), females lay bright yellow, oval eggs in clumps of 40-50 hanging out of sight. Both adults and larvae feed on leaf tissue. While it is difficult to tell the difference between this pest’s eggs and the beneficial ladybeetles’ eggs, the larvae and pupae are strikingly different: bright yellow, 3/8 inch, with long black bristles. The bright yellow pupae are attached to leaves. Mexican bean beetle may have 1-3 generations each season; later generations tend to feed on top of the leaves, and those adults may damage blossoms and beans as well.
**IPM solutions:** Use row covers through harvest if you had lots last year. Plant early if conditions permit, and interplant with other crops to confuse them. Pull each plant as you harvest the last beans; put in airtight bags until plants and beetles are quite dead. Leave soil exposed for a few weeks and birds will eat remaining beetles. Some biocontrol houses carry *Pediobius foveolatus*, a parasitoid; commercial growers use it with success.

**Borers**

**European Corn Borer (Ostrinia nubilalis)**

**Key hosts:** Corn, beans, potato, tomato

**What they are and what they do:** The European corn borer overwinters as larvae in plant debris—often inside dead corn stalks. It pupates and emerges in late May as a yellowish-brown moth, ~1-inch wingspan, with faint zig-zag markings on its wings. Eggs are laid on the undersides of leaves in a tight, overlapping mass. Pale gray larvae (sometimes appear pinkish) have brown head capsules and mature at about 3/4 inch. On corn, early instars feed on tassels; later entering tips of the cob. On other crops, larvae tunnel into stems. While corn is their first choice, it’s thought that, when necessary, European corn borer females move to crops in a moister setting. A second generation of larvae can cause more damage to the edible crop—they will bore into peppers and tomato fruit. European corn borer not only damages by feeding, but can carry bacterial infections. Look for small entry holes and frass, which often collect in leaf axils.

**IPM solutions:** Good weed control and encouragement of ladybird beetles is a helpful step in reducing these pests. *Trichogramma* wasps are natural egg parasitoids and can be purchased for release. There are many varieties of corn resistant to larval pests. If your growing season is long enough, plant quickly maturing varieties late so ears mature after borers are gone—remembering that borers generally have two generations. Scout, and remove visible larvae. Compost infested stalks or debris in hot piles only; chopping the stalks first helps them break down more quickly. If your compost pile doesn’t heat up, consider other ways to destroy crop debris.

**Squash Vine Borer (Melittia cucurbitae)**

**Key hosts:** Pumpkin, squash; also gourd, melon, cucumber

**What they are and what they do:** Pay attention to your vine crops at the end of June with the adult vine borer emerges from its pupal case in the soil where cucurbits grew the prior year. The ½ inch adult is a clearwing moth, but flies in the daytime. It has an orange body dotted black, and has fuzzy, orange and black hind legs, and metallic front wings. Eggs are laid at the
base of host plants, and larvae emerge and quickly enter stems and vines. These grub-like larvae are a creamy color with brown or black heads. Larvae mature to 1 inch. Their black body is marked with orange or red. Hind legs look feathery, with black-and-orange hairs. Wilting of squash plant in hot sun occurs, and plant may bounce back with water, but will eventually die out.

**IPM solutions:** A difficult pest to manage. By the end of June, you should be scouting the base of vines often. Look for adults flying (and buzzing by you), and eggs on soil near stems. Remove any larvae you find. Consider row covers only if you’re planted where no cucurbits were the prior year, and then remove row covers at blossoming. If you see a hole with frass spilling out, slit stem lengthwise about ½ inch with a needle or knife and scrape the larvae out (they stay in there for 4-6 weeks), then bury the slit, watering nearby soil, so the vine can reroot. Some gardeners place yellow bowls of water near plants to trap adults—they are drawn to yellow, but have trouble getting out of the water. Remove and destroy any wilting vines to reduce the chance of larvae dropping out to pupate.

### Caterpillars

#### Armyworm, Fall Armyworm (*Spodoptera frugiperda*)

**Key hosts:** Corn, beet greens.

**What they are and what they do:** Adults are pale gray-brown moths, 1 inch long with a 1½ inch wingspan; a white dot in each forewing. Armyworm moths move in from the south, looking for crop fields. Eggs are laid in groups anywhere on corn plants, and look like big fuzzy gray masses. When hatched, larvae begin feeding (around mid-June) and can leave large ratty holes in leaves that resemble hail damage. Larvae go from pale green to tan and greenish-brown with white side stripes and dark back stripes. Up to 1½ inch long, Caterpillars move in masses—armies—in search of food, but their damage can be spotty, as it’s localized near their hatch site. Large armies can do considerable damage overnight. They are an occasional feeder on beet greens as well.

**IPM solutions:** Choose resistant varieties. Scout often for egg masses to stop them before they hatch. Look carefully in crowns of corn and under mulch, boards, and stones—if you find one, search for more. Follow pest forecasts from sources like NEWA. Consider biocontrols. Bt corn is generally resistant.
Cabbage Looper (*Richoplusia ni*)

**Key hosts:** Brussels sprouts, broccoli, cabbage, cauliflower, kale, lettuce, others

**What they are and what they do:** The cabbage looper adult moth is a mottled brownish gray with a tiny silver figure eight on each forewing. Their wingspan is 1½ inches. They lay small clusters of greenish-white eggs on the underside of leaves, their food source. Larvae are a solid green—the color of broccoli—with a faint yellow stripe along each side, and will grow to 1½ inches. Loopers chew holes in leaves and stems, sticking to the leaf surface between the leaf veins in mature plants. Feeding on the growing tip of broccoli or cauliflower causes stunted heads. Feeding lasts 2-4 weeks before the larva creates a cocoon for pupation; there can be multiple generations per season. Another problem is the messy green frass that collects in the plant. Dead loopers sometimes float into hot cooking water, to the dismay of cooks.

**IPM solutions:** Scout for eggs on the underside of leaves. Hand pick adults and larvae and drop into a can of soapy water. Look for holes and you may find the culprits nearby. Till in crop residue in fall or spring or remove completely. Consider using row covers for the early season, and remove before hot spells or upon harvest.

Cabbageworm, Imported Cabbageworm (*Pieris rapae*)

**Key hosts:** cabbage and other crucifers

**What they are and what they do:** As green as its habitat, these 1½ inch larvae would be inconspicuous if not for the large ragged holes and green frass they leave behind. Adults are the very common, nectar-feeding white butterflies (1½ to 2 inches) flitting around in fields and gardens throughout the summer. Up close, you’ll see a couple small black spots on the wings. It is thought cabbageworms overwinter as pupae; adults fly early in the season. Females lay one egg at time on the underside of leaves, and after 2-3 weeks of feeding, the larvae pupates by hanging from a thread from a leaf (no cocoon). With a possible 3-5 generations each year, you’ll see cabbageworm and moth activity throughout the season. While young larvae eat leaves, mature larvae can damage growing heads.

**IPM solutions:** Scouting and removing by hand or water helps as the larvae are slow movers. Encourage their many natural enemies, and try a trap crop along the edge of your garden. Remove plant debris after harvest and destroy or bury promptly.
Corn Earworm, Tomato Fruitworm (*Helicoverpa zea* formerly *Heliothis zea*)

**Key hosts:** Corn, tomato

**What they are and what they do:** Adults moths are drab brown with dark spots in the centers of their wings, and a 1½-inch wingspan. In mid-summer, they fly in from the south, and repeatedly lay single eggs (yellow and basically round) on leaf hairs or corn silk. Caterpillars are brown to tan or green with brown heads, micro-bristly bodies, and lengthwise stripes (also variable). Length to 1¾ inches. Larvae bore into ears of corn via the tassels or tunnel through tomatoes. Their feeding leaves behind decay, holes and frass, or you might just see one looking back at you.

**IPM solutions:** Plant corn early and choose early-maturing varieties—moths don’t arrive in the Northeast until mid-July to late August, though some years there are two generations. (Tomatoes need a warmer soil, so this won’t work for them.) As corn tassels turn brown, pull back tips of leaves to inspect for borers; remove and destroy. Many gardeners deal with these by removing damaged tips from fresh-picked corn, and go on to enjoy fresh sweet corn from their own gardens!

Cutworms: *Noctuidae* spp., and others

**Key hosts:** Brussels sprouts, cabbage, cauliflower, beet, spinach, peas, eggplant, tomato, lettuce, onion and others

**What they are and what they do:** A number of night flying moths, often called millers, are responsible for the fat, gray or brown caterpillars that we call cutworms. Adults are generally gray or brown, 1 inch long with 1½-inch wingspans and their larvae aren’t much fancier: generally brown, or dark gray; 1¼-1¾ inches long and known for curling up when disturbed. Some of these moths overwinter in the northeast as pupae or larvae, while others fly in from the south. Some species have multiple generations each year; the female moths can lay hundreds of eggs on plants or plant debris of the many hosts, so cutworms are a season-long problem. While the moths are not a problem, the larvae are prone to chewing the stems of young plants and transplants, essentially cutting them at the soil line.

**IPM solutions:** Collars placed around seedlings are the primary precautions for cutworms. Push a tin can or 3-4-inch tall cardboard collars 1-2 inches into soil around seedlings and young transplants. Cultivate soil lightly around seedlings in early morning to uncover resting cutworms; destroy them. Or scout at night with a flashlight; handpick. Where chronic, set out transplants when they’re larger and less vulnerable. Weed garden well in fall, and till before planting.
Diamondback Moth (*Plutella xylostella*)

**Key hosts:** Cauliflower and other crucifers

**What they are and what they do:** This tiny moth is notably different from others by the way it holds its wings—held folded over the back, rather than flat and to the side. This habit and its small size make it harder to see. Adult moths are 1/3 inch long, gray or brown, and, on the males, white marks on the folded wings look like three diamond shapes. These moths may overwinter as pupae, but more often migrate in from the south. They do no damage on their own, but egg-laying begins promptly—a couple pinhead-sized eggs at a time on the undersides of leaves. Larvae are white and change to pale green, maturing at about ¼ inch. They appear to be pointy at both ends. First instars tunnel into leaf tissue; later instars feed on leaf surface and drop by a silk thread if disturbed. Summer generations pupate in silk cocoons on leaves. A large number of larvae can reduce leaf surface and plant vitality, including damage to cole crop heads.

**IPM solutions:** Natural enemies such as ground beetles, spiders, lacewing larvae and parasitic wasps can control these pests if they are not reduced by pesticide use. Heavy rainfall also helps! Trap crops such as yellow rocket are often successful (remember to remove and destroy them when they are full of pests). Check any incoming transplants for these tiny pests.

Leek Moth (*Acrolepiopsis assectella*)

**Key hosts:** Leek, onion, garlic, chives

**What they are and what they do:** Leek moth is found mostly in northern New York and thought to overwinter as pupae or adults, surviving in plant debris. It’s a drab nocturnal moth—speckled brown, black, and white; 3/8 inch long with ½ inch wingspan. Distinctive triangular white spot halfway down outer wings which it holds folded tight to the abdomen. Eggs are translucent and nearly impossible to see. A female can lay a hundred or so on plant leaves. Larvae are creamy yellow, slender, with a brown head capsule and less than a half inch long. Larvae create cocoons that are loosely netted, about ½ inch long; you can see the green pupa through the cocoon which is attached on leaves, neighboring vegetation, or debris. Note the difference in damage based on leaf structure: on leeks and garlic, larvae bore into center of leaf fan, creating a series of pinholes. Next, they feed on inner leaves, leaving vertical whitish dead streaks on maturing leaves. On onion, chives, and shallots, larvae feed inside hollow stems or leaves, creating a “windowpane” effect. There are two or three generations per year, and those later generations can tunnel into bulbs, stunting growth and providing entry to soilborne pathogens.
Tomato Hornworm, Tomato Fruitworm, *(Manduca quinquemaculata)*

**Note:** *Helicoverpa zea*, the Corn Earworm, also attacks tomatoes and may be called tomato fruitworm.

**Key hosts:** Tomato, other solanacea

**What they are and what they do:** The adult is sometimes called a hawk moth or sphinx moth, and moves about in short, jerky movements like a hummingbird (and nearly as big!). They are a grayish-brown moth with a 4 – 5 inch wingspan! Look for faint yellow marks on its big, but tapered body. Small, pale yellow-green eggs laid singly beneath leaves. Caterpillars are few, big, noticeable; green (occasionally brown) with a black “horn” on tail end; eight diagonal or V-shaped white stripes on each side. They can reach almost four inches in length, so they can make short work of your plants! (A close relative, the tobacco hornworm, has a red horn and seven diagonal white stripes per side.) Hornworms chew gaping holes in leaves and leave dark green frass—huge dark frass. Mature plants usually survive, but seedlings don’t.

**IPM solutions:** Scout in July and August. Handpick larvae (or eggs) and toss them into the bushes—it’ll take them a long time to get back. If you see a hornworm with a bunch of little white tags attached—that’s the work of a parasitic wasp; the hornworm will die soon. Fall tilling destroys many pupae. If you have been overwhelmed, consider insecticides such as Bt.

**Flies**

**Swede Midge, Cabbage Midge, Cabbage Crown Gall Fly (Contarinia nasturtii)**

**Key hosts:** Crucifers and cruciferous weeds

**What they are and what they do:** Midgees are tiny flies with long legs, about 1/16 inch long. Swede Midge is relatively new and formidable pest. They overwinter as pupae in soil, and adults emerge from May to June for the first of multiple generations that last through October. They are weak fliers and are carried easily on the wind. Eggs are laid on stem tips and growing heads, and impossible to see. Larvae (maggots) are tiny and transparent at first, maturing to lemon-yellow and to 3/8 inch while feeding on leaves and those parts you also want to eat. Look for puckered leaves, brown corky scarring, galls, blind heads or lots
of small heads. Some symptoms could be confused with heat or cold injury, herbicide injury, or other pests. Broccoli is especially susceptible.

**IPM solutions:** Consider row covers for early season but pest pressure may remain high after mid-June when they should be removed. Rotate if possible, but the goal is more than a thousand feet away, with a minimum two year rotation. Scout along sheltered areas near trees, hedges, or buildings—especially areas downwind of last year’s crucifer crops. Swede midge overwinters and also lays eggs on alternate hosts like wild mustard, field pennycress and yellow rocket; remove these weeds. Till or disk soil right after you harvest in fall, but don’t till everything at that time—you don’t want to spread pupae. In early season, use loupe to find larvae. If you suspect damage, but don’t find any larvae, put piece of leaf or stem into a jar with rubbing alcohol and shake—larvae will come out if they haven’t already dropped to the soil to pupate. Keep looking. This is a serious, relentless summer pest. Destroy infected plants right away, and hoe between rows to expose pupae to drying sun or predators. Consider pesticide applications.

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**Leafhoppers and Leafminers**

**Leafhoppers, Potato Leafhopper** (*Empoasca fabae*), **Aster Leafhopper** (*Macrosteles quadrilineatus*), and others

**Key hosts:** Potato, bean, celery, lettuce, carrot, parsnip and others

**What they are and what they do:** Leafhopper adults fly in on windstorms from the south, ready to lay eggs. These tiny (1/8 inch) wedge-shaped insects vary in color and can blend in well: green, brown, or tan, sometimes with spots or stripes. No surprise—they jump, but pay attention and you’ll see they run sideways. There are multiple generations each season, so you may find adults and the pale, wingless nymphs on the same plant. The potato leafhopper is an opportunist and eats over two hundred plant species, while others are more host-specific. Despite their tiny size, their sheer numbers and their method of feeding can distort, stunt or kill plants. Leafhoppers scrape plant tissue and feed on juices. By doing so, they inject toxins into the leaves which may even contain plant diseases. Look for leaf curling, a leaf browning called hopper burn, or tiny white marks like stippling. They also leave honeydew on leaves.

**IPM solutions:** Leafhoppers are hard to control. Consider row covers, but make sure you aren’t limiting pollination on some flowering plants. A good hosing can remove some leafhoppers. Plant early to evade the first generation if crop and soil permit. Destroy crop debris after harvest if you see disease symptoms.
Leafminers, Spinach Leafminer
(Pegomya hyoscyami)

**Key hosts:** Beet greens, Swiss chard, spinach, others

**What they are and what they do:** These tiny pests overwinter as pupae in the soil where they fed the previous season. Adult flies emerge in May; they are tiny, ¼ inch long, dark and hairy. Eggs are attached to the underside of leaves so hatched larvae can immediately begin tunneling through leaf tissue. *Pegomya* larvae are pale green, nearly transparent, and barely noticeable at 1/16 – 1/8 inch. Unfortunately their feeding isn’t, and leaves pale, winding trails behind that enlarge into big, dry blotches. Mature larvae drop to the soil to pupate, which is why you need to rotate to a new spot the following year.

**IPM solutions:** Scout for damage, egg clusters, and active feeders, then remove and destroy. Keep weeds down, especially dock, lambsquarter, chickweed, nightshade, pigweed. Rotate and consider floating row covers.

Mites

Spider Mites, Two-Spotted Spider Mites
(Tetranychus urticae), and others

**Note:** Mites are arachnids, not insects.

**Key hosts:** Bean, pumpkin, summer squash, others, tomato, potato, pepper, eggplant, and many ornamentals

**What they are and what they do:** Mites are not insects because of that six-legged rule. Two-spotted mites go from egg to six-legged larvae, then to 8-legged nymph, but in general mites have eight legs, can be pale green, red, yellow, and can’t fly. Adults overwinter and start laying eggs in warm weather. Both adults and nymphs feed on leaves, and on flowers and fruit, leaving stippling, speckling and sometimes webbing. They feed with sucking mouthparts and can cause leaves to curl, brown or die. Populations can boom in hot, dry weather; plants can weaken, produce stunted fruit/crops and even feel the effects the following year.

**IPM solutions:** Scout, especially during droughts; use a hand lens or loupe, and look on the underside of leaves. Hose off, repeat often. Beneficial mites are bigger and faster, and prey on mites; they like damp soil, so water often to encourage them.
**Slugs and Snails**

**Key hosts:** Wide range of crops, especially those with tender leaves, near damp hiding spots.

**What they are and what they do:** Slugs are soft and usually gray; sometimes tan, green, black, orangey-brown, or spotted; wide range of sizes. Snails have coiled shells. Both leave slimy mucus trails where they crawl. Both leave clear eggs, round or oval, in jellylike clumps in soil under plants or under mulch, stones, and debris. Both thrive in rainy weather and can demolish young plants. They prefer seedlings; thin, smooth, or new leaves, and fruit, but usually avoid plants with hairy leaves such as tomatoes and squash.

**IPM solutions:** Clear mulch away from vulnerable plants in cool, wet weather, and then push it back with hot, dry weather comes. Cultivating soil around roots may destroy eggs. Use a stick to flick slugs and snails off leaves and into a bucket of soapy water. To trap slugs, place boards, inverted pots, cabbage leaves, newspaper, or citrus or melon rinds near plants overnight. In the morning, drop your captives into that soapy water. Spare the helpers such as ground beetles, which eat slugs and snails. Tuna cans, filled with beer or water and yeast, and set just below ground level, also make good traps. Other deterrents are copper or zinc strips around plants, wood ash, coal ash, crushed eggshells or diatomaceous earth.

**True Bugs**

**Squash Bug (Anasa tristis)**

**Key hosts:** Cucumber, melon, pumpkin, squash.

**What they are and what they do:** These large, flat adults overwinter under debris or inside structures. They are dull brownish-black, about 5/8 inch, with noticeable striping around the edges of the abdomen. In June, females lay orange-bronze eggs in clumps on leaves, and generations overlap by the end of the season. Nymphs are light gray, darkening as they mature; ¼ – ½ inch. As members of the true bug family (Hemiptera), adults and nymphs suck plant sap, disrupting nutrient flow. Leaves and shoots blacken; stem feeding causes plants to wilt and may prevent flowers or fruit. They can kill small plants. These squash bugs tend to hide when disturbed.

**IPM solutions:** Scout for eggs or adults and nymphs under leaves, especially in June when seedlings are susceptible—handpick and drop into soapy water. Because they like to congregate, you can make traps by laying out boards and newspapers at night—roll up and destroy. Remove plant debris throughout the season, and especially in spring and fall where they may be overwintering.
Stink Bug, Brown Marmorated Stink Bug (BMSB) (*Halyomorpha halys*)

**Key hosts:** Tomato, pepper, corn, beans, eggplant

**What they are and what they do:** More and more people can recognized the BMSB because it seems to enjoy living inside our homes in the winter. They are spotty brown shield-shaped bugs, ~ 5/8 inch; look for white banding on antennae and legs. Nymphs look similar but have red eyes and no wings. Adults generally overwinter in crevices of tree bark or buildings. They emerge in the spring to feed and reproduce one or more generations. Eggs (white or light green) are laid in masses, and early nymphs are brightly colored and stay close to the hatch site. They darken as they mature. Feeding continues all season as it moves from crop to crop (vegetables, fruits and ornamental plants). Adult females lay eggs all season. Adults and nymphs damage plants when they insert sucking mouthparts and cause distortions and marking.

On corn ears, you’ll see discolored, broken kernels. On peppers, BMSB feeding leaves mottled discoloring on smaller than normal fruit. Tomatoes have yellow discoloration and spots that may resemble disease, but skin is rarely broken, or sunken. Bean and pea damages shows up as pale discoloration.

**IPM solutions:** Early season crops may peak before BMSB populations. Reduce overwintering sites (crates, woodpiles, for instance), and encourage beneficials such as egg parasitoids. BMSB has become a major agricultural pest and new methods of control are being researched. Contact your local cooperative extension office for the latest news.

Stink Bug, Harlequin (*Murgantia histrionica*), Green (*Chinavia halaris*), and Brown (*Euschistus servus*) Stink Bug

**Key hosts:** Tomato, pepper, cucumber, beets, pea, corn, sometimes crucifers; many fruits

**What they are and what they do:** While variable in color, stink bugs are predominantly shield-shaped bugs, ½ inch. The harlequin bug is bright red and black; its nymphs are oval. Others are green, tan, brown, gray. Some are smooth; others look bumpy. Stinkbug egg clusters look like little barrels, some with fringes, and are also a variety of colors. After overwintering in nearby weeds, females begin egg-laying when the temperatures are in the 70s. Both adults and nymphs pierce leaves and suck sap, leaving scarred, distorted fruit, and setting them up for disease problems.

**IPM solutions:** Reduce habitat for egg-laying and overwintering by keeping weeds down near the garden. Persistent scouting and
removal of adults and nymphs into soapy water, and crushing eggs is very helpful. Stinkbugs have many natural enemies: toads, birds, spiders, snakes and parasitic wasps and flies. Yellow sticky tape helps. Consider row-covers but don’t hinder pollination at flowering. Sunflowers planted far from vegetables work as trap crops.

**Tarnished Plant Bug (Lygus lineolaris)**

**Key hosts:** Tomato, pepper, lettuce, many others

**What they are and what they do:** Adults overwinter in plant litter and under rocks and debris. They are ¼ inch, oval, green or brown, mottled or tarnished looking but look for the yellow triangle behind their heads. They begin laying eggs in May on plant tissue and crops—even egg-laying can damage crops. Nymphs are yellowish green and develop yellow, green, or black spots. Constant stress from adult and nymph feeding, with sucking mouthparts (they are ‘true’ bugs of the Hemiptera family), distorts and dimples leaves and stems. Feeding transmits saliva that also damages plant tissue. There may be two to four generations each year. TPB moves from crop to crop, garden to garden during hot dry weather and attacks fruits, vegetables and field crops like alfalfa. Take note when farmers make hay—this bug will flee that field and may come to visit you.

**IPM solutions:** Reduce as much habitat—weeds—as you can. Use row covers in weed-free gardens. Predators include big-eyed bugs, damsel bugs, pirate bugs, and some parasitoid wasps, but they can’t reduce a booming population. Avoid planting near alfalfa crops, weedy and debris-littered areas which provide winter shelter. Mow to remove weed hosts in nearby plots, but not right before or after bloom time. Scout for signs of feeding, and then take a shallow white dish, hold it under leaves and blossoms, and watch for green nymphs. Consider pesticides in severe infestations.

**Thrips**

**Key hosts:** Onion, tomato, cauliflower, others

**What they are and what they do:** Even thrips adults are barely visible (around 1/16 inch), so you’d need a loupe or microscope to see the immatures. Adults range in color: white, pale yellow, brown or black. They have feathery wings, but are weak fliers without help from the wind. Nymphs are slender, pale, and red-eyed. Both adults and nymphs can overwinter in fields, and both feed on plants with raspy mouthparts that scrape tissue for sap. Females lay eggs on crops—the start of multiple generations each season. Thrips (remember, there is no such thing as one thrip—even one of these is called a thrips) are hot weather fiends and don’t thrive in cool, wet summers. They barely move...
if temps are 65°F or below. On onions, thrips feed between newly emerging leaves; hard to detect unless you part the leaves (look for silvery streaks and spots on leaves). Damage is bronze colored on cabbage-family crops. Dark flecks are frass. Tomatoes from damaged flowers are scarred. Early on a cool morning when thrips are less active, put a white cloth, tissue, or frisbee under leaves or flowers and tap them. If you see lots of tiny moving critters on the cloth, you’ve got thrips. (Flower thrips can bite people; they’re checking to see if you’re a plant. It’ll feel like a little prickle, possibly leaving a mysterious rash if lots attack—but you won’t know what got you. Discomfort is temporary).

IPM solutions: Water well; thrips thrive when it’s hot and dry. Hose off as needed. Onion sets often have thrips, so inspect carefully with a magnifier before planting and destroy infested sets right away. Monitor with yellow sticky cards.

**Soil and Root Pests**

**Cabbage Maggot, Cabbage Root Maggot, Root Maggot** (*Delia radicum*)

**Key hosts:** Broccoli, Brussels sprouts, cabbage, cauliflower, radish, kale, turnip

**What they are and what they do:** Cabbage maggots overwinter as larvae and adults emerge around early May to begin 3-4 generations of tiny, hump-backed flies and their tiny, white larvae. (They resemble other pest flies and you’d have to have magnification to notice.) Eggs are laid at the base of plants by flies capable of traveling a mile to find a host. The legless maggots—1/4 inch—tunnel through and feed on roots, including root crops like turnips. Look for brown tunnels in stems at soil level or in roots just below soil. Plants may show yellowing leaves, and wilting on hot days.

**IPM solutions:** Flat barriers on ground around stems prevent egg-laying. Plant cabbage late in spring or as a fall crop; maggots can’t take summer heat. Encourage natural soil predators with organic matter and no pesticides. Parasitic nematodes attack root maggots. Follows NEWA pest models to determine when to scout. High soil temperatures reduce this pest. Floating row covers can prevent egg-laying, providing you’ve planted your crops in a new spot, not the same as the prior year.

**Carrot Rust Fly** (*Psila rosae*)

**Key hosts:** Carrot, parsnip, others

**What they are and what they do:** This dainty fly with the red head is not currently a common pest in New York, and we’re thankful for that. It zips into a field, lays eggs near carrots where
subsequent larvae begin eating at root hairs ... and then the roots. This can create stunted, unmarketable crops when you don't even know you've had a pest encounter. Adults are small black flies; to ¼ inch. Skinny, yellowish-white larvae mature to 3/8 inch in length.

**IPM solutions:** Plant after June 1st in most of the Northeast. Use well-anchored row covers (flies will find a way under when possible). Harvest by late August (southerly zones) through mid-September (northerly zones) to avoid a second brood. Destroy damaged roots; don't compost. Fall cultivation reduces overwintering. Consider parasitic nematodes when faced with infestation. There are no resistant varieties, and even chemical control isn't always effective.

**Carrot Weevil (Listronotus oregonensis)**

**Key hosts:** Carrot, parsley, parsnip

**What they are and what they do:** Adults are tiny copper and brown snout beetles, aka weevils. They overwinter in garden debris or hedgerows and move in to lay eggs on crowns when small carrots have their first four leaflets. Hatched larvae (white with brown heads) make zigzag tunnels through stems and into roots—this stunts growth and makes them un-appetizing and unmarketable. Larvae mature at about 1/8 inch, and then pupate about 2 inches deep into soil, generally close to the carrot.

**IPM solutions:** Routine fall cleanup—including garden edges—helps keep them from migrating back into the garden next year. Crop rotation helps because adults don't fly. Parasitic nematodes are effective for large infestations, and the parasitoid wasps of the *Anaphes* genus are an excellent natural enemy. This is a minor pest in much of New York.

**Onion Maggot (Delia antiqua)**

**Key hosts:** Onion, leek, other alliums

**What they are and what they do:** The adult is gray, slender, long-legged, slightly smaller but very similar to a house fly, except its wings overlap at rest. It emerges from the pupal case in soil in mid-spring and lays eggs in soil near early onion crop. White larvae, to 3/8 inch emerge and feed on roots for 2 to 3 weeks, then pupate. Second-generation adults emerge about 2 weeks later. Cool, wet weather favors 3 generations per year. Later generations cause more damage to the bulb, and their feeding also facilitates diseases that may show up as storage rots. Onion plants may wilt or die.

**IPM solutions:** Rotation is not helpful unless you are moving them a half mile away. Onions from sets and bunching onions are less vulnerable than transplants. Plant in light, sandy soil.
where possible. Put in a trap crop of early onions; flies may find it about 2 weeks after sprouting. Row covers work as long as eggs didn’t overwinter on plant debris. Monitor with sticky tape if you’re willing to ID with magnification. If you discover maggots, harvest the crop and dig out infested soil; destroy infested plants; pull volunteers next year. Don’t use a cull pile—this only serves as a breeding ground.

**Seed Corn Maggot (Delia platura)**

**Key hosts:** Beans, peas, corn, onion, summer squash, others

**What they are and what they do:** Adults are 3/8 inch, slender, grayish-black flies that resemble small house flies or the adult onion maggot. They overwinter as pupae in soil under plant debris. Adults emerge in spring and lay eggs in soil near decaying plant material or new seeds; look for them in moist cracks in soil. Maggots are ¼ inch, yellowish-white and legless with wedge-shaped heads, and they thrive in moist soil during cool, wet spells when germination slows. They feed on seeds or organic matter for 2 – 3 weeks, returning to the soil to pupate. Seed corn maggots are more common in soils with high organic matter. Larvae—the maggots—scavenge dead plant material in early springs until they find sprouting seeds. They hollow out seeds and can feed on cotyledons or first true leaves. Chewed cotyledons show browning holes; snakehead seedlings curl downward, killing or stunting young plants. Symptoms can be tricky to tell apart from root rot or wireworm damage.

**IPM solutions:** Don’t spread manure or till in cover crops directly before planting, and don’t till in bean or pea debris if you had them last year. Delay planting until plant debris has deteriorated. Good drainage is critical. First generations causes most damage—plant late to miss it (example: 3rd week of June in upstate New York). Shallow planting helps, as do beneficial nematodes. Consider treated seed.

**Wireworms:** *Agriotes spp.*, *Limonius spp.*, *Melanotus spp.*

**Key hosts:** Potato, carrot, others

**What they are and what they do:** Wireworms are often found in soil under turf because they are root feeders. When turf is made over into garden space, wireworms are waiting for your root crops. Adults are narrow, dark click beetles (noted for their ability to flip themselves off their backs with a loud clicking sound), and they feed on pollen, flowers and soft insects like aphids. Eggs are laid in soil near plant crowns so hatched larvae can feed on roots. Wireworms are hard-bodied, have six legs close together behind head capsule, and are generally tan or orange. They live for years in the soil before pupation (2-5 year
life cycle, depending on species). We often see them coiled up under boards, mulch, or stones. They feed on seeds as well as roots, crowns and stems, so carrots and potatoes are attractive to them; easy to tunnel through. Root feeding damages crops and may kill or stunt plants.

**IPM solutions:** Trap larvae with one-inch potato pieces poked onto sticks or skewers; tuck under the mulch or into the top layer of soil before you plant. Place every two feet—as many as you can stand to do. Do the same with carrots. Check every 2-3 days—weekly at least. When infested, remove and destroy wireworms, and then start over. Harvest main-crop potatoes as soon as you can: they’re a sitting target. If turning a lawn into garden, till in fall to 4 inches, once a week for 4 – 6 weeks; kills or exposes larvae to natural enemies; hoeing also exposes them to predators, but don’t overdo tilling. Or plant a cover crop for one season after tilling the lawn. Consider beneficial nematodes if severe. Avoid root crops in the same place next year; rotate with non-host crops such as onions.

**Whiteflies**

**Key hosts:** Tomatoes, also on other plants, especially greenhouse transplants

**What they are and what they do:** These sap-sucking insects aren't really flies; think of them as more like aphids. The adults have powdery white wings, and are barely visible at 1/16 inch unless clustered together. Pinpoint-sized eggs are laid under leaves. Early nymphs crawl, later nymphs barely move. In hot weather you’ll have new generations in no time. Whiteflies seem to rise up in a white cloud when disturbed. Because they don’t overwinter outside, it’s a good chance they came into your garden on a transplant or seedling from a greenhouse. Their feeding causes damage—yellowing spots and drying, or death of seedlings. Whitefly may also spread disease. Their honeydew excrement encourages sooty mold. Overall, a difficult insect to banish.

**IPM solutions:** Inspect plants you’re about to buy—a simple tap on the plant will reveal them. Don’t buy infested plants. The extra time you spend examining them may prevent a lot of trouble later. Consider yellow sticky traps to monitor and reduce populations (slightly). Natural enemies help, but without the success they are in a greenhouse environment. Try hosing them off. Because of differences in susceptibility during life cycle, contact your cooperative extension office if you are considering insecticides, including horticultural oils.
Enjoy Your Bountiful Garden

With a little knowledge and some simple IPM methods, you can grow a bountiful and healthy vegetable garden. From planting to harvest, your vegetable garden can be a busy place—even if it’s as small as a patio container of cherry tomatoes. In this chapter you’ve learned about the major vegetable pests, but in spite of the risks, we believe you’ll find vegetable gardening an easy and rewarding experience. You choose the amount of effort, the size of your plot and the number of plants. (Word to the wise: one or two zucchini plants are generally enough!) Experiment with a trellis, or find a sunny spot in your flower garden. Working in the garden can be relaxing exercise. It’s interesting, educational, and rewarding! It might even expand your cooking repertoire, because it’s hard to beat the pleasure of picking something fresh from your garden and eating it later that day.