



Introduction to Organic Gardening



What is this

This book is intended as a crash course to organic gardening— in no way is it a comprehensive manual. Our hope is that this will serve as a guide to help you get started and to point you in the direction of additional resources.

- ◆ In this book you will find guides to:
- ◆ Understanding soil
- ◆ Planning your garden
- ◆ Techniques for maintaining a healthy garden organically
- ◆ Common beneficial insects and harmful pests and diseases
- ◆ When and how to plant different crops

If you are an educator please use this book as a starting point for tailoring to your audience’s needs— children, low literacy adults, brand new gardeners, etc. We hope that you will find it useful for creating additional educational material.

The material provided is intended for educational purposes and *not for profit*.

The glory of gardening: hands in the dirt, head in the sun, heart with nature.
To nurture a garden is to feed not just on the body, but the soul.
–Alfred Austin

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Crop Planning for Beginners

An ideal location for a your new garden will have the following features:

- Relatively flat (no more than 5% grade)
- Receive 8 hours of sunlight. Morning light is better than afternoon light. You can grow some crops with 6-8 hours of sunlight, but not tomatoes, peppers, or cucurbits.
- Near a water source.
- A shovel goes down at least a foot before hitting solid rock or tree roots.
- Is not in a flood zone nor have standing water in it after a rainfall. If there is a lot of moss, this indicates shade and bad drainage.
- Is not on top of or near to a septic tank field.
- Ideally your rows are oriented East to West, if your garden area is flat. If you are on any kind of slope, your rows must orient along the contour of the slope to prevent erosion.
- Keep your garden as far from the tree line as you can. Roots extend out at least as far as the branches do, if not farther. Never plant a garden anywhere near a walnut tree!
- Does anyone have a truly “ideal” location? Probably not, but do the best that you can!

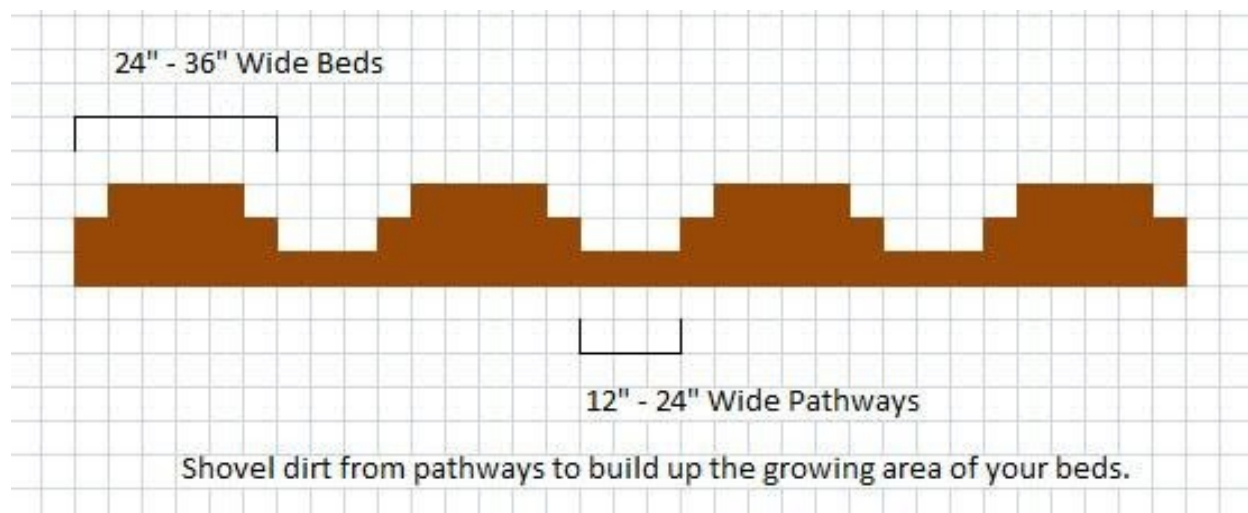
Preparing for Tilling:

If you have your garden spot picked out and are waiting for the tiller to come, there are things you can do to help prepare the soil!

- Start smothering your grass with dark tarps, layers of cardboard, or a very thick layer (8-12”) of straw.
- Add some compost or well-rotted manure to the spot before you till, so that it can be tilled in and incorporated well. Please ask your manure source if anything is sprayed on the field or hay that the animals are eating. There are persistent herbicides that survive the digestive track and will kill your garden plants if you use the manure. Compost from vegetative sources is your safest bet!
- Do a soil test! [See page 8 for soil sampling instructions.](#)

Building your garden beds:

- When we say Raised Beds, most people envision wooden boxes filled with soil. However, the term refers to any planting area that has been raised up. Raising up the planting area improves drainage and helps soil warm up earlier. By creating separate walking paths and planting areas, you can improve the soil structure of the planting areas by not compacting it with your feet.



- Planting areas should be 24-36" wide and pathways should be 12-24" wide. Smaller planting areas are not an efficient use of space and wider areas will make it too hard to reach into the planting area without stepping on the soil. If you have an especially large garden, you will likely want at least one extra wide pathway 36-48" wide running down the middle of your garden for wheelbarrow access. After tilling your soil, mark off where your planting areas will be with wooden stakes on either side of your garden and then run twine between them. Shovel soil out from your pathways into the planting area. Now make a solemn commitment to never step on the planting area!

1.) What are you going to plant?

- What kinds of veggies do you and your family like to eat?
- What do you buy the most of?
- What are the veggies you wish you could eat but don't feel like you can afford regularly?
- What are veggies you would like to try canning or freezing for use in the winter?
- If you are returning, what did well in your garden last year and what didn't?
- What new vegetables would you like to try?

2.) How much of each vegetable are you going to plant?

- Check the Planting Cheat Sheet, which has a range of how many plants per person to grow.
- If you want to eat it once or twice a week, go with the lower range. If you'd like to can or freeze enough to last you through winter, go with the higher range or even double or triple the quantity listed.
- Always plant 10-20% more than you think you will need to account for inevitable loss to disease and pests.

3.) What are you going to plant?

- There are three general planting times in the garden: early spring (March-April), late spring (April-June), and late summer (August-September).
- Certain plants like cool weather and don't do well in the heat, plant these in the early spring or late summer for a fall harvest. Generally, these are leafy greens, peas, and many root vegetables.
- Certain plants like hot weather and don't tolerate temperatures below 40 degrees. Plant these only when all danger of frost has passed, generally the first few weeks of May. These include most fruit bearing plants (tomatoes, peppers, squash, beans, etc.)

- The Planting Cheat Sheet tells you which month you can start planting a certain crop in the spring and the latest you can plant them in the early fall.

4.) When are you going to harvest it?

- Plants have a set amount of time that they generally produce in. A packet of seeds will give you a “days to harvest” number. This is an average for that crop, but you can generally expect that under normal conditions, it will produce its first harvest in that time. The Planting Cheat Sheet has average times for most crops.
- Some plants are harvested once and the plant is killed: lettuce, radishes, potatoes, cabbage, etc. If you want more of these crops, you will need to replant them. See below for more info on “succession sowing.”
- Some plants, like beans, cucumbers, and summer squash, will produce for 3-4 weeks and then the plants get old and become less productive. They also need to be replanted, but less often than the harvest killed crops.
- Some plants are continuously harvested over a period of weeks or months. Some plants, like peppers and tomatoes will produce for the whole summer and fall up until the plants are killed by frost.

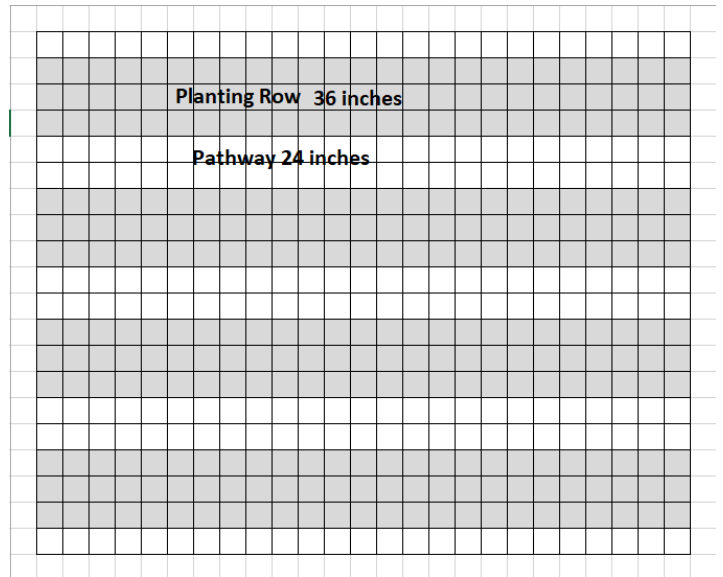
5.) How often will you replant it?

- This is also known as “succession planting” *See page 19 for instructions on succession planting.*
- Some crops will need frequent succession sowing. For instance, if you would like 4 heads of lettuce each week, then you will need to plant new lettuce seeds every week. Make sure to leave room in your garden diagram to account for these successions.
- Some crops need less frequent successions. For beans, cucumbers and summer squash, plan for 2 or 3 successions each year, spaced 3-4 weeks apart. By the time your first planting gets old and unproductive, a new planting will be gearing up to produce a fresh new crop!
- The Planting Cheat Sheet has suggestions for how many successions per season you can do to create a steady supply of that vegetable for you!

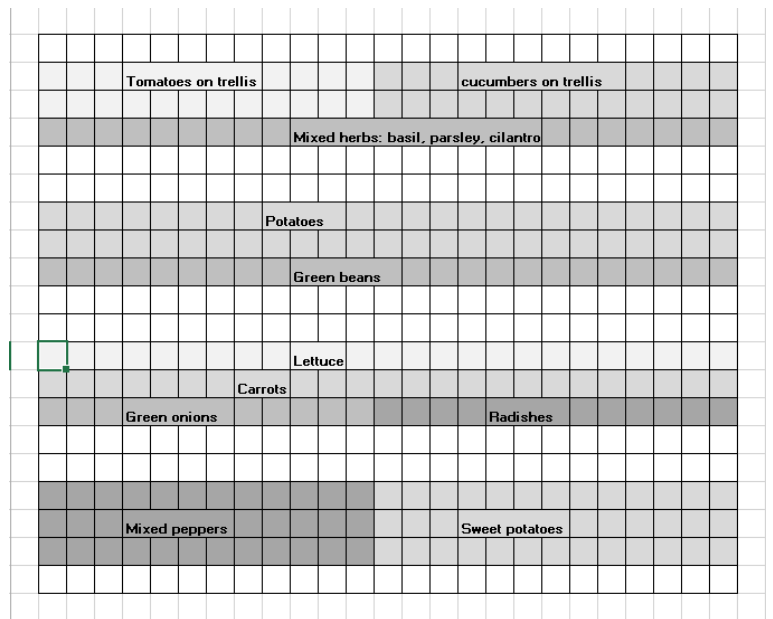
6.) Where will it grow?

- This is the fun part where you draw out your garden map for the year!
- You can do one map; 3 maps for spring, summer and fall; or a map for each month if you’re really looking to maximize your garden’s growing potential. It’s okay to start with one during your first year.
- You need to start with your garden’s dimensions. For this example, we will talk about a 20 foot by 25 foot garden (20’ x 25’). Next identify where in your yard the sun rises and sun sets. The sun rises in the East and sets in the West. Orient your rows East to West as best you can. IF your garden is on a SLOPE, then you need to orient your rows along the contour of the slope.
- How wide are your rows? We recommend rows that are 24” to 36” wide, with 30” being the standard for organic farms. There should be at least 18” between rows, more if you have trouble walking or kneeling and need to be able to sit down to work in the garden. Using the grid paper, draw out your rows. To make this easy, we’re going to do 36” rows with 24” between each row. This means we can fit 4 rows and 3 paths in our 20’ wide garden.

- Now decide where you are going to plant all of the crops you want to include. In general, tall crops or crops that are trellised, should go toward the Northern side of the garden because they will create shade if they are toward the Southern side.
- Crops come in different sizes and spacing needs. A radish plant only needs a couple of inches between it and its neighbor. A winter squash vine can need up to 5 feet between plants! The Plant Cheat Sheet has general spacing information about different crops.



- If your row is 25 feet long and a potato plant needs 12" of space, then you can fit 25 potatoes in that row. Tomatoes need 18" or 1.5 feet of space each, so you can only fit 16 plants in a 25' row. Radishes need 3" of space, so you could fit 300 of them in a row that is 12" by 25' long.
- Keep in mind that your row are 24-36" wide, so in many cases you can plant more plants in a row than you could if it was only 1 foot wide. This is similar to Square Foot Garden methods. Tomatoes need 36" between rows, so you can only plant one row of plants in each garden bed. Potatoes need 24" so you can get two rows per bed, if your beds are 36" wide. With radishes, you could plant 600 plants in a 36" by 25' bed.



- Once you've mapped out where everything is going, you can check your crop plan for any holes. If you've got extra space, put something in it or note where it is and leave it empty to allow for succession sowing of another crop. Just keep in mind that bare ground invites weeds to grow and it's always better to have something growing than not!

Understanding Soil

Before you DIG, Call 811

Soil Testing

When is the best time to test your soil ?

Take a soil sample before initiating any new planting. Sampling well in advance of planting will allow time for applied soil amendments to begin making the desired adjustments in soil pH or nutrient levels. If an established area exhibits abnormal growth or plant discoloration, take a soil sample right away. For areas recently limed or fertilized, delay sampling at least six to eight weeks.

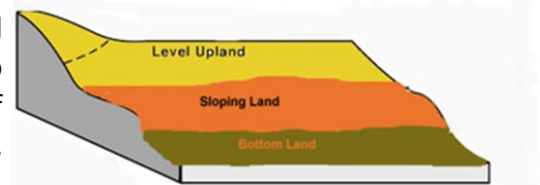


Figure 1. Land Sections

How often should I test?

Once every 3 to 4 years.

Where should I sample?

To obtain an accurate soil sample, divide your landscape into areas of unique use, for example; vegetable garden, lawn, or perennial flower bed. Or by location such as: top of hill or lowland, or test areas of different soil colors and textures. Sample unique areas individually.

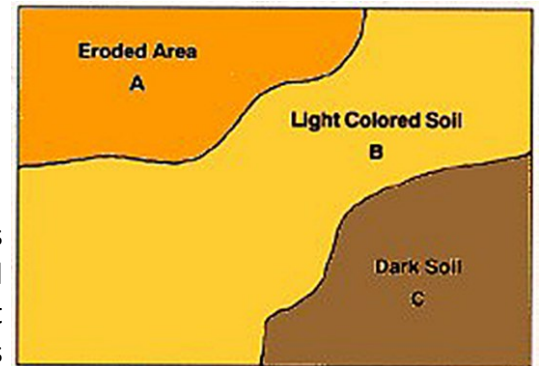


Figure 2. Soil Segments

Why should I sample different areas?

If one area of your landscape seems healthy and another area has bare or yellow areas or yields poorly, soil sampling may help to diagnose a problem. However, it should be pointed out that other factors may have a greater influence on plant growth that will not be accounted for by a soil test. These include soil drainage, soil compaction, insects, diseases, rainfall, and other factors.

How do I take a representative soil sample?

1. Open a hole with a shovel, spade or trowel from the surface to 6 inches deep. Set that soil aside.
2. With your shovel or trowel remove a 1 inch thick slice from the smooth side of the open hole.
3. With the slice of soil on the blade of the shovel, remove the sides of the slice with a trowel, knife or your hands to create a ribbon of soil 2 inches wide and 1 inch thick of the proper depth. Place the ribbon into a **clean** container such as a bucket.
4. Remove any surface mat of grass and any rocks.
5. Continue to take additional soil samples from the uniform landscape area (at least 6 different times). Mix your sample thoroughly together. Fill the sample box to be sent to Soil Testing Laboratory.

How do I submit my soil sample?

1. Obtain free Soil Sample boxes and Soil Sample Information Sheets from your local Cooperative Extension office, certain agribusinesses, and garden centers. Use permanent ink or pencil to fill out forms and label boxes.
2. Fill the sample box completely with soil and label it with your name, address, and sample identifier. Your sample identifier helps identify where you took your sample.
3. To get the most value from your soil test, take the time to fill in the blanks on the Information Sheet provided as completely and accurately as possible.
4. Fold the Information Sheet and slide it between cardboard top of soil sample box. Tape all sides of box so soil doesn't sift out.



Figure 3. Soil Sample Box

What will the results tell me?

- Soil samples from the Virginia Tech Soil Testing Laboratory are usually analyzed within one week of the time they are received. However, in early spring, processing the sample and mailing your results may take two weeks due to the large number of samples sent in by farmers at this time.
- The Soil Testing Laboratory will provide you with information on the availability of nutrients in your soil. The test measures and makes recommendations for the following major nutrients: P (phosphorus); K (potassium); Ca (Calcium); Mg (Magnesium) and five micronutrients. In addition, the routine test determines the soil pH and makes recommendations on how to raise or lower soil pH. Soil pH is a measurement of the acidity or alkalinity of a soil. On the pH scale, 7.0 is neutral. Below 7.0 is acidic, and above 7.0 is basic or alkaline.

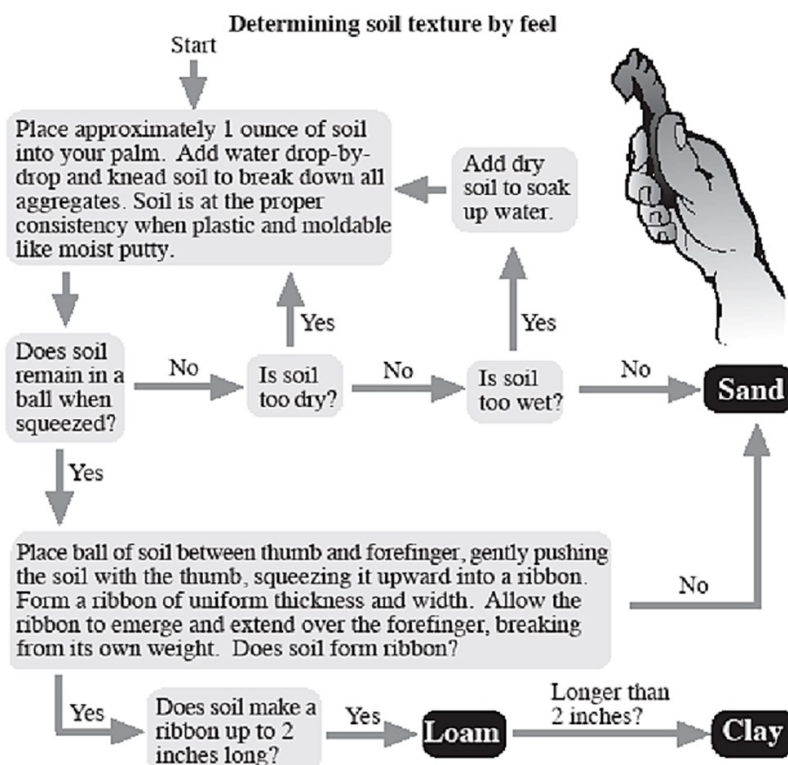


Figure 4. Soil Texture

- When testing is complete, a report is mailed to you and an electronic copy is available at the Agriculture Extension Agent for your county or city. Supplemental notes are also sent with the report. The notes explain the technical terms used in the report and provide extra details on fertilizer application schedules for specific kinds of plants. Feel free to contact your Extension Agent for more help on sampling, interpreting soil test results, and understanding how to implement them. The phone number for your local Extension office appears on the upper left of your report.

Soil Structure

The Physical Nature of Soil revolves around how porous your soil is or how compacted it can get.

The ideal garden soil is a sandy loam that is half solid and half porous—a structural balance which allows for water and insects to move around. Soils are a combination of three basic “particles.”

Sand - These particles are the largest of the three; tiny rocks. Sandy soils will drain very easily, but this can be a problem, leaving your plants too parched. Amend sandy soils by adding organic matter, like compost!

Silt - These particles are jagged like sand but smaller. Holds nutrients well like clay but drains better, like sand.

Clay - These particles are miniscule and flat, with a tendency to pack together tightly. As a result, clay retains water and nutrients well. Clay soils can be some of the best soils if you can loosen them up. Clay can be changed by adding a lot of organic matter such as compost. Peat moss can lighten a clay soil but can lower the pH. Good for acid loving plants such as blueberries.

Most soils are a combination of these sized particles. Soil that is considered “loamy” will have nearly equal parts of sand and silt with a smaller portion of clay. For more detailed information about your garden soils visit your local USDA service center. They can help you find soil maps for any location.

Understanding Elements

pH: The measure of how acidic or alkaline (basic) a substance is. Soil acidity or alkalinity influences how easily plant’s roots can absorb nutrients from soil.

Phosphorus (P) & Potassium (K): Two of the most important nutrients we add in our gardens—they are essential for strong root growth and producing fruits and flowers. (They’re the “P” and the “K” on fertilizer labels with the three “NPK” letters.)

Nitrogen: The “N” in NPK; the nutrient that makes plants grow BIG. Soil Labs don’t generally test for nitrogen because it changes so quickly it really can’t be tested, but they do test “percentage of organic matter” as an indicator of how much N your soils have.

Percentage of Organic Matter: A measure of the richness of your soil; high levels mean happy plants and lots of beneficial life in your dirt.

Calcium: Every plant needs calcium to grow. As a soil amendment, calcium helps to maintain chemical balance in the soil, reducing soil salinity, and improving water penetration.

Balancing Soil pH

Factors:

The pH, or acidity, of soil is one of the most important factors affecting the growth of your garden plants. A pH between 6.5 and 7.0 is ideal for a wide range of crops. The best way to know your soil's pH is to do a soil test. Do not assume that a friend or neighbor's garden pH is the same as yours because soil types can change dramatically even over a small distance. Test your garden soil and make changes to pH as determined by the test.

Correcting acidic soil:

If your soil is too acidic, a low pH, you must add alkaline material, a process commonly called liming. The most common liming material is ground limestone. The best time to apply lime to the garden is in the autumn to allow time for it to act on the soil pH before the next growing season. Follow recommendations from your soil test but a rule of thumb for slightly acidic soils is to apply 5 pounds of lime per 100 square feet to raise pH by one point.

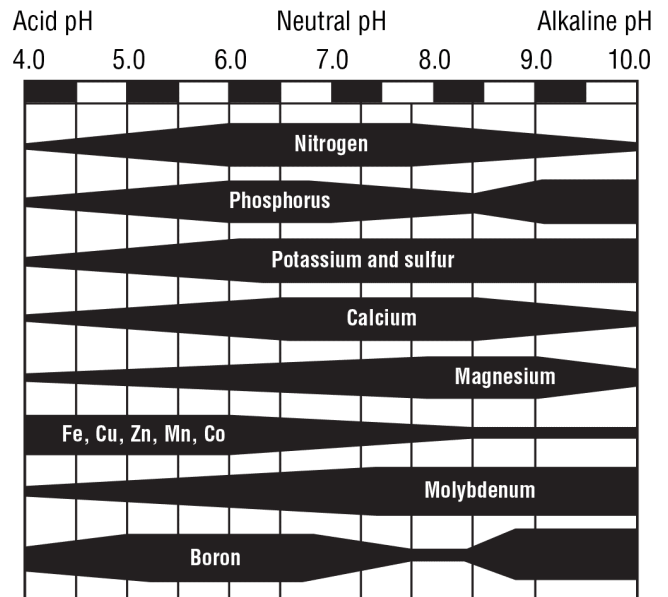
Applying wood ashes is similar to adding lime and can change an acidic soil more basic. Because it has a very fine particle size, wood ash is a fast-acting liming material. USE WITH CAUTION, because over applying wood ash can create serious soil imbalances. Limit applications to 25 pounds per 1,000 square feet, and apply ashes only once every 2 to 3 years in any particular area. At this rate, your soil will get the benefits of the trace minerals without adverse effects on pH. If you are using wood ashes, reduce your lime recommendation by half.



Figure 6. Adding wood ash

Correcting alkaline or basic soil:

If your soil is too alkaline, add a source of acidity. The most common material to add is powdered elemental sulfur. As a rule of thumb, add 1 pound of sulfur per 100 square feet to lower pH 1 point. But as with lime, the correct amount will depend on your soil type and its initial pH. Testing your soil and following lab recommendations is the best approach if you want to lower the pH of an entire bed or area of your yard. Incorporating ample organic matter (such as shredded leaves), or applying thick layers of peat moss, is an environmentally friendly option to lower your pH as well.



Effect of soil pH on the availability of plant nutrients

Figure 5. Nutrients and pH

Garden Design

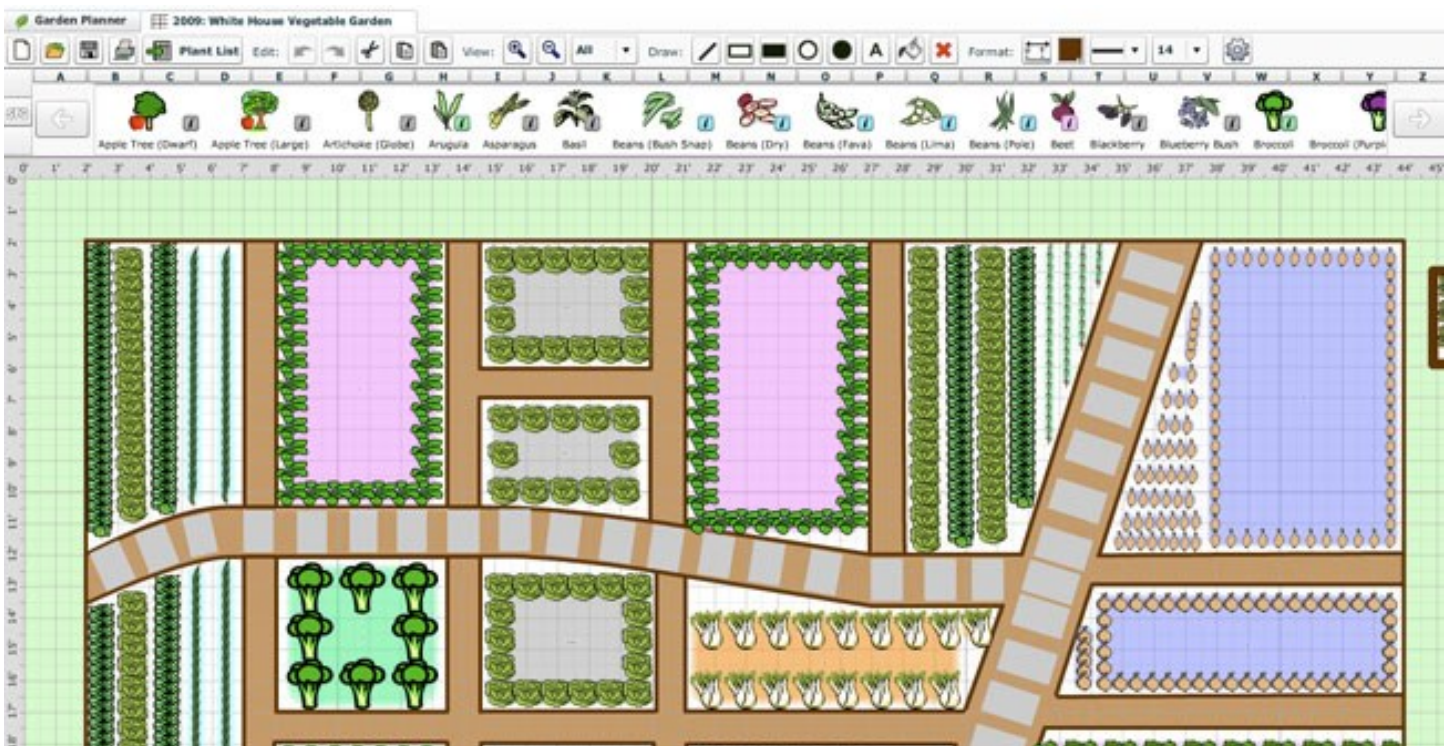
BEFORE YOU DIG CALL 811! Don't want to hit a gas or electric line!

What do you want to eat/grow/see/do? Fun things? An herb spiral? A butterfly garden?

Graph paper is great for sketching and mapping.

While this is an exercise in creativity, it is also an exercise in planning. There is only a certain amount of nutrients in the soil, and a certain amount of water, so plants that are too close together will not grow well. Healthy plants should have enough space. Plants have different space requirements. See guidelines for particular crops.

Check chapter 5 for links to online garden planners, plant spacing guides, and more! There is also information on how much of what vegetables to grow to feed a family. On the following page is the design plan we used to design our first garden for the Grow Your Own program. It is in the style of 8 blocks, all housing a different family (related vegetables) in each block. You will notice arrows—these designate crop rotation by season.



Garden Planning is crucial! The above photo is of the garden planner software in action at www.growveg.com

Compost: An Overview

What is compost?

Compost is one of the most valuable resources for your garden. It is created when organic matter—such as leaves you rake, grass, kitchen waste, and debris from your garden—is broken down by bacteria and fungi.



Why is it important?




- Compost improves the structure of your soil
- Compost reduces soil erosion and water runoff. Plant roots penetrate compost rich soil easier and hold the soil in place.
- Compost provides food for earthworms, soil insects, and beneficial microorganisms
- Compost assists the soil in holding nutrients—reducing your need for chemicals
- Compost promotes healthy plants that are less susceptible to disease and insect pests
- Compost recycles wastes that otherwise might go to landfills

IMPORTANT
Virginia commonly has clay based soil. Adding compost will improve soil structure by creating more air space and variety of soil particles. The term *tilth* refers to your soil structure.

How do I make compost?

1. Begin with an area that is at least 3' wide and 3' long. Cover area with thick layer of cardboard.
2. Place 3-6 inches of straw on top of cardboard.
3. Add about 9 inches of dry leaves or other old dead plant material
4. Add 3-9 inches of fresh plant material, kitchen waste, or manure to contribute nitrogen
5. Chop or shred all materials before adding them to speed the compost process
6. Moisten the pile as you add leaves and other dry material (similar to a wrung out sponge)
7. Mix the materials thoroughly and add material as available—it should heat up in a few days
8. Turn the pile regularly (once every two weeks) to increase oxygen flow
9. The pile should reach 140 degrees in order to kill most weeds and insects



<u>Green Matter (Nitrogen)</u>	<u>Brown Matter (Carbon)</u>	<u>What NOT to add</u>
Kitchen scraps, grass clippings, fresh plants, weeds, manure 	Dry leaves, hay, corn and flower stalks, dried vines 	Diseased plants, dog or cat manure, treated material, meat or dairy or fish products, glossy paper 

Solutions to Common Compost Problems

1. My compost is wet , soggy, or slimy.

Three factors are usually to blame: poor aeration, too much moisture, or not enough nitrogen-rich material in the pile. A pile burdened with materials that mat down when wet, such as hay or grass, can become too dense and suffocate your heap- especially if left uncovered during rainy spells. *Aerobic* bacteria—the tiny microorganisms that make compost cook—cannot live in such an oxygen-poor environment. Instead use *anaerobic* bacteria, which doesn't require air to thrive. These microbes will eventually make compost, but they work much more slowly than aerobic bacteria and the compost will be slimy and soggy during the long (about 2 or 3 years) process. This kind of anaerobic pile makes a great home for sow bugs, pill bugs, and earwigs. Weed seeds are more likely to survive in this kind of pile because it does not get hot enough to kill the weed seed.

THE FIX:

If relentlessly wet weather is part of the problem, place a loose-fitting lid or tarp over the pile. Turn the pile over and fluff it up thoroughly. If you have some "hot," nitrogen-rich ingredients (like shellfish shells) and fibrous, non-matting ingredients (like shredded corn cobs or sawdust), add them to help get things cooking. Your pile should heat up within a few days, after which you can keep it cooking by turning it every week or two.

2. My compost is dry and dusty

THE FIX:

Here's a rule of thumb you can rely on: your compost ingredients should feel about as wet as a damp sponge when they're in the pile. Put an oscillating sprinkler on top of your dry compost pile and run it for an hour—this will moisten the materials better than running an open hose on top. After sprinkling, check the center of the pile to be sure it's moist—sometimes you'll need to turn the pile and water the layers as you go. Turning and watering your dormant pile should bring it to life quickly. If it doesn't heat up, it might lack nitrogen-rich materials. If that's the case, tear the whole thing apart, add some manure or bloodmeal to get it going, and pile it up again. And once the pile does start cooking, don't let it dry out again. As they multiply, those tiny microorganisms use up a lot of water. You may have to water your compost almost as often as you water your roses during a heat wave!

3. There are bugs in my compost

Pill bugs and sow bugs are small crustaceans (not insects) that live on decaying organic refuse. If you turn over the top layer of your compost pile and see thousands of tiny, grey, creatures that look like armadillos with seven pairs of legs each, you have discovered a nest of these bugs. (Pill bugs roll up into a ball when threatened and sow bugs don't; other than that, there isn't much difference between them.) Sow bugs won't harm your compost—in fact, they're actually helping to break it down. But if you don't remove them from the finished mixture before you spread it on the garden, you might find them snipping off the emerging roots and leaves of your beans, beets, and other seedlings.

THE FIX:

To get these bugs out of your compost, raise the heap's temperature to above 120°F. (You can use a regular old meat thermometer wrapped in plastic.) Turn the pile over and rebuild it, watering it well as you go. If it contains lots of leaves or straw, mix in a nitrogen source like blood meal, manure, or shellfish shells. It should start heating soon, and when it does, those bugs will depart for a more comfortable place.

To keep your pile cooking, turn it at least every 2 weeks; more often if possible. But what if your finished compost is infested with sow or pill bugs and you want to use it where seedlings are growing? Do you have to start all over again? No. Spread the compost in a thin layer on a tarp in direct sunlight and leave it there to dry. The bugs will bail out quickly.

4. Plants are growing in my compost

Even a hot compost pile doesn't always heat up enough to kill all the weed seeds it contains. The heat causes weed seeds or even volunteer vegetables (a plant that grows on its own, rather than being deliberately planted by a farmer or gardener) to sprout.

5. My compost smells bad

If your pile emits the sharp, nose-twisting stench of ammonia, it contains too much nitrogen-rich material (raw manure containing lots of urine is the likely culprit); it may also be too wet to allow aerobic bacteria to thrive. If it just "smells rotten" and lots of flies are hanging around it, you've most likely added large loads of kitchen scraps or canning wastes to the pile without chopping or mixing them in thoroughly. In either case, you should remake the heap to bring your stinky compost under control.

THE FIX:

If you have added manure and stable bedding to your pile, mix in some absorbent and slow-working materials such as chopped straw or shredded tree leaves. The pile should start to heat up quickly, and once it gets going, it will smell just as sweet as compost can. If kitchen scraps, canning waste, or similar large amounts of mucky stuff are producing offensive odors, turn the pile without adding anything, and be sure to break up all the mucky stuff and mix it in well as you go. In the future, you can avoid this unpleasant task by first finely chopping up such material and mixing it thoroughly into the heap, where it won't come back to haunt you.

6. Raccoons are eating my compost

Actually, raccoons (...or opossums or dogs or skunks or rats or bears or...) do not eat compost; they tear up the pile to get at any fresh, edible kitchen garbage (especially if you risked adding "forbidden" meat scraps or fat) that you recently buried.

THE FIX:

Mixing kitchen garbage with soil or wood ashes before burying it (in the hot center of your pile) might discourage animals from trying to reach the hidden goods to begin with. But once such scavengers have gotten used to visiting your heap for a free meal, your best bet is to build or buy a covered bin (go for an off-the-ground model, such as the Compost Tumbler, if you can) to keep the garbage hounds away.

7. I can't turn my compost pile

Most experts will tell you that a hot compost pile should be turned at least twice a month and as often as twice a week to keep it cooking away at that ideal 150°F. Too few of us have the time and energy to work that hard and often on composting. You may also not have enough materials on hand all at once to build a hot pile, which needs to be about 3 by 3 by 3 feet to start with.

THE FIX:

You can still create this valuable soil amendment without turning. Simply build your "cold" pile right to start with, and you'll avoid many. Build the pile in layers—alternating "brown" (carbon-rich materials like leaves and straw) and "green" (nitrogen-rich materials like grass clippings and garbage) components, mixing them together as you go. Try to include some finished compost or rich topsoil in the mix to introduce those all-important beneficial bacteria to the pile. And remember to water your pile well as you build it. Keep the moisture content as even as possible (if it dries out, give the compost a soaking with the sprinkler). That's it.

Transplants: The How To

Why?

Planting transplants gives you a head start on weeds and mature earlier than they would from seed. It is space efficient, as you are only placing out healthy plants—no need to fill in blank spots with seed later or thin crowded plants.

How?

Temperature: Starting seeds in flats and pots does require attention and care. Seeds need heat to germinate. In general seeds need between 68-86 degrees. This varies with plant species, so check online. Using a heating mat to place flats on is ideal, but a warm room in your house can work too.

Light: Our common vegetable plants do not need light to germinate, but as soon as seedlings emerge move them to a bright sunny location and keep warm. In Abingdon, VA, sunlight is available for less than 10 hours a day until January 18th, so consider starting your seeds when ample sun will be available. Do not move seedlings outside until they have been hardened off correctly.

Seedlings will get leggy if they do not have enough light. A grow light helps, but a sunny window can work depending on light levels and if your house faces south. Pay attention and experiment. Keep flats moist, and evenly watered. Seedlings are very fragile, and do not like extremes or fluctuations. Keep moisture, light, and temperature levels steady.

Tips:

Avoid touching the stem as it is weaker at this stage—handle transplants by lifting out the plant with a spoon or other tool. Some people start many seedlings in one big flat, then move them once they have sprouted to their own individual “cells”

Transplants should not be planted outside until they have at least one set of true leaves—see the photos at right. The first leaves that come up when the seedling emerged were in the seed to start — they are the food the plant comes equipped with, true leaves are the first leaves the plant creates after the seed leaf.

And you must harden off plants before planting in the garden. These tender creatures have been in a greenhouse environment and are not equipped for the wild outdoors. Before transplanting, take plants outside during the day for several hours, for two or three days. This will toughen them up and prepare them for wind and fluctuating temperatures. You can also move them from the indoors into an unheated glass or plastic structure outside, such as a cold frame, to transition them.



Transplants

Continued

Root Bound

The young plant on the left stayed in its cell too long. This is known as becoming “root bound”. The young plant roots ran out of nutrients and circled around looking for food. This can weaken plants and set them back. Usually they can recover, but some plants are more sensitive.

If this happens, gently pull apart and “tease” the roots when planting outside, this alerts the plant that there is more room to spread out.

When to Transplant

NEVER set out transplants in the heat of the day—like noon for example. They will sizzle in the hot sun! Also, not hardening off correctly or rough handling at planting time leads to transplant shock. Handle these plants gently and avoid touching the stems, and lift the whole “cell” — the roots and the soil out together, bringing as much of the soil with you into the new planting space.

Biodegradable pots are made of materials such as peat moss, composted cow manure, and coconut husks. The benefit is that the pot can be planted directly into the garden when your transplant is ready, as it will easily break down. The cons are these pots are expensive, fragile, and plants can become root bound.



Root bound plant



Soil blocks are another transplanting method. Instead of each plant having its own plastic cell, each plant has a cube of soil. This allows for plants to be “air-pruned” when they hit the edge of the soil block. This avoids root binding.



Figure 8. Seedlings breaking through soil



Most common way to start plants is in plastic .

Hardening Transplants

Tender young plants from a garden center or grown at home need to “harden” before they are placed outside in spring. Find out how to help them adjust from an indoor to an outdoor environment.

When both the calendar and thermometer indicate that it is time to plant outdoors in Pennsylvania, I have trouble controlling my enthusiasm. I have rushed to plant both warm-season vegetables and tender annuals too quickly without allowing the plants to harden. This has resulted in wilting, brown leaf margins, slowed growth, and sometimes plant death. Here is an explanation of what hardening entails, why it is important, and how to do it successfully.

What is hardening?

Hardening, or “hardening off,” is the process of allowing a plant to transition from a protected indoor or greenhouse environment to the harsh outdoor conditions of fluctuating spring temperatures, wind, and full sun exposure. A gradual introduction of these outdoor stresses will cause the plant to accumulate carbohydrates, to trigger more root development, to reduce the amount of freeze-prone water in the plant, and to actually thicken its cell walls. Plant growth will change from soft and supple to much firmer and harder.

Hardening Timetable

- Start the process of moving plants outdoors about two weeks before the weather will be favorable enough for the particular plant to live outdoors.
- Check seed package instructions or inquire where you purchase seedlings as to when the plant can tolerate outdoor conditions. (Keep in mind that air temperature is often warmer than soil temperature.)

Hardening Process

- When temperatures are at least 45-50°, move plants outdoors to a shady, protected spot.
- Initially place in the shaded, sheltered location for two to three hours.
- Gradually increase the amount of sunlight the plants receive over the two-week period. The last day or two, the plants can spend 24 hours outside.
- Reduce the amount of water plants receive, but do not allow them to wilt.
- Avoid placing seedlings outdoors on windy days.
- Cold frames are excellent places to harden plants, but another spot that provides protection, such as a porch, will work.
- Pay attention to the weather forecast; if temperatures will fall below 45°, be prepared to bring the plants inside.
- Keep in mind that the overall goal of hardening is to slow the growth of the plants to allow them to adjust to a change in conditions. After proper hardening, even warmth-loving vegetables, such as tomatoes, can withstand an unexpected dip in spring temperatures.

Source: PennState Extension <https://extension.psu.edu/hardening-transplants> UPDATED: March 20, 2019

Succession Planting:

Some veggies have large windows of growing time (Beans for instance can grow from May to September) so succession planting can begin, where new seeds are sown every 2 weeks. This allows for lengthy waves of harvests of the same crop, rather than getting all of your veggies all at once!

Planting an early spring, late spring, summer, fall, and winter garden is another form of succession — rotating between cool, warm, hot, and cold crops produces more food and more options year-round. An example of seasonal succession planting could be: peas in the early spring, peppers in spring throughout summer, broccoli in the fall, and then salad greens for winter.



Tips:

For ultimate succession planting, start crops in flats while other crops are still in the ground. That way when the initial crop is ready for harvest, there are transplants waiting to fill that row. This avoids wasted garden space. Having new transplants ready to go directly into the garden bed saves about 6 weeks of prime growing season. Rotating between food crops and cover crops is a great way to enrich the garden soil with nutrients in-between plantings and minimize soil erosion.

Succession planting is a form of intensive gardening that can be tough on soil—more and more plants are sucking up nutrients. Be sure to put back nutrients in between crops—add compost, fertilizer, or grow cover crops/green manures in between food crops that take a lot of nutrients. Rotate legume crops in and out as well, as legumes fix nitrogen in the soil.

Crop Rotation:

What is crop rotation?

Crop rotation is a systematic approach to deciding which crop to plant where from one year to the next. Continually planting the same crop in the same place each year can reduce the success of vegetable crops due to diminished soil nutrients and residual plant diseases and insects.

Balancing Soil Fertility

Different crops have different nutrient requirements and affect soil balance differently. Some, like corn and tomatoes, are heavy feeders that quickly deplete the soil's nitrogen and phosphorus. Thus, planting corn in the same spot year after year, will deplete nitrogen and phosphorus from the soil more quickly than other parts of the garden. By moving corn to a new section of the garden each year, phosphorus and nitrogen can be added back to the soil with either cover crop, fertilizer, or compost.

The goal of crop rotation is to help manage soil fertility and to avoid or reduce problems with soil borne diseases and soil dwelling insects.

The general rule for balancing out soil nutrients is to avoid planting the same general category of crop (root, legume, and leafy/fruitle) successively in the same place. It's best to follow nitrogen-fixing legumes such as peas or beans with nitrogen-loving leaf or fruiting crops such as lettuce or tomatoes. Then, follow the heavy feeding crops with light-feeding root crops.

Disease and Pest Prevention

Crop rotation can help in overall management of diseases and pests because crops in the same botanical family tend to suffer from the same pest and disease problems. For example, Colorado potato beetles like to eat potato plants, but they also enjoy feasting on tomato leaves and eggplant foliage. Since these beetles overwinter in the soil, avoid planting eggplant where tomatoes were last season. Likewise, several serious bacterial and fungal diseases overwinter in plant debris in the soil. Keep in mind that cover crops can be included in a rotation plan to discourage specific types of pests and to improve soil.

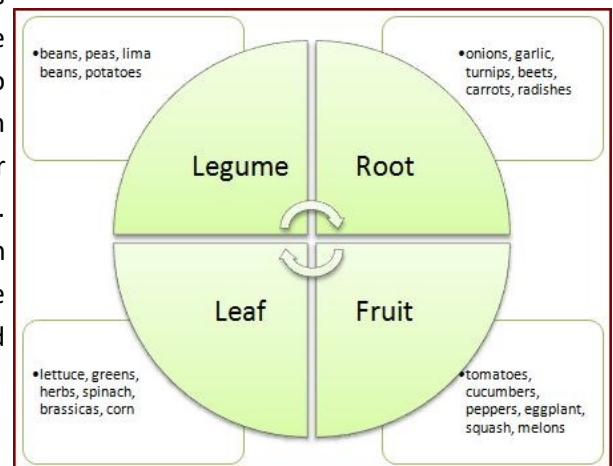


Figure 8. Types of Vegetables

Season Extension: Row Cover & Cold Frame

In the heart of winter, plant growth slows to a minimum. Here are some ways to extend the growing season to keep those healthy veggies on the menu well into winter!

Row Cover

Row cover is light-weight cloth used primarily to protect plants from the undesired effects of cold and wind, as well as insects. There are multiple sizes which range from light at 0.6 oz to heavy at 1.8 oz. Row cover can be held up and off of plants by using half-circles of 9 gauge wire that can be purchased from Southern States Cooperative. Row Cover can be ordered from Seven Springs or Johnny's Selected Seeds.

How to use it effectively

First frost is generally around October 5th. Pay attention to frost warnings. Be mindful to cover plants consistently at night when temperatures dip into the mid 30's F. If there is a freeze

warning, make sure to keep covered during the day to trap any available heat.

In October, you'll need to uncover these crops during the day—we are still getting sun and some heat. REMEMBER—plants should not touch top of cover—the tips of your plants will freeze this way.

In November and December, you can leave the cover on the whole time. A row cover is not giving you an entirely new climate or growing condition—it is simply a way to tack on a few weeks to the beginning and end of a normal season, and provide more overwintering protection for growth on old plants to start up again in early spring. Seal edges (burying is best) to trap heat and keep out pests.

Cold Frame: A cold frame is a four-sided frame of boards with a removable glass or plastic top. The frame is placed on the ground and is used to house, protect, and harden off seedlings and small plants without artificial heat. It acts like an unheated green house.

How to use if effectively: The best site for your cold frame is a south-facing, sunny spot with good drainage and some protection from the wind. Ideally, the site should get full sun from midmorning to midafternoon. You can set up a cold frame permanently in your garden, or make one that you put away when you're not using it.

The key to using a cold frame successfully is paying attention to the temperature—and the trick is keeping it cool rather than warm. The temperature inside the cold frame should stay below 75°F for summer plants and below 60°F for plants that normally grow in spring and fall. The way to keep temperatures cool inside a cold frame is to lift the lid. A good rule of thumb: When outdoor temperatures are above 40°F, prop open the lid 6 inches; when the outdoor temps clear 50°F, remove the lid. Be sure to restore the lid in late afternoon to trap the heat inside for the cool night.

On frigid nights, the plants inside the cold frame may need a little extra protection to keep from freezing. Most heat escapes through the glass, so pile insulation on top. You can use old blankets, straw, newspaper or whatever is handy. Snow insulates well, too, but brush heavy snow off the glass so it doesn't break.



These are Cloches—individual glass or plastic houses that trap heat. You can use milk jugs as well. These heat up FAST in the sun!



Row Cover



Cold Frame

Understanding Plant Diseases

Starting your seeds for success:

A healthy garden requires both healthy soil and healthy plants. And one of the most important times in the life of a garden plant is in its first few weeks of life. Here are some keys for growing healthy seedlings:

- ⇒ Start with good seed. Seeds lose vigor and strength over time. Some seeds remain viable for many years, but others are only good for a year (or less). It is best to start with new seed, but if you wish to store seed, keep it in a cool, dark, dry place (many seed savers store seed in the freezer).
- ⇒ Sow seeds in well prepared garden soil or in clean containers filled with a quality potting soil. Different seeds have different needs for good germination, so do your homework and know each plant's preference for temperature, depth of seeding, water needs and sunlight. Try your best to give each plant its ideal growing conditions, particularly in the first few weeks of life.
- ⇒ Once seedlings are growing, thin your stand to provide the ideal spacing for individual plants and to reduce competition for sunlight, soil nutrients and water. Proper plant spacing is an important way to reduce disease in your garden.
- ⇒ If growing seedlings in a greenhouse, be careful to provide adequate moisture for young plants, but not to over-water – watering is a delicate balance, plants need water, but too much can lead to fungal disease problems. Using a fan to provide better airflow can minimize the chances for disease to set in and can strengthen the stems of growing seedlings. In general you will need to water less on cloudy days and more on sunny days.

Managing Plant Disease in the Garden

A healthy garden requires both healthy soil and healthy plants. Attentive management of soil and plants will help to reduce plant diseases in the garden, but we live and grow in a warm, humid region of the country – the perfect conditions for many diseases, particularly those caused by fungi.

Soil: Liberal use of compost in the garden, a well-planned crop rotation, soil testing and cover cropping are all important to creating and maintaining a healthy soil. Healthy plants will naturally be more resistant to disease pressure, and healthy plants grow from healthy soil. Do not underestimate the value of building healthy soil.

Plants: The best way to reduce disease pressure on plants is to reduce plant stress. Make sure your plants have the soil nutrition they need, know the ideal spacing for each garden crop, provide water to growing plants when needed and try to protect plants from weather stress when you are able. These simple steps will go a long way towards growing a healthy garden, but there are many common plant diseases out there and even the best gardeners are bound to encounter disease at some point during the season.

Learning when to best take action against plant diseases in the garden is a vital part of organic gardening.

Common Plant Diseases

Plant Diseases:

A healthy soil is teeming with micro-organisms, fungi and bacteria – most of which are vital to crop growth and health. However there are also fungi, bacteria and viruses whose job it is to break down and return plant matter back into the soil – many of these are what we call plant diseases when they act upon living plants. A plant that is stressed or malnourished will be a ripe target for diseases, but given the right conditions, healthy plants can be affected as well.

There are far too many garden plant diseases to list in this manual, but knowing the most common ones and some techniques to ward them off can help to ensure a good harvest. If you have questions about the health of your plants, ask Grow Your Own staff or your County Cooperative Extension agent – for best results, ask sooner rather than later!



Tomato Blight

Fungal Diseases:

Some of our most common (and most treatable) garden diseases are caused by fungi (relatives of mushrooms). Fungus thrives on warm, wet conditions to spread and fungal spores can live in garden soil for many years. Additionally, many fungal spores (think seeds) can travel for miles on the wind, so it is very unlikely that any of us will completely eliminate fungal diseases from our gardens.



Powdery Mildew

How to Prevent fungal disease:

A healthy garden requires both healthy soil and healthy plants. A rich, living soil will out-compete many fungal diseases and a healthy plant will resist diseases much better than a stressed or struggling plant.

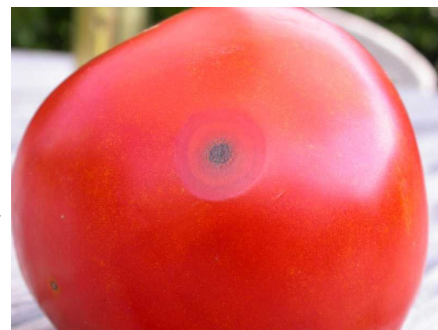
That being said, early action against disease is important for a bountiful harvest. These simple steps can help to reduce the spread of fungal diseases in your garden:

Maintain good air flow in your garden by following recommended plant spacing and keeping weeds at bay.

Keep soil borne fungus off your plants by mulching with grass clipping or straw (this also maintains good soil moisture which reduces plant stress).

Wet leaves are a common source of fungal infection – try to keep leaves dry by watering the base of the plant rather than the leaves.

Some fungal spores survive even a hot compost pile, so remove infected plant material from your garden to reduce future spread of the disease.



Anthracnose

Common Plant Diseases,

Some Common Fungal Diseases:

Early Blight (tomatoes): Perhaps the most common of garden diseases, EB is marked by yellowing leaves (that soon dry up and die) starting from the bottom of the plant and working its way up. Often EB will move up the plant so quickly that the harvest can be severely reduced.

Compost around the base of the plant and thick straw mulch can help slow the infection of EB. Removal of all leaves and suckers up to 8" above the soil will help to promote beneficial air flow around the plant. Weekly sprays of Serenade (a biological fungicide) starting at first fruit set will also help keep the disease in check.

Powdery Mildew: Mildews are primarily a disease of squash, cucumbers and melons. Marked by a powdery white coating on the leaves of the plant, PM can spread quickly and ravage even a strong plant. Try to avoid overhead watering, particularly in the evening. If you see the disease, Green Cure is an effective spray for slowing its spread.

Anthracnose: This is a disease caused by many different fungi. It causes sunken, soft, and watery spots on fruits, particularly tomatoes and peppers. Maintain good air flow around plants and keep plant leaves dry as often as possible. If you see signs of Anthracnose, remove any diseased fruits and spray with copper to slow the spread of the disease.

as plants begin to set flowers. Note the yellow surrounding the dark spots.

Other Diseases:

There are a wide range of diseases affecting garden plants from wilts and leaf spots, and from bacterial to viral diseases. The most important aspect to dealing with disease is speed – the faster you catch a disease, the easier it is to manage. If you feel that something about one of your plants doesn't look right, let someone know as soon as you can, so the correct action can be taken quickly and effectively.

Blossom-end Rot: This fruiting plant malady is not actually a disease, but a physical response to variations in soil moisture and air temperature – certain conditions that restrict the uptake of calcium from the soil, causing a black scab to form on the blossom end of affected fruits. This condition does not spread, but it can be minimized by mulching young plants with straw to keep soil temperatures and moisture levels even. This generally only affect the early fruits and later fruit sets will be fine.



Disease Prevention Techniques

Why Do Crops Get Diseased?

A healthy garden requires both healthy soil and healthy plants. Generally a diseased crop means that something is out of balance – it could be unbalanced soil fertility, too much water, an insect problem, physical damage to crops, or the disease could have been brought in from outside sources (diseased transplants, tobacco use in the garden or carried in by wind). Some diseases, like early blight in tomatoes, are so common they are difficult to avoid.

Prevention Techniques:

The best time to deal with a crop disease is before you see any signs.

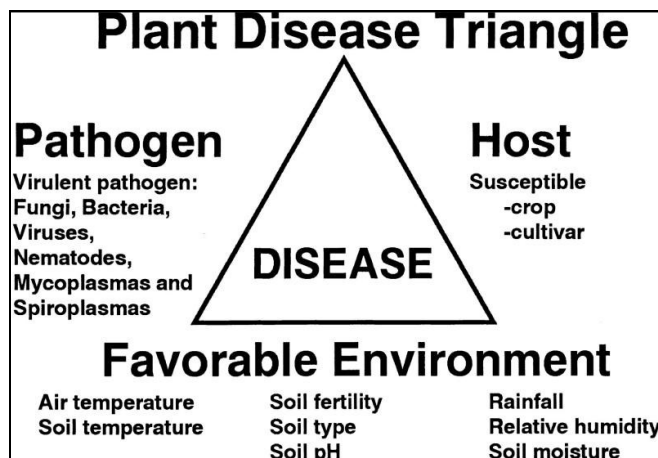
Take a soil test, balance out your soil fertility, use proper crop spacing, practice crop rotation, control weeds and insects, time your plantings to avoid weather that can harm your plants and spend time just looking at your crops so you can see changes and growth patterns. These simple steps will go a long way towards preventing disease in your crops.

The chart below (Plant Disease Triangle) shows that you need three things for disease to show up – first you need the disease itself (pathogen – fungi, viruses and bacteria are the most common); second you need the proper host plant; and third you need the right conditions for the disease to spread. If you can stop any of these three factors, you will not see disease problems. Here are a few examples:

- 1) If your garden has a history of a certain disease (say, Tobacco Mosaic Virus in peppers), you might consider selecting pepper varieties that show resistance to that disease – information you can find in many seed catalogs or from Cooperative Extension.
- 2) If you know that fungal diseases thrive on wet leaves, you might consider drip irrigation on crops to avoid wetting the leaves when watering.

3) Bacterial Wilt is a common disease in cucumbers and melons. It is spread by cucumber beetles (and some other insects), so controlling your cucumber beetles will reduce your risk of the disease in your garden.

The more you can learn about garden diseases, the better you can prepare your garden to avoid them.



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garden diseases, the garden to avoid them.

Organic Insecticides and Pesticides

What are Organic Pesticides?

A healthy garden requires both healthy soil and healthy plants, but sometimes pests will get the better of even the healthiest of gardens. In these cases there are a variety of products that can help reduce the numbers of pests and help the gardener still see a healthy harvest.

Organic pesticides are generally derived from natural sources, and while they are very effective against their target insects, they break down quickly in garden so there is little risk of accidental exposure. Many organic insecticides are “pest specific” meaning that they are only effective against a particular pest and will not harm the many beneficial insects (or other animals – birds, toads, pets, etc.) in the garden.

As with all garden sprays, organic pesticides should only be used when needed. Proper fertility, garden maintenance, plant spacing and weed control will help encourage strong plants that do not attract pests (stressed plants will often release chemical signals that attract pests).

Tips:

Get to know the insects in your garden – many insects are beneficial, meaning that they are working towards the health of the garden either by pollinating flowers or by actively eating pest insects. Before you spray anything, check to make sure if the insects you see are friend or foe!

Pay attention to pests you are attempting to control. For example, spraying for beetles before you see them doesn't really help—most pesticides that work on beetles kill on contact—you need to spray the bug itself to have an effect.

Read labels to understand how a spray works and can be used most effectively.

USE CAUTION!

- ⇒ With any spray, be careful about the time of day. Spraying when the sun is at its hottest can burn plants—the spray droplets will heat up on the leaves and potentially cause burning.
- ⇒ Try not to spray when bees and other pollinators are active – a healthy garden needs its beneficial insects. As day becomes dusk, after the sun has set, is one of the best times to spray to reduce harm to beneficial insects.
- ⇒ If you are not seeing the control you want, please check in with Grow Your Own staff – there may be other products that can help or other solutions to the pest problem.

Organic Insecticides and Pesticides, continued

Which do we recommend?

- ◆ **Bt** is derived from bacteria and is very effective to control caterpillar pests. As it must be eaten by the caterpillar to be effective, Bt has very little effect on the rest of the garden ecosystem and, in fact, is completely harmless to mammals (people, dogs, cats, etc.). Bt is used primarily to control cabbage worms in broccoli, kale, cabbage and Brussels sprouts.
- ◆ **Spinosad** is also a bacterial insecticide, but is listed for a wider range of pests including caterpillars, potato beetle larvae, corn borers, some beetles, thrips and spider mites. Like Bt, Spinosad is harmless to birds and mammals.
- ◆ **Insecticidal Soaps** are fatty acid soaps that smother soft bodied insects like aphids, thrips, whiteflies, mites and young leafhoppers. It is a “contact” insecticide, meaning that it must make direct contact with the pest to be effective.
- ◆ **Neem Oil** is an oil derived from the Neem tree. It is unique in that it has both insecticidal and fungicidal properties. Like soaps, neem oil is effective against soft bodied insects (not adult beetles or true bugs). Used on aphids in tomato and pepper crops, it will also help guard against early blight.
- ◆ **Pyganic** is a broad spectrum contact insecticide, meaning that it will affect most any insect that gets sprayed, including beneficial insects and bees. Pyganic is best used in a targeted way (spraying a specific pest) to reduce damage to beneficial insects in the garden – use only when other means have failed. Derived from natural poisons in chrysanthemum flowers, Pyganic will break down quickly in the garden, but when fresh, it is dangerous to both birds and mammals – use with care!
- ◆ **Sluggo** is a mineral-based bait for controlling slugs and snails. It is safe to use and has some fertility benefit when it breaks down.

Organic Fungicides

What are Organic Fungicides?

A healthy garden requires both healthy soil and healthy plants, but sometimes diseases will get the better of even the healthiest of gardens. In these cases there are a variety of products that can help stop or slow the effects of disease and help the gardener still see a healthy harvest.

Organic fungicides fall into two categories: biological fungicides and mineral fungicides.

Biological fungicides are living strains of fungi and/or bacteria that kill or out-compete the disease organisms when sprayed on the leaf surface of plants. These are generally very safe to use and are best used in a preventative manner – before you start to see disease symptoms.

Mineral fungicides attack disease organisms directly, killing them or stopping their ability to spread. Copper and sulfur are the two most common mineral fungicides. These must be applied with care because it is not healthy for humans to breathe these minerals directly – fruits and vegetables sprayed with mineral fungicides should be washed before eating.

As with all garden sprays, organic fungicides should only be used when needed. Proper soil fertility, crop rotation, garden maintenance, plant spacing and weed control will help encourage strong garden plants that can stand up to disease.

Remember

All the sprays and amendments we use in the Grow Your Own program are approved for use in organic agriculture to help promote the health of our gardens and those who eat from them. Other organic fungicides are available – please check with Grow Your Own staff if you need help finding a product for your needs.

Which do we recommend?

Serenade is a biological fungicide that works best as a preventative spray. For tomatoes, we recommend weekly applications of Serenade starting when plants set their first fruits. Most seasons, this spray plan will ensure a healthy crop of tomatoes by greatly slowing the development and spread of early blight.

Cueva Copper is a liquid form of copper octanoate that is effective against a wide range of fungal diseases including tomato blights (early and late), anthracnose, bacterial spot, powdery mildew, apple rust, fireblight, and many others. As large amounts of copper can be bad for soil health, copper sprays should only be used when disease is present or weather conditions are right for severe disease development. Talk with a Grow Your Own staffer before using copper sprays.

Green Cure is a mineral fungicide that works well for stopping the development of powdery mildew on squash, cucumber and melon plants. Potassium Bicarbonate is the active ingredient and it should be sprayed weekly as soon as you see signs of the disease.

Neem Oil is more commonly used as a pesticide, but it also has fungicidal properties. If you need to spray a crop for aphids, thrips or whiteflies, using neem oil would have the added benefit of warding off disease development.

Organic Weed Control

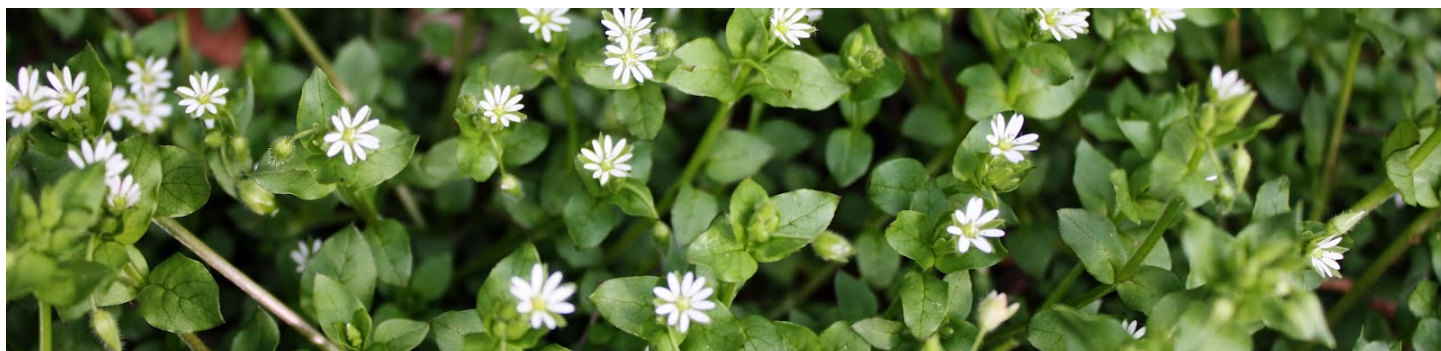
Why Control Weeds?

- ◆ Weeds compete with crops for water, soil nutrients and sunlight. In general, weeds are much more aggressive and successful at fighting for these needed elements, and cultivated plants suffer with poorer health and lower yields. Plants that are weak from weed competition are also more prone to diseases and insect damage.
- ◆ Weeds can severely impede air circulation around crops. This can create very humid conditions that promote fungal growth and plant diseases.
- ◆ Unmanaged weeds can provide habitat and a food source for many crop pests. On the other hand, *carefully selected* plant species, grown among your crops, can provide food and shelter for a wide variety of beneficial and predatory insects.

What is our favorite weed control method?

MULCH!

Mimic the forest floor and its layers. Block out light, cut down on weed germination, and minimize water evaporation. By protecting the soil surface, you need to weed and water less.



When Should I Control Weeds?

- ◆ The sooner the better! Weeds are easiest to knock back when they are small (preferably before you even see them).
- ◆ Do not allow weeds to go to seed! This is difficult, but many weeds create thousands of seeds on each plant creating a weed seed bank in your soil that can last for decades.
- ◆ When mulching, lay your mulch as soon as possible after tillage or cultivation to discourage weed growth. Even tiny weed seedlings can find their way through a thick mulch if you let them sprout before mulching.
- ◆ Remember that each time the soil is disturbed (planting, cultivating, tilling), new weed seeds are encouraged to germinate. Always hoe as shallowly as possible.

Organic Weed Control,

How Do I Control Weeds?

Hand Hoeing – the best weed control for gardens. The best hoes allow the user to stand up straight while hoeing, reducing back strain. Also a hoe that slices with a sharpened edge works best. Stirrup hoes, Swan-neck hoes and collinear hoes are some common types. You are unlikely to find good quality cultivating hoes at local hardware stores – GYO can help you locate a good source.

Wheel Hoes – cultivating blades mounted on a set of wheeled handles. The blades are generally wider than hand hoes and allow the farmer to quickly cultivate pathways and between rows of crops. Again, must be kept sharp to be most effective.

Rototillers – For weed control, shallow cultivating with a rototiller (either walk behind or tractor pulled) can be very effective.

Mowing – For tall weeds or “green” pathways, blade mowers and string trimmers can keep the growth short, reducing crop competition and maintaining good airflow. Be careful that flying bits of weeds do not damage or blemish crops.

Organic Mulches – Organic mulches (leaves, straw, grass clippings, newspaper, etc.) do not only suppress weeds, but also help to cool the soil and keep the soil moist beneath crops. Apply as soon as possible after disturbing the soil for maximum weed control. Mulches can also keep crops clean, by reducing soil splashing during rains. They are also a great source of organic matter for soil health.

Plastic Mulches – create a barrier to weeds, but also to water – should be used together with drip irrigation. Also warms the soil, helping the growth of warm weather crops in the spring.

Hand Weeding – often necessary when weeds “get away” or when weeds grow up through and around mulches. Be careful to disturb crop roots as little as possible.

Flame Weeding – uses a propane torch to destroy the cell structure of young weeds, killing them without disturbing the soil. These can also damage garden crops – use with great

Weed Identification

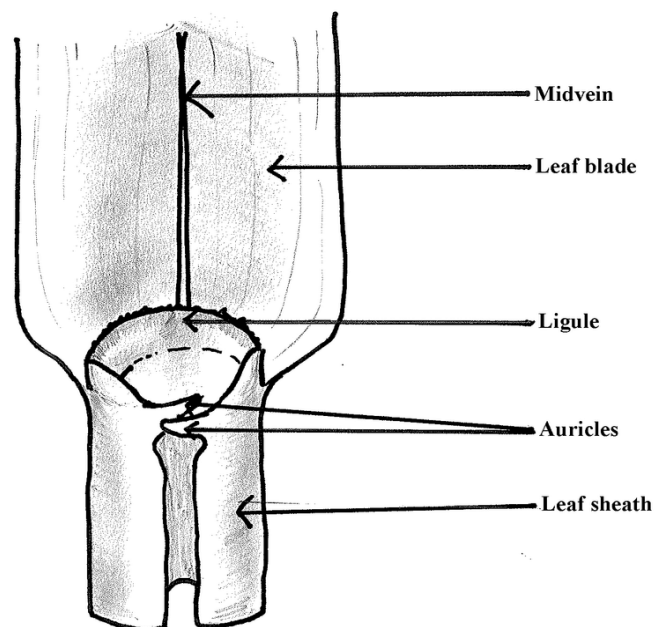
A Short Primer on Grass Identification

Grasses are difficult to ID. At quick glance, they all look the same. Flowers often do not appear until late in the growing season or are mown off. Grass identification in spring and summer must be based on growth habit and leaves.

Growth habit: Look for overall shape (i.e. upright, prostrate) and growth (spreads all over vs. stays in a clump). Look for stolons and rhizomes in grasses that spread.

Leaves: Key ID characteristics are often hidden. A grass leaf has two parts, a sheath that wraps around the stem and a blade that grows away from the stem. The junction between the sheath and the blade is the collar and is important for grass identification. Gently pull the blade away from the stem to see the collar. Young leaves are more likely to retain ID characteristics than older leaves. Check several leaves (a hand lens is useful) looking for:

- *Ligules*— growth standing up from the collar. It may be short or tall, membranous, hairy, or membranous with a fringe of hairs. Not all grasses have ligules.
- *Auricles*- Protrusions that extend from the collar and wrap around the stem. Not all grasses have auricles.
- *Blade & sheath*— look for presence or absence of hairs; wavy or straight edges; color; prominence of mid-rib.



Weedy Grasses

Description:

Bermudagrass (*Cynodon dactylon*)

Weed Type: Perennial grass

Identification: Warm-season grass that spreads by both stolons and rhizomes, will turn brown in cool weather, green in summer. Creates mats and is difficult to pull out of the ground. Ligule is a fringe of hairs, no auricles. Leaf edges are hairy near the collar and may be slightly rough. May be confused with crabgrass (note difference in growth habit and ligules). (Fig. 1)



Fig. 1 Bermudagrass

Description:

Crabgrass (*Digitaria sanguinalis*)

Weed Type: Annual grass

Identification: Grows in clumps; leaves are light green; nodes swollen and stem zigzag; prostrate habit and may root at lower nodes. Membranous ligules and no auricles. May have hair depending on species. No stolons or rhizomes. (Fig. 2)



Fig. 2 Crabgrass

Description:

Creeping Bentgrass (*Agrostis stolonifera*)

Weed Type: Perennial Weed

Identification: Cool season grass that spreads by stolons. Usually lighter or more blue-green than lawn grasses with a much finer texture. No auricles. Ligules are long and membranous. Leaves are ridged but not hairy. May be confused with nimblewill (ligules different) or Bermudagrass (which has rhizomes). (Fig. 3)



Fig. 3 Creeping Bentgrass

Description:

Foxtails (*Setaria viridis*)

Weed Type: Annual grass

Identification: There are three common foxtail species, all with thin elongated flower clusters (like a fox's tail). Green foxtail has hairy ligules but otherwise leaf has few hairs (may be rough to touch). Yellow foxtail has hairy ligules and long hairs on the upper surface of leaves, usually near that collar region. Leaves may have a spiral.



Fig. 4 Foxtails

twist. Giant foxtail has hairy ligules and the upper surface of the blade is covered with short hairs. None of the foxtails have auricles. All grow as a clump. (Fig. 4)

Description:

Nimblewill (*Muhlenbergia schreberi*)

Weed Type: Perennial grass

Identification: Warm season grass that spreads by stolons and forms mats. Will turn brown in cool weather, green up in summer. Leaf blades are relatively small, usually less than 3" long. Leaves have very few hairs and no auricles. Ligules are very short, membranous with distinctive teeth along top. It can be confused with Bermudagrass (nimblewill has no rhizomes, is small and wiry, and has different ligules) or with bentgrass (ligules are different). (Fig. 5)



Fig. 5 Nimblewill

Description:

Quackgrass (*Elymus repens*)

Weed Type: Perennial grass

Identification: Cool season grass with long rhizomes. Leaves have very short ligule but long, clasping auricles. (Fig. 6)



Fig. 6 Quackgrass

Description:

Zoysiagrass (*Zoysia japonica*)

Weed Type: Perennial grass

Identification: Spreads by stolons and rhizomes, will turn brown in cool weather, green in summer. No auricle. Ligule hairy, collar region with many long hairs. Upper leaf surface may also have long hairs. May be confused with Bermudagrass which also has rhizomes. Zoysiagrass has hairs standing upright on the leaf blade whereas Bermudagrass does not. Zoysiagrass is stiff to the touch. (Fig. 7)



Fig. 7 Zoysiagrass

Non-grass Monocots

Description:

Wild garlic (*Allium vineale*)

Weed type: Perennial monocot

Identification: Perennial plant with grass like leaves that begins growth in very early spring. Leaves are slender, hollow, and nearly round. They will smell like garlic or onion when crushed. Flowers are white to purple held in a small rounded cluster in May or June. Will form aerial bulblets on flower stalks and also bulbs underground. Leaves and stems are waxy. (Fig. 8)



Fig. 8 Wild Garlic

Description:

Yellow nutsedge (*Cyperus esculentus*)

Weed Type: Perennial monocot

Identification: Perennial sedge with a triangular stem, usually much more yellow than lawn grass and faster growing. Flowers and seeds are held in clusters of short spikes. Forms underground structures, small and round, called nutlets. It is very difficult to control with cultivation. (Fig. 9)



Fig. 9 Yellow nutsedge

Broadleaf Weeds

Description:

Broadleaf plantain (*Plantago major*)

Weed Type: Perennial broadleaf

Identification: Leaves form a low rosette, more prostrate than that formed by buckhorn plantain. Leaves, 3-6", have a broad flat petiole and a rounded blade with several parallel veins. Flowers cover the long, very thin flower stalk creating clusters 5-10 inches long. Has a short, thick taproot. (Fig. 10)



Fig. 10 Broadleaf plantain

Description:

Dandelion (*Taraxacum officinale*)

Weed Type: Perennial broadleaf

Identification: Leaves form a low rosette. Leaves are deeply lobed with the tips of the lobes pointing back toward the center of the plant. Flowers are held singly above the leaves, up to 2" wide, and have many yellow petals. Flower stalk is hollow. Seed cluster is a small puffball. Spreads by seed. Taproot allows plant to regrow

but it does not naturally spread in this way. However, if pieces of taproot are spread around a garden area by cultivation, each will produce a new plant. (Fig. 11)



Fig. 11 Dandelion

Description:

Wild Violet (*Viola sororia*)

Weed Type: Perennial broadleaf

Identification: Leaves form rounded clump about 5" high. Leaves are heart-shaped and waxy, with a long petiole, the blade often cupping toward the petiole. Flowers blue to violet to white in May, asymmetrical with 5 petals. Spreads through rhizomes. Hand digging can be effective if rhizomes are thoroughly removed. (Fig. 12)



Fig. 12 Wild Violet

Description:

Common chickweed (*Stellaria media*)

Weed Type: Annual broadleaf

Identification: Winter annual that forms a low, rounded mound of leaves, prostrate stems will sometimes root at nodes. Roots are fibrous. Leaves are opposite, very small with a pointed tip and teeth on the leaf edge. Leaves are smooth and not very hairy. Flowers are small but conspicuous, with 5 deeply divided petals that appear as 10. Can persist well after flowering if environmental conditions remain favorable. (Fig. 13)



Fig. 13 Common chickweed

Description:

Ground ivy (*Glechoma hederacea*)

Weed Type: Perennial broadleaf

Identification: Leaves opposite on long petioles. Leaves kidney-shaped, almost encircling petiole, about an inch wide, edges are scalloped. Leaves have a mint scent when crushed. Purple flowers in May but they may not be noticed. Ground ivy forms long slender stolons that root at the nodes. Plant is an aggressive spreader and difficult to control. Hand weeding is seldom completely effective. (Fig. 14)



Fig. 14 Ground ivy

Description:

Hairy galinsoga (*Galinsoga ciliate*)

Weed Type: Annual broadleaf

Identification: A summer annual that can grow to 2 ft. Leaves are opposite, oval, and coarsely toothed. Upper surface is densely covered with hairs. Stems are green, sometimes with a red tinge, and covered with hairs. Flowers are less than 1/2" wide with a yellow center and 4 or 5 white petals, each with 3 lobes. May flower through the summer. In the aster family. (Fig. 15)



Fig. 15 Hairy galinsoga

Description:

Henbit and Purple deadnettle (*Lamium amplexicaule* and *Lamium purpureum*)

Weed Type: Annual broadleaf

Identification: Winter annual in the mint family with square stems and opposite leaves. May germinate in fall. In spring, it grows rapidly, flowers, and dies. Will be gone by mid-summer. Flowers in early spring are purple and held on upper stems. The upper leaves of henbit have no petioles, they are short and broad (kidney-shaped) with scalloped edges and may appear to clasp the stem. Upper leaves of deadnettle have short petioles. The leaves are triangular with small teeth. (Fig. 16)



Fig. 16 Deadnettle (left) Henbit (right)

Description:

Purple loosestrife (*Lythrum salicaria*)

Weed Type: Perennial broadleaf

Identification: Branching perennial to 5 ft. Leaves are opposite or whorled low on the stems, may be alternate near tips of stems. Leaves are elongated, the largest about 4" and clasp the stem. Showy purple flowers with 6 petals are held on a tall spike above the foliage, blooming mid-summer to fall. Spreads by rhizomes to form colonies, can also spread by seed. (Fig. 17)



Fig. 17 Purple Loosestrife

Description:

Purslane (*Portulaca oleracea*)

Weed Type: Annual broadleaf

Identification: Mat-forming summer annual that grows low to the ground. Leaves are succulent, opposite, oval, waxy, and without teeth. Stems are succulent and red. Flowers are yellow and small. Has a thick, fleshy taproot. Broken stem segments left on soil will root and resume growth. This species is sometimes cultivated as an ornamental annual. (Fig. 18)



Fig. 18 Purslane

Description:

Common ragweed (*Ambrosia artemisiifolia*)

Weed Type: Annual broadleaf

Identification: Summer annual that can grow to 3 ft. Leaves are opposite low on the plant, alternate as you move upward. Leaves are divided several times and are hairy. Stems have long, rough hairs. Flowers are small, green to yellow, held in narrow elongated clusters mid-late summer. Male and female flowers are in different clusters. Male flower at the top of the plant, female flowers lower in the leaf axils. Releases large amounts of pollen that can cause hay fever. (Fig. 19)



Fig. 19 Common ragweed

Description:

Common speedwell (*Veronica officinalis*)

Weed Type: Annual broadleaf

Identification: Winter annual with prostrate stems. Leaves are very small. Those near the center of plant are opposite, coarsely toothed, almost scalloped, and have petioles. Leaves at tips of stems may be alternate and lack petioles. Flowers in early spring have 4 blue petals. (Fig. 20)



Fig. 20 Common speedwell

Description:

Spotted spurge (*Euphorbia maculata*)

Weed Type: Annual broadleaf

Identification: Summer annual that can create a mat of stems more than a foot wide. Stems hug the ground and radiate from a central point. All parts release a milky sap when broken. Leaves are waxy, succulent, opposite, and oblong. Often have maroon mark in the center of the leaf. Flowers are inconspicuous, pink, and found in the leaf axils. Forms a short taproot. (Fig. 21)



Fig. 21 Spotted spurge

Description:

Common thistle (*Cirsium vulgare*)

Weed Type: Perennial broadleaf

Identification: Leaves begin in a low clump early in the season, become alternate as the stem elongates and flowering begins. Large, spiny flower clusters and stems. Flowers are purple. Spread through rhizomes. (Fig. 22)



Fig. 22 Common Thistle

Description:

Common lambsquarters (*Chenopodium album*)

Weed Type: Annual broadleaf

Identification: A summer annual that can grow to 4ft. The leaves are alternate with long petioles, usually triangular or diamond shaped, may be toothed or entire, several inches long. Seedling leaves are typically covered with a gray mealy coating. Individual flowers are small and are held in elongated clusters at the tips of the stems. Stems are angular, grooved, and may have a reddish tinge. The taproot makes it difficult to pull this weed from the ground. (Fig. 23)



Fig. 23 Common lambsquarters

Description:

Field bindweed (*Convolvulus arvensis*)

Weed Type: Perennial broadleaf

Identification: Bindweeds have long vining stems that can wrap around and smother any nearby plant. Leaves are alternate with petioles but without teeth. Flowers are white, pink, or purple. Large and showy with petals that fuse together into funnel or trumpet shape. Spreads by a deep, extensive rhizome system. Pulling the thin stem out of the ground will kill the bindweed that is wrapping around your plant but new stems will soon grow from the roots. Closely related to Morning Glory. (Fig. 24)



Fig. 24 Field bindweed

Description:

Pokeweed (*Phytolacca americana*)

Weed Type: Perennial broadleaf

Identification: A well-branched perennial growing up to 10 ft with smooth stems sometimes with a purple tinge. Leaves are alternate with petioles, blade an elongated egg shape. Flowers in summer are white to pink, with 5 petals, held in a long drooping cluster. Berries formed are a deep purple releasing a red staining juice. Stalk turns bright red-purple as the fruit matures. Has a taproot up to 6" in diameter. Spreads by seed. (Fig. 25)



Fig. 25 Pokeweed

Description:

Japanese knotweed (*Reynoutria japonica*)

Weed Type: Annual broadleaf

Identification: Summer annual that forms a broad, low, tough mat. Stems radiate from a central point, up to

24" long. Begins growth early in season. Leaves are alternate, elongated, and without teeth, about 1". A thin membranous sheath circles the stem at the leaf base. Flowers are white to pink and inconspicuous. (Fig. 26)

Description:

Redroot pigweed (*Amaranthus retroflexus*)

Weed Type: Annual broadleaf

Identification: A summer annual that can grow up to 6 ft. Leaves are alternate, up to 6" long, with prominent veins. The petiole may be as long as the blade. Leaf blades are elongated and broadest in the middle. The lower portion of the stem/upper portion of the taproot is often, but not always, tinged with red. Flowers are inconspicuous, with one elongated cluster at the tip of the stem and shorter clusters in the leaf axils. (Fig. 27)

Description:

White clover and Red clover (*Trifolium repens* and *Trifolium pratense*)

Weed Type: Perennial broadleaf

Identification: Short plant with alternate leaves with three leaflets. Each leaflet may have a faint, white crescent or "v" shaped mark. White or red flowers are held in a rounded cluster, about 3/4" across, occurring sporadically through the summer. Spreads by stolons and by seed. When managed properly, clover can be a great nitrogen fixing cover crop. (Fig. 28)



Fig. 26 Japanese knotweed



Fig. 27 Redroot pigweed

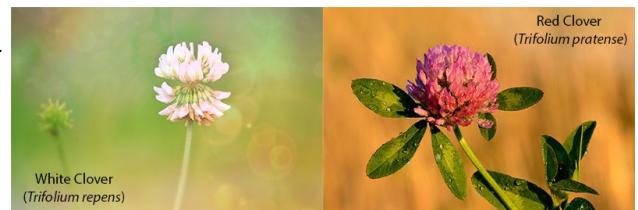


Fig. 28 White clover (left) and Red clover (right)

Prevention and Control: When is a Problem a Problem?

Your garden is part of the larger living system. It does not exist in a vacuum, a blank space where just the things we intentionally planted spring forth to live alone. The earth is composed of many interlocking ecosystems that all combine into a working whole. Ecosystems fluctuate, go in and out of balance, change, develop and grow. And every creature, cockroaches included, has its place.

Plants have been around for a long time; adapting to changes and conditions and so have insects, bacteria, viruses and microbes. As gardeners, we strive for healthy plants, those that can defend themselves from pests and disease. We seek to create a balance.

However, sometimes systems get out of balance. Systems can naturally correct themselves without our intervention, but sometimes the scale is tipped too far in one direction and stepping in with sprays, traps, or other methods to reduce pest populations are necessary. BUT everything we do will effect something else in the system in addition to the problem (a pest) we are trying to correct, from threatening honey bees or birds, to changing the bacterial composition of the soil. Depending on severity of damage, amount of pests present, we will choose different control methods.

To effectively intervene in a system, it is useful to know how a pest functions. This requires a basic understanding of lifecycles and when damage occurs.

Do the larvae cause damage or adults? Where and when do the pests lay their eggs? What plants do they effect? Do they over-winter (wait out the cold until next season to feast again) in old crop debris or in the soil?



Spend time with your plants.

Interrupting lifecycles works—turning over leaves, crushing eggs, or knocking them into soapy water prevents the next generation from hatching. Adults insects lay thousands of eggs during their short lifetimes, so any adults killed reduced the next population significantly.

Safe Spraying

Sprays and insects:

Some of the sprays recommended in this manual are “pest specific” meaning they will not harm bees or lady bugs but rather a certain pest. But other sprays we mention, such as pyganic can do a great deal of damage to beneficial insects such as bees ,wasps, and butterflies. Some sprays must touch the pest directly, while others will be effective as the pest crawls around. Know the pest in question, try physical control methods before attempting chemical controls. But if you must spray, take caution!

Spray with Caution!

Even organic pesticides and fungicides can harm you if breathed or swallowed.

- ◆ READ THE LABEL of anything you spray.
- ◆ Use the right amount of chemical to water ratio's.
- ◆ Keep all chemicals out of reach of children!
- ◆ Wear protective clothing; long sleeves and pants.
- ◆ Use gloves, dust masks and eye protection.
- ◆ Wash your clothes, hands, and face after spraying!
- ◆ Be aware of pets and children in the garden during and after spraying.

What to Avoid:

- Avoid drift. Drift refers to chemical particles ending up where you did not intend—instead of coating your tomato plants, the particles blow in the wind to neighboring habitats. Besides being harmful to humans and the environment in general, drift is bad for beneficial insects and can destroy their habitats.
- Avoid spraying on windy days!
- Avoid spraying when it is about to rain, as all your hard work will be washed off.
- ◆ Avoid spraying in mid day; water droplets can magnify sunlight, burning plants.
- ◆ Avoid spraying in mid day to protect beneficial insects. Spraying in the dusk of the day after sunset assures that sprays will dry before bees land on plants.

Cover Crops: An Overview

What are cover crops?

Cover crops can be legumes or grasses planted prior to, or following, a harvested crop primarily for seasonal soil protection and nutrient recovery. Cover crops protect soil from erosion and recover/recycle phosphorus in the root zone. They are grown for one year or less.

Why should you grow cover crops?

Control wind and water erosion during periods when the harvest crop doesn't create adequate soil cover and reduce surface runoff

- Add diversity to your garden and create habitats for beneficial insects
- Improve soil health and structure by breaking up soil and recovering phosphorus and other nutrients in the root zone by plant uptake
- Add organic matter when tilled or chopped into the garden
- Increase Nitrogen through legumes for healthy plant growth

How much of a cover crop do you seed?

The cover crop needs to be dense enough to protect the soil surface. The key is to distribute seed evenly over bare soil areas. Timely planting is important to minimize the time between crop harvest and cover crop planting. Seed catalogues will tell you how much to plant per 100 square feet.

Which cover crop to choose?

Soil protection that will die in winter – Oats, Cowpeas, Sorghum, Millet

Soil protection that will NOT die in winter—Barley, Wheat, Rye

Builds Nitrogen— Leguminous crops; Sweet Clover, Crimson Clover, Soybeans, Summer Alfalfa—all of these need to be mowed and tilled into soil

Smothers weeds— Buckwheat, Sorghum

Breaking hard soils— Daikon Radish, Sweet clover



Type	Legume/ Non-legume	When to sow	When to turn	Notes
Alfalfa	L	Spring, Late Summer	Fall, Spring	Needs warm temps for germination. Hardy. Drought tolerant.
Barley	N	Fall, Spring	Spring, Fall	Not as hardy as Rye. Drought tolerant.
Buckwheat	N	Spring, Summer	Summer, Fall	Grows quickly. Not hardy.
Crimson Clover	L	Spring, Fall	Fall, Spring	Not reliably hardy. Not drought tolerant. White clover is hardier.
Fava Beans	L	Early Spring, Late Summer	Early Summer, Fall	Likes cool growing weather. If planted in early spring can grow late veggies.
Vetch, hairy	L	Early Fall	Spring	Slow to establish. Fairly hardy. Till under before it seeds.
Oats	N	Spring, Fall	Summer, Spring	Not hardy. Grows quickly.
Rye	N	Fall	Spring	Very hardy. Can plant until late Oct.
Wheat	N	Fall	Spring	Not as hardy as rye. Tolerates drought.



White Clover



Fava Beans



Rye



Barley



Buckwheat



Alfalfa

Beneficial Insects

Beneficial Insects need habitat!

Many beneficial insects are not pollinators, but insect predators.

To encourage beneficial insects plant patches, borders or edges of their favorite plants to create a beneficial habitat.

In general, the more different sizes, shapes and colors of flowers you have, the more beneficial insects you will have.

A simple beneficial habitat should include herbs such as dill and cilantro. These herbs have “flat topped” flowers that encourage beneficial wasps. Allow parsley to overwinter and flower. Plant buckwheat as a summer cover crop and allow to flower. Perennials such as black-eyed susans, mint, and fennel are excellent flowering plants as are annual flowers like cosmos, sunflowers, and marigolds.

Planting flowers brings not only color to your garden but can help protect it from pests.



Lacewing Eggs



Lacewing Larva



Adult Lacewing



Wheelbug



Assassin Bug



Ground Beetle



Predatory Stink Bug

These living creatures can also be considered some of the many organic gardening techniques you have available.

Nourishing and encouraging their presence is economically beneficial and decreases chances of ecosystem imbalances.

Identifying Beneficial Insects



**Adult Swallowtail
Butterfly**



**Swallowtail Butterfly
Larvae**



Braconid Wasp



**Braconid Egg Cases on Tomato
Horn Worm**



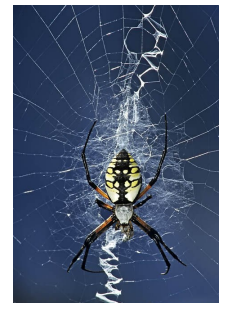
Ladybird Beetles



Ladybird Beetles



Minute Pirate Bug



**Garden Orb
Spider**



Ladybird Beetles



Bumble Bee



Mason Bee



Damsel Bug

Insect Profiles

Aphids

Cabbage Moth

Colorado Potato Beetle

Cucumber Beetle

Cut Worm

Flea Beetle

Harlequin Bug

Japanese Beetle

Leafminer

Leafhopper

Mexican Bean Beetle

Squash Bug

Squash Vine Borer

Stink BugsThrips

Wireworms

Aphids

Description

Aphids (or plant lice) are small, soft-bodied sucking insects. They typically have a pear-shaped body and are generally less than one-tenth of an inch. They are often colors that blend in with leaves or stems so they can easily go unseen. Aphids commonly feed in groups, and numerous species are found in gardens around the world.

Host Plants

ALL

Damage

Curled and blotched leaves are often a sign of aphids at work. In time, infested plants become stunted and sickly. When aphids infest a young stem it is often curls and stops growing. Grey-green cabbage aphids often cluster in the sheltered spots where leaves join the stem or inside broccoli heads.

If you see ants moving up and down your plant, aphids are likely present. Many aphid species excrete copious amounts of sweet fluid called honeydew, which ants relish and readily gather up. In fact, some ants “milk” their aphid herds and in exchange help protect the aphid colony.

Physical Control:

One of the best methods of organic aphid control is hand picking, which requires pinching the infested leaf or stem from the plant and composting it. First look for predators among aphids. If several beneficial insects are present, consider leaving some aphids as food for them.

Chemical Control

To combat expanding colonies, treat plants with insecticidal soap. Properly diluted insecticidal soap, or a solution of 1 table tablespoon of dishwashing liquid per gallon of water, gives good control of aphids by removing their waxy coating, which causes them to die from dehydration. Be aware soap sprays can taint the flavor of leafy greens, and cause damage to leaves when applied in bright sun.

Beneficial Habitat

Lady beetles (adults and larvae), lacewings, and hoverfly larvae are major aphid predators. Some gardeners leave small aphid colonies found in spring intact in order to provide a food supply for early generations of these important beneficial insects.



Cabbage Moths

Description

Cabbage moth eggs are tiny, yellow or white, laid in clusters found under the leaf. The larvae start as small bright green worms and quickly grow to about an inch long. Larvae leave large amounts of dark green excrement as they eat. The adult moth is white with two black spots easily identifiable on their wings.

Host Plants

Cabbage moths plague all crops in the brassica family—cabbage, broccoli, kale, cauliflower, kohlrabi and collards. Cabbage experiences a lot of damage as leaves are tightly wrapped, making it difficult to spray inner leaves and prevent caterpillars within the head of cabbage.

Damage

Holes are eaten in the outer leaves of all brassicas and damage may also be seen on the inner leaves of cabbages when the heart is cut through. Caterpillars and their excrement are often found on the plants. Infestation can cause skeletonization of leaves often stunting growth. Little green worms found in broccoli heads during cooking are gross.

Physical Control

Hand pick green caterpillars into pail of soapy water.

Cover plants with row cover as a barrier to stop moths from landing and laying eggs.

Apply row cover directly after planting burying edges with soil to create a seal.

Don't forget to check plants periodically for weeds and overall growth.

Fall planted brassica crops often suffer less damage as the season temperatures cool, but stay on alert.

If you see the little white butterflies, then you have little green caterpillars!

Chemical Control

Bacillus thuringiensis, known as Bt, is a living bacteria that is sprayed on plant leaves. Cabbage moth larvae feed on applied bacteria which interrupts the digestive process of the caterpillar causing death. Bt can harm ALL caterpillars that come in contact with the spray, including beneficial butterflies and moths! Apply Bt to plants that cabbage moth is harming ~ brassica family plants. If applied every 7-10 days as soon as transplants are set out in the field, all the periodically hatching caterpillars will be killed.

To reduce the chance of insects developing resistance, spray in rotation with Spinosad.

Beneficial Habitat

Create habitat to attract shield bugs, insect eating birds, braconid wasps, tachinid flies, paper wasps and yellow jacket wasps by planting small flowering plants such as dill, cilantro, zinnias, sunflowers, mints and fennel.



Adult Moth lays eggs on leaves



Caterpillar Waste—called frass, this is evidence of infestation.



Tiny white/green egg

Colorado Potato Beetle

Description

Larvae are soft bodied, tan to coral in color with two rows of black spots on each side. Adult beetles are bright yellow orange with five bold brown stripes along the length of its body. Female beetles lay orange-yellow eggs on the undersides of leaves.



Host Plants

Potatoes are the preferred host for the Colorado potato beetle, but it may feed and survive on a number of other plants including tomatoes, eggplants, and rarely, peppers.



Damage

Both adults and larvae feed on potato foliage and can severely reduce yield or kill plants.



Physical Control

Hand picking adults into pails of soapy water and crushing larvae are the most effective methods of controlling beetle populations. Over her life, a female can lay up to 3500 eggs. So just going out and squishing eggs, and knocking adults and larvae into a bucket of soapy water will dramatically reduce the population.

Crop rotation is always recommended! Use of row cover can be helpful in keeping beetles off plants. Since they don't need pollination row cover can be left on for most of the plants growth.

Chemical Control

The Colorado potato beetle is known for its ability to develop resistance to insecticides that are used repeatedly for control. Use Pyganic as a last resort when infestations occur. Spinosad may also be effective on the larvae. Be mindful to spray in the late afternoon to reduce harm to other beneficial insects.



Beneficial Habitat

Building habitat for parasitic flies and predatory stink bugs such as assassin bugs and wheel bugs by growing dill, parsley, fennel, asters, sweet alyssum, nasturtium, daisy, coneflowers, yarrow and goldenrod.

Cucumber Beetles

Description

The striped cucumber beetle bears three longitudinal stripes down its wings. The spotted cucumber beetle, is marked with 12 black spots. Both kinds of cucumber beetle are somewhat oblong in shape with black heads and yellowish bodies. Cucumber beetle larvae are thin white grubs with brown head capsules. Eggs are yellow to orange in color, oval, and found in clusters of up to 50.

Host Plants

Cucumber, cantaloupe, winter squash, pumpkin, gourd, summer squash, and watermelon, as well as many other species of cucurbits. Cucumber beetles may also feed on beans, corn, peanuts, potatoes, and other crops.

Damage

Cucumber beetles cause serious damage to the seedling, foliage, flower and root and can transmit bacterial wilt disease to the plant. Damage from cucumber beetles starts in the spring with adults feeding on young seedlings and their roots. The first generation of adults emerges by early June. Feeding damage by cucumber beetles to foliage is usually very minor, but feeding on flowers can result in poor fruit set. The second generation emerges in September and October.

Cucumber beetles transmit bacterial wilt that usually starts with a single leaf and spreads to the entire plant, killing it. A stringy, viscous, white bacterial ooze forming a 'string' between cut ends of an affected stem is considered diagnostic for the disease in the field. Remove and destroy (not compost) these plants.

Physical Control

Crop rotation is important!

Use of row covers is the most effective defense against cucumber beetles. Make sure to tightly secure bottom edges with soil to create a barrier against adult beetles. Row covers must eventually be removed to allow bees and other pollinators to visit the flowers.

Seedlings and small plants are most susceptible to cucumber beetle feeding damage and to bacterial wilt. Using transplants avoids exposure to cucumber beetle feeding during the most susceptible plant stages. This also reduces the total time that cucurbit plants are in the field each season, providing less time for cucumber beetle densities to build and for disease symptoms to develop.

Straw mulch can help reduce cucumber beetle problems by providing habitat for beneficial insects.

Chemical Control

Use of Spinosad has had some effectiveness in large infestations.

Beneficial Habitat

Wolf Spiders, ground beetles, tachinid fly and braconid parasitoid wasps are all beneficial animals that aid in reducing adult populations of Cucumber beetles. Plant buckwheat, lemon balm, thyme, fennel, sweet alyssum, fennel, dill, cilantro, cosmos, zinnia and mint.



Both of these are adult cucumber beetle—striped and spotted. Looks a bit like a ladybug, but as you can see they are narrower. Turn into adults in early summer, and usually have 2-3 generations a year.



Eggs laid below soil or underside of leaves, larvae eat the roots, adults work their way up the stems.



larvae

Cut Worm

Description

Cut worm is the name given to the larvae of various moth species. As these larvae all mature into various moths, their colors can vary from grey, green, pink, and black, with various striped and spotted patterns also seen. Cut worms are sneaky, and feed primarily at night, hiding during the day.

Host Plants

Cut worms come out of hibernation in early spring, right in time to move in and feed on newly-transplanted early crops. All garden vegetables are host plants.

Damage

During the night cut worm larvae attack roots and stems at or below the soil surface. Seedlings will be completely gone the next day, while transplants will look like they've been cut off.

Physical Control

The most effective control is by protecting spring seedlings with barriers. When transplanting, wrap a collar of stiff paper, cardboard or a tin can around the plant, blocking the stem. Make sure the barrier is placed at least an inch into the soil. Good garden hygiene can help reduce cut worms—keep up with cultivation as moths like to lay eggs in tall grasses and weeds. Maintain a clear area around your garden as well as within.

If you find cutworm damage, dig around the stem of the plant effected and find the cut worm and destroy it.

Chemical Control: Bt can be used in cases of infestation. Pay special attention to spaying plants at dusk so as not to harm beneficial caterpillars such as swallowtails or monarchs.

Beneficial Habitat

Ground beetles prey on the soft bodies of cutworms and they are eaten by nighttime predators such as bats, toads and snakes. Tachinid flies, braconid wasps and yellow jackets will claim cutworms as victims although these predators are more active during the daytime when cutworms usually take cover.



Have you seen this larvae above curled up in the soil? The larvae overwinter, and moths emerge around late August.



Most cutworm moths look like dull-brown moths.



Adult moths lay eggs in grass and on plant stems.



Man down—we got a man down!

Flea Beetle

Description

Flea beetles are small beetles that jump when disturbed. They damage plants by chewing small holes in foliage. Flea beetles do serious damage to young seedlings. Infestations can skeletonize leaves in a matter of days.

Host Plants

Flea beetles feed on many different plants, but eggplants, potatoes, and brassica family crops (cabbage, cauliflower, broccoli, collards, radish, turnip, and kale) are favorites and experience the most damage.

Damage

Damage is most devastating when plants are young. If flea beetle damage can be prevented until plants are larger and growing faster, they can outgrow damage and produce more leaf mass ahead of munching beetles.

Flea beetles feed on leaves and in most cases will not do enough damage to prevent normal plant functions, however an infestation can stunt normal plant growth and interfere with proper fruit formation.

Physical Control

Plant trap crops such as radish to attract flea beetles away from main crop.

Trap crop should be sprayed or burned to destroy adult populations.

Floating row covers are very effective tools to keep flea beetles off of crops.

Apply cover at planting and seal edges with soil so not to trap adults under the cover.

Thick mulches help reduce adult populations by interfering with insect soil activity.

Sticky traps, applied within cash crop planting or trap crop planting can help catch beetles.

Crop rotation is important.

Many beetles, including flea beetles, find plants through smell. Confuse beetles by planting strong-smelling vegetables and herbs (dill, cilantro, carrots, onions, thyme, marigolds, calendula, lavender) among susceptible crops.

Chemical Control

Spinosad is an effective spray. Use pyganic in serious infestation situations.

Be mindful of spraying late in the afternoon to reduce harm to beneficial insects.

Beneficial Habitat

Parasitic wasps can aid in reducing larvae populations. Plant small flowers such as dill, cilantro, and mountain mint.



Damaged eggplant leaves



Flea beetles emerge in early Spring in SWVA area, and usually die out by late July. If spring crops failed, try fall



Tiny, white flea beetle larvae



Yellow sticky trap.

Harlequin Bug

Description

The harlequin bug, also known as calico bug, or fire bug is a black stinkbug, brilliantly marked with red, orange and yellow.

Host Plants

The harlequin bug is a pest of brassica family damaging crops of cabbage, collards, cauliflower, broccoli, mustard, turnips, and kale. During heavy outbreaks, or when all their favorites are gone, Harlequin bugs will eat other garden plants such as squash, okra, tomatoes, corn, beans, tree fruits and a variety of flowers.

Damage

This pest has the ability to destroy the entire crop when not controlled. The harlequin bug injures the host plants by sucking plant sap, causing them plants to wilt, brown and die.

Physical Control

Hand-pick in the early morning by knocking insects into a pail of soapy water. Check undersides of leaves and crush egg masses. Remove weeds such as pigweeds and wild mustards. Plant trap crops to help lure insects away from preferred crops. Hand-pick concentrated areas or burn with a flame weeder.

Chemical Control

Most chemical controls are ineffective because insects have to be sprayed directly. These insects like to hide underneath leaves. Pyganic is the best bet, although frequent hand picking has proven the best remedy.

Beneficial Habitat

The assassin bug can contribute to long-term control. Create beneficial habitat by including daisy, dill, mints, zinnia and sunflowers.



Date Night with two adults...squishing a couple is nice because you eliminate an incoming generation as well.



Eggs are beautiful and hard to squish, laid in groups of 12. Here young just-hatched beetles flourish.



Damage caused by sucking away the plants lifeblood.



Assassin Bug—
A natural
predator

Japanese Beetle

Description

The adult Japanese Beetle is bright metallic green and copper in color and about 3/8 inch long. It is smaller than its cousin the Green June Beetle which is over 3/4 inch long. The eggs of Japanese beetle are rarely observed as they are tiny and found in the soil. The larvae of the Japanese beetle appear as white grubs with a brown head. They curl into a C-shape when not active.



Adult Japanese Beetle

Host Plants

Japanese Beetles feed on a wide variety of trees, shrubs, and herbaceous plants. They can severely damage the foliage for fruit trees and grapes and can at times be pest of vegetables and field crops. The immature stage, also called a grub or white grub can reach pest status on many varieties of grass grown for turf in Virginia.



Beetle larvae = grub

Damage

The adult Japanese beetles chew small holes in leaves between the leaf veins. This damage gives the leaves a lacy appearance called skeletonizing. They will also feed on fruit and buds such as raspberries, grapes plums, sunflowers, zinnias and roses. Heavily damaged trees and plants will take on a brownish cast as leaves shrivel and die.



Beetle damage skeletonizing plant leaves

Life Cycle

Adult Japanese beetles start emerging from the ground in June. The beetles feed and the females release pheromones that attract males. After mating, females dig small burrows in the soil and lay eggs. Egg laying lasts from July to August. Eggs hatch in 8-9 days. Immature grubs feed and develop until the soil starts to cool in the fall. At this point they burrow down about 4-8 inches and stop feeding. In the spring when the soil temperatures start to warm, the grubs move up and start feeding again. The grubs reach full size in late May or early June and pupate. Adult beetles emerge several weeks later and complete the cycle.

Physical Control

In early morning, hand pick beetles into pails of soapy water to drown. Cover plants with floating row cover.

Chemical Control

Beware of placing pheromone traps near your crops. In most cases, these "bug bags" attract beetles from near and far to your garden.

Beneficial Habitat

Nematodes are microscopic parasitic roundworms that seek out the larva in the soil and inoculate the grub with a bacteria that feeds on the grub tissue. The most effective commercially available insect-eating nematode is called *Heterorhabditis bacteriophora*.

Leafminer

Description

Leafminers are the larval (maggot) stage of insects that live in and eat leaf tissue of plants. The majority of leafminers are moths, sawflies, true flies, and some beetles. The most common leafminers that plague gardens are black to gray flies with yellow stripes and clear wings. They are similar in appearance to small, hunched-back house flies and lay their eggs on the undersides of leaves. Larvae are worm-like maggots which are often pale yellow or green in color.

Host Plants

Leaf miners are commonly found on beans, blackberries, cabbage, lettuce, peppers, spinach, tomatoes, squash and a variety of ornamental flowers, trees and shrubs.

Damage

Leaf miner larvae consume nutrient rich chlorophyll within the leaves of the host plant. Damage appears as winding tunnels across the leaf. Different species produce different tunnel shapes. Most injuries are only cosmetically damaging and don't harm overall plant functions. However, if the leaf of the plant is the income source, such as kale or spinach leaves, cosmetic damage means the crop is unsellable.

Physical Control

At first sight of leafminer damage, squeeze tunnels to crush larvae. Use floating row covers in areas prone to high damage.

Chemical Control

Spinosad is effective, but may require two or three applications because it must be ingested by the leaf miners. Since leaf miners live within the leaf itself spray results can be difficult to achieve. Spinosad is very detrimental to populations of syrphid flies, an important beneficial insect. If choosing to spray, use caution!

Beneficial Habitat

Parasitic wasps can be very effective! Normally there are enough naturally occurring parasitic wasps and other beneficial insects to manage leafminers. Leafminer infestations can be a sign of past over-spraying of various chemicals. Plant small flowers such as angelica, chervil, fennel, dill and cilantro to attract beneficial parasitic wasps.



Severe tunnels



Small amount of damage.

Leafhopper

Description

There are more leaf hopper species worldwide than all species of bird, mammal, reptile and amphibian combined!

Leafhoppers range in size from 2-30mm in length. They can be colorful with stripes and patterns to shiny black. All have piercing, sucking mouth parts.

Host Plants

As a group leafhoppers feed on leaves of a wide variety of plants including many types grasses, flowers, vegetables, fruit trees, shrubs, deciduous trees, palms and weeds.

Damage

Leaf hoppers suck sap from plants, and can spread plant disease as they hop from plant to plant. Damage appears in the form of browned, burnt-looking, or yellowed leaf edges and tips.

As they are so jumpy and quick, leaf hoppers are difficult to control. These pests do not usually cause enough damage to be economically damaging. Usually normal beneficial insect populations keep leaf hoppers under control. An infestation can be a sign of over-spraying in the past that weakened beneficial insect populations.

Physical Control

Use of row covers can reduce damage but make sure cover isn't trapping leafhoppers inside. Removing damaged leaves and throwing in the trash (not in compost), can help aid the spread of disease.

Chemical Control

Insecticidal soap, Spinosad or Neem oil can be applied to leaves to reduce larvae populations. In an infestation, Pyganic can be used but be mindful of spraying in the later afternoon to protect beneficial insect populations.

Beneficial Habitat

Damsel bugs and assassin bugs are great predators. Grow small flowers that insects can reach into such as: Queen Anne's Lace, Daisy, Fennel, Goldenrod, Cosmos, Dill, Lemon Gem Marigolds and Mint



Damage is sometimes referred to as "hopperburn"



Sometimes the yellowing caused by leafhoppers looks similar to the yellowing signs of nitrogen deficiency.



Life stages from newly-hatched larvae to adult.



Adult leaf hopper

Mexican Bean Beetle

Description

Eggs are pale yellow to orange-yellow in color. They are typically found in clusters of 40 to 75 on the undersides of bean leaves. The newly-hatched larva is light yellow in color and covered with rows of stout branched spines. The newly emerged adult is straw or cream-yellow color. Shortly after emergence, eight black spots of variable size appear on each wing cover. The adults darken with age until they become an orange brown with a bronze tinge, at which time the black spots are less conspicuous.

Host Plants

Beans are their favorite crop but will also bother cowpea, soybean, clover, and alfalfa.

Damage

The insect in both the larval and adult stages will feed upon the leaves, flowers and growing pods of the bean plant, but the greatest amount of injury is done to the leaves. The upper surface of leaves quickly dries out after the lower section is injured, giving a lace-like, skeletonized appearance.

Physical Control

Cover seedlings with row cover until flowering.

Handpick larvae and adults and crush egg masses daily. If done with regularity, this will reduce damage from the second generation considerably.

Plant numerous successions of bush bean crops.

After harvest, remove crop debris to remove overwintering sites.

Chemical Control

Plants can be sprayed with insecticidal soap to decrease soft bodied larvae populations. Pyganic can be used in worst case scenarios; be mindful to spray in late afternoon to reduce harm to beneficial insect populations.

Beneficial Habitat

Beneficial insects such as spined soldier bugs and parasitic wasps prey on beetle larvae. Plant dill, fennel, cilantro, and perennial plantings of Queen Anne's Lace, yarrow and mints to encourage these beneficial to your garden.



Mexican Bean Beetle Eggs



Mexican Bean Beetle Larvae



Bean Beetle Adult



Bean Beetle Damage

Squash Bug

Description

Adult squash bugs are flattened in appearance and approximately $\frac{1}{2}$ to $\frac{3}{4}$ inch long. Gray to black in color, adults are winged with orange and brown stripes visible on the edges of the abdomen. Eggs are $\frac{1}{16}$ inch long, yellowish-brown to brick red in color. Upon hatching, nymphs (a juvenile that looks like the smaller version of the parent) are wingless, pale green to white with red legs, heads, and antennae. As nymphs mature, they become more gray in color with black legs.

Host Plants

All cucurbits are hosts, but pumpkin and squash are most attractive; cucumber, melons and gourds are less attractive. Pumpkins, 'Hubbard' and yellow (straightneck and crookneck) squash are more severely damaged than other squash varieties.

Damage

Squash Bugs suck the sap, or lifeblood, of the plant. A sign there is an infestation is pock-marked leaves covered in little yellow indentations—these are bite marks from this insect. They travel from plant to plant, and are known to carry plant viruses that harm yield. Feed mainly on underside of leaves.

Physical Control

Hand pick adults into soapy water. Crush egg clusters on leaves. Adult squash bugs overwinter in whatever they can find. You can reduce their chances of finding shelter by removing crop residue, especially squash residue. Researchers have found mulching with newspapers and straw combined with tightly secured row covers provided effective control of both weeds and insect damage. Row covers are removed just before flowering to allow for pollination. Crop rotation will help break up lifecycles, as will fall tillage and deep spring tillage. Plant cover crops to avoid winter erosion.

Chemical Control

Adult squash bugs are more difficult to kill as their exoskeleton hardens. Soft tissue nymphs are easier to kill. Use Insecticidal soap, Spinosad and in case of infestation your last resort should be Pyganic. Be mindful of spraying late in the afternoon to reduce harm to beneficial insects.

Beneficial Habitat

Limiting pesticide use is a most important step in protecting beneficials in agricultural systems. For squash bugs, predators include spiders, predatory mites, and especially ground beetles and robber flies. Plant bachelor buttons, sweet alyssum, borage, anise hyssop, fennel, mountain mint, cosmos and pussy willows. Plant ornamental grasses to provide overwinter habitat for many beneficial insects.



Squash Vine Borer

Description

The adult borer resembles a wasp. It is about 1/2 inch long with an orange abdomen with black dots. The first pair of wings is metallic green while the back pair of wings is clear, although that may be hard to see as the wings are folded behind them when they are at rest. Eggs are flat and brown. The larvae are white or cream-colored with brown heads, growing to almost an inch in length.

Host Plants

It is a serious pest of vine crops, commonly attacking summer squash, winter squash, and pumpkins. Cucumbers and melons are less frequently affected. In home gardens, entire crops may be lost in a year of high borer populations.

Damage

Larvae and pupae overwinter in cocoons in soil 1 inch deep. Adults emerge as squash vines start to spread, laying eggs on stems and stalks. Larvae burrow into stems. Larvae chew on the base of stems causing vines to wilt suddenly. As they feed, larvae push masses of greenish excrement or frass out of their entry holes into the stems.

Physical Control

Plant early! Cover plants at seedling stage with floating row cover until flowering. Covers need to be removed for pollination.

On wilting vines, look for frass at entry holes, slit stem and remove borer.

Heap dirt over the damaged stalk to promote rooting. After harvest shred and compost residue.

Cultivate soil to disrupt overwintering larvae.

Crop rotation is important, but vine borers are great fliers; if they're around, they'll find your plants.

Fall tillage exposes cocoons to predation. Plant cover crops to minimize risks of erosion of bare soil.

Chemical Control

There are no known organic chemical options at this time.

Beneficial Habitat

The Tachinid fly is a fantastic beneficial insect that preys upon the squash vine borer. Plant perennial patches of lemon balm and tansy in the far corners of your garden as these plants tend to spread! Plant rows of buckwheat beside squash or between plants to encourage this beneficial to live in your garden. Be aware that buckwheat will self seed easily becoming a weed itself, but root mass is limited and can easily be hoed down when needed. Buckwheat is also a "smother" crop, growing fast and reducing light for weeds to grow beneath. Excellent choice in every garden. Plus, seeds can be ground into flour. Pancakes anyone?



Adult vine borer moth



Larvae inside squash vine



Vine damage



Vines will wilt and not rebound as in the case of heat stress

Stink Bugs

Description

Known for their smell when crushed, stink bugs are shield shaped insects that come in a range of color from browns, greys to green.

Host Plants

Stink Bugs aren't picky eaters, they feed on a wide range of vegetables including tomatoes, peppers, cucurbits, sweet corn, tree fruits such as apples and peaches. For homeowners, the Brown Marmorated Stink Bug is a nuisance pest, as it invades houses looking for a place to over-winter.

Damage

Injury to tree fruits and fruiting vegetables appears as discolored and sunken areas. In the case of apples, conspicuous brown corky areas occur beneath the skin; in the case of stone fruits, there may be an internal breakdown of tissue.

Physical Control

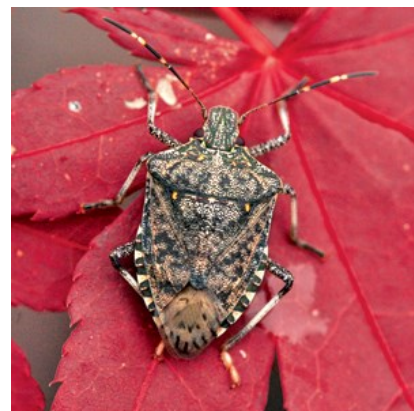
Hand-pick the nymphs and adults into soapy water. Destroy clusters of light green, barrel-shaped eggs found on the undersides of leaves.

Chemical Control

Chemical control is difficult as sprays need to contact the pest. Stink bugs are very mobile and quickly repopulate treated areas. The risk of harm to beneficial insects makes spraying even organic pesticides undesirable.

Beneficial Habitat

Natural enemies of stink bugs include ants, ladybird beetles, and some lacewings, all of which prey on stink-bug egg masses. Plant dill, yarrow, butterfly weed, cilantro, buckwheat, fennel, sunflowers and French marigolds to attract these beneficial insects.



Thrips

Description

Thrips are tiny winged insects; adults average between 1/50 and 1/25 of an inch in size. Various species of thrips exist, in colors from brown, to yellow, to white, to black. Even smaller, thrip nymphs (juvenile insects/larvae) are normally clear to whitish and lack wings. Thrips are poor fliers. They are transported from plant to plant and garden to garden by wind, or hitchhiking on transplants from nurseries. Their small size and feeding habits make them difficult to see and control.

Host Plants

Thrips trouble many garden plants, but are particularly troublesome with onions. Brassicas, cucurbits, citrus and other tree fruit, along with most garden plants, can all host plants for thrips. Thrips are especially troublesome in greenhouses where it is warm enough for them to reproduce year-round.

Damage

Thrips feed inside furred leaves, buds, and other crevices of plants. The effect of thrips are usually seen before the thrips themselves. Damage to leaves appear as greyish white spots and streaks. Adults overwinter in debris or cracks in bark and emerge when temperatures warm and lay eggs inserted into leaf tissue.

Physical Control

The best control for thrips is thru maintenance. Reduce areas where thrips may breed. Remove green plant debris from the ground. Using yellow sticky traps to catch adults can be effective, but can also catch beneficial insects.

Chemical Control

Insecticidal soap, and spinosad are used to manage problem areas. Pyganic can be sprayed in case of infestation. Be mindful of spraying pyganic in the late afternoon to avoid harming beneficial insect populations.

Beneficial Habitat

Thrips are preyed upon by multiple beneficial insects such as the minute pirate bug, lacewing, ladybug and several predatory mites. Plant dill, fennel, yarrow, queen anne's lace, cosmos, buckwheat, marigolds, mints, cilantro and butterfly weed to attract these beneficial insects.



Thrip nymphs.



Thrip adults



Flowers damaged by thrips exhibit white or brown blotching and streaks.



Thrips can spread viruses as they nibble on different plants. Shown above is tomatoes infected with tomato spotted wilt virus.

Wireworms

Description

Wireworms are the larval stage of click beetles. Wireworms are narrow, shiny, orange, and brown in color, and appear jointed. They feel “harder” than earthworms.

Host Plants

Wireworms burrow into roots, tubers, and crowns. crops such as carrots, beets, potatoes, sweet potatoes are most susceptible. Roots of corn and grains are also susceptible.

Damage

Adults overwinter and lay eggs at the base of plants. Crops attacked by wireworms have reduced plant populations, since they feed on the seeds prior to germination or just after germination. The plant stand may continue to deteriorate because wireworms bore into underground portions of stem causing plants to wither and die. They continue to feed upon the small roots of many plants throughout the season.

Physical Control

Wireworms are the most troublesome in new gardens—where sod has just been turned over. Wireworms are attracted to grass roots; when vegetables are planted in a newly-worked sod patch, you’re basically presenting a feast to a bunch of waiting worms. Avoid planting root crops in newly-turned sod. Practice crop rotation to prevent build up of wireworm populations in certain areas.

Avoid planting root crops where a root crop was previously planted .

Potatoes make great wireworm traps. Cut a potato in half and run a stick through the middle. Bury the spud about one inch deep so that the stick stands vertically as a handle. Pull the traps out after a day or two and discard wireworms.

Chemical Control

there are no known organic chemical controls for wireworms.

Beneficial Habitat

Birds consume some wireworm larvae but do not reduce them below economic levels.



The wireworm



Adult click beetle. If flipped over, these beetles will flip right-side up with a sharp clicking noise.



Wireworm damage



Plant Profiles

Beans

Beets

Broccoli

Cabbage

Carrots

Cauliflower

Corn

Cucumber

Garlic

Kale

Kohlrabi

Lettuce

Onions

Peas

Peppers

Potato

Spinach

Summer Squash

Tomato

Turnips

Winter Squash

Beans *Phaseolus vulgaris*

When to Plant

Plant your first crop of beans in early to mid-May after danger of frost in warm soil. Pole beans are even more sensitive to cold than bush beans. They also take longer to mature (10 to 11 weeks), but they produce about three times the yield of bush beans in the same garden space and can keep on bearing until the first fall frost.

Soil Preparation

Beans need a sunny, well-drained area rich in organic matter. Lighten heavy soils with extra compost to help seedlings emerge.

Planting

Don't soak or presprout seeds before sowing. Sow the seeds 1 inch deep in heavy soil and 1½ inches deep in light soil. Firm the earth over them to ensure soil contact. Plant most bush cultivars 3 to 4 inches apart in rows 2 to 2½ feet apart. They produce the bulk of their crop over a 2-week period. For a continuous harvest, stagger plantings at 2-week intervals until about 2 months before the first killing frost is expected.

Plant pole beans in single rows 3 to 4 feet apart. Sow seeds 2 inches deep and 10 inches apart. Provide a trellis or other vertical support at planting or as soon as the first two leaves of the seedlings open.

Germination

Beans germinate in 7—10 days. It's important to maintain even soil moisture during this period and also when the plants are about to blossom.

Harvest

Pick green beans when they are pencil size, tender, and before the seeds inside form bumps on the pod. Harvest almost daily to encourage production. Pulling directly on the pods may uproot the plants. Instead, pinch off bush beans using your thumbnail and fingers; use scissors on pole and runner beans. Also cut off and discard any overly mature beans you missed in previous pickings. Pick shell beans for fresh eating when the pods are plump but still tender. The more you pick, the more the vines will produce.

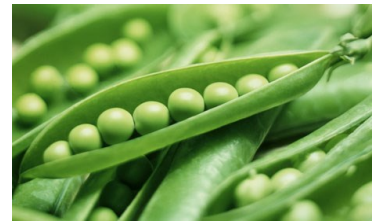
Storage

To dry beans, leave the pods on the plants until they are brown and the seeds rattle inside them. If the pods have browned and a rainy spell is forecast, harvest the dried pods and continue curing in a dry, well ventilated area. Bean seeds are ready for storage when they shatter when tapped with a hammer. Freeze dried beans for 4—6 weeks in storage jars or freezer bags to kill bean weevil eggs and larvae, then store in air-tight containers in a dry, dark space (or leave in freezer until needed).

Pests and Disease

Mexican Bean Beetles (pg. 42) are common in our area. Beans are also a favorite of deer, rabbits and groundhogs.

Beans that grow too closely together can develop molds or mildews due to poor air circulation



Beets *Beta vulgaris*

When to Plant:

Put seeds in the ground in early to mid-April or 4 weeks before your last spring frost date. Sow more seeds every 2 weeks, to keep a steady supply of fresh, tender beets. Stop planting when the temperatures hit 75 degrees but then begin sowing seeds again about 8 weeks before the first expected fall frost for a delicious late-season harvest. *Tip: Soak the seeds in warm water for a few hours prior to sowing to increase chances of germination. Full Sun, Part Sun.

Soil Preparation

As with most root vegetables, clear beds of rock. Till to a depth of 4 –6 inches with good organic material.

Beets require an ample amount of phosphorus to produce large, healthy roots. Since this nutrient is not very mobile within the soil, it is most often applied as a sidedressing by distributing it along the length of the rows. If a soil test notes a lack of phosphorus, an early-season, side-dress application of bonemeal or rock phosphate should fill in the gap.

Planting

Sow beet seeds to a depth of 1/2 inch and space rows 6 –12 inches apart.

Maturation

Thin the seedlings to leave 2 inches of space between plants. It's important to note that most beet seeds are multigerminant (though a handful of monogerm varieties do exist), meaning there is not just a single embryo in each seed but rather a cluster of several. This results in multiple plants emerging from each planted seed, making thinning necessary.

Harvesting

Beet greens can be picked and used as baby greens in salad mixes when they are just an inch or two high. Older greens are best served steamed or sautéed. Roots can be harvested when they reach an inch in diameter, but they remain tender until they measure 3 or 4 inches.

Storage

Before storing unwashed, harvested roots in a plastic bag in the fridge, cut off the tops, but leave an inch or two of the stems intact to keep them from bleeding. Beets should last several weeks stored this way. Long-term beet storage should take place in layers of damp sawdust or sand in a cold (around 32°F), moist (85 to 90 percent humidity) place. Beet greens only last about a week when refrigerated.



Broccoli *Brassica oleracea*

When to Plant

Start spring transplants indoors 5 to 7 weeks before the last spring frost date. Set out transplants 3 to 4 weeks before the last spring frost. Or plant seeds directly 3 weeks before the last spring frost. For fall crops, direct seed the broccoli in the garden 85 to 100 days before the average first fall frost date. Full Sun.

Soil Preparation

Prepare the garden bed by using a garden fork or tiller to loosen the soil to a depth of 6 to 8 inches, then mix in a 2- to 3 inch layer of compost. Prefers sandy soil.

Planting

Plant seeds 1 inch deep, 3 inches apart. Space transplants 18 inches apart. Protect seeds from hard frosts with a layer of mulch. Protecting young broccoli plants from temperature extremes is critical for a successful crop. A prolonged period of nights below 28°F can produce tiny, immature heads called buttons. To prevent this, protect plants with cloches or row covers during cool weather. Unexpected warm spells can cause the heads to bolt or open too soon.

Maturation

When planting from seed, thin seedlings until they are 12—18 inches apart. Keep soil well watered and do not get developing heads wet when watering.

Harvest

Harvest before the florets start to open and turn yellow. Cut just below the point where the stems begin to separate. Once you've harvested the main head, tender side shoots may form in the leaf axils all along the lower stalk. Keep cutting, and broccoli will keep producing until the weather turns too hot or too cold.

Storage

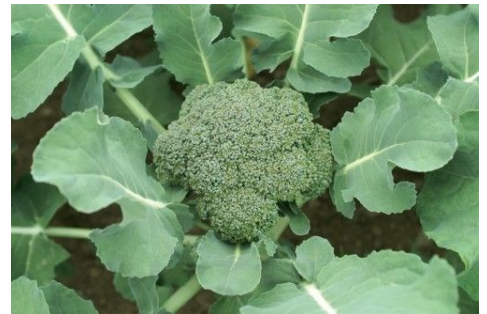
Can, freeze, or pickle broccoli, or keep it refrigerated for up to 2 weeks. Green cabbage loopers and imported cabbageworms often go unnoticed on harvested heads and can end up in your cooked broccoli. To prevent this, drive them out by soaking the heads in warm water with a little vinegar or salt added for 15 minutes before cooking.

Pests and Disease

Flea Beetles (pg. 36) can do great damage to young plants. Cabbage Moth caterpillars (pg. 33) need to be controlled throughout the life of the plants. Harlequin bugs (pg. 38) can cause damage as well. Watch for Cutworm (pg. 35) damage soon after transplanting.

Prolonged wet weather can cause a number of fungal problems, but proper plant spacing and weed control should keep damage to a minimum.

Club Root is a sign of acidic soils — proper pH maintenance is vital to avoid this.



Cabbage *Brassica oleracea var. capitata*

When to plant

Sow seeds indoors, 1/4 inch deep and 2 inches apart, around mid- February or March. For fall crop plant in mid-summer.

Soil preparation

Select a site with full sun and well-drained soil. Prepare the garden bed by using a garden fork or tiller to loosen the soil to a depth of 6 to 8 inches, then mix in a 2- to 3 inch layer of compost.

Planting

Plant seeds 1/4 inch deep, 1-1/2 to 2 inches apart, thinning plants to 12– 18 inches apart. Space transplants 12 to 16 inches apart in rows 1 to 2 feet apart. Wide spacing produces bigger heads, but young, small cabbages are tastier. Start your late crop in midsummer, sowing seeds in flats or directly in the garden. Space these seedlings farther apart than the spring crop, and place them so a tall crop, such as corn or pole beans, provide some afternoon shade.

Maturation

Side-dress seedlings with rich compost 3 weeks after planting. Hand pull weeds to avoid damaging cabbage's shallow roots; use a mulch to keep the soil moist. Uneven watering can cause a sudden growth spurt that will make the developing head split.

Harvesting

Use a sharp knife to cut heads when they are firm. Leave stalks and roots in place to produce tasty little cabbages; eat them like Brussels sprouts. This will take around 70 days for most green cabbage varieties. Most early varieties will produce 2 to 3 pound heads.

Storage

Cabbage can be stored in the refrigerator for several weeks, wrapped lightly in plastic. Make sure it is dry before storing. In proper root cellar conditions, cabbage can keep for up to 3 months.

Pests and Disease

Flea Beetles (pg. 36) can do great damage to young plants. Cabbage Moth caterpillars (pg. 32) need to be controlled throughout the life of the plants. Harlequin bugs (pg. 37) can cause damage as well. Watch for Cutworm (pg.35) damage soon after transplanting.

Prolonged wet weather can cause a number of fungal problems, but proper plant spacing and weed control should keep damage to a minimum.

Club Root is a sign of acidic soils — proper pH maintenance is vital to avoid this.



Carrots

Daucus carota

When to plant

Start sowing this cool-weather crop in mid to late March; plant again every 3 weeks for a continuous harvest. Most cultivars take 70 to 80 days to mature, so sow your last planting 2 to 3 months before the first expected fall frost. Full Sun.

Soil Preparation

To produce the best crop possible, double-dig your planting area or build up a raised bed. Loose, rock-free soil is the goal. If you have heavy soil, add plenty of mature compost or select shorter varieties.

Planting

Put about 6 seeds per inch. Lightly cover seeds with sand, compost, or potting soil. Covering seeds with burlap or boards will allow the seeds to remain in place and sprout in a cold, damp place. Once seeds have visibly sprouted remove boards, usually 10-14 days.

Maturation

Thin to 1 inch apart when the tops are 2 inches high, and be thorough, because crowded carrots can produce thin or crooked roots.

Harvest

Carrots are ready for harvest after 2 ½ months, or up to 1.5 inches in diameter. Use a garden fork to carefully loosen the soil around the carrots. Do not just pull on the tops of the carrots as they can break off, making harvest more difficult.

Storage

Remove greens from carrot and store in the refrigerator or a cool, moist cellar. They can be stored in damp sand to last over winter.

Pests and Disease

Wireworms (pg.46) can make deformed roots if present in your soil. Leafhoppers (pg. 40) and Aphids can damage leaves leading to poor harvests if unchecked.

In warm wet weather, fungal diseases can damage the leaves.



Cauliflower *Brassica oleracea*

When to Plant

Cauliflower usually performs best as a fall crop. Plant seeds $\frac{1}{4}$ to $\frac{1}{2}$ inch deep, 4 to 6 weeks before the last average frost. Full Sun

Soil Preparation

Cauliflower needs a soil rich in nitrogen and potassium, with enough organic matter to retain moisture.

Planting

Start the seeds 4 to 5 weeks before the plants are needed. Transplant them 2 to 4 weeks before the average frost date in the spring, no sooner and not much later. Set the seedlings 16 to 20 inches apart. Firm the soil, and water seedlings thoroughly. Cover beds with floating row cover to prevent insect pests from damaging tender transplants.

Maturation

Provide at least 1 inch of water a week, soaking the soil to a depth of 6 inches. Cauliflower requires constant moisture to produce large, tender heads; soil that dries out between waterings will cause heads to open up and become "ricey." Use a thick layer of compost or organic mulch.

Give young plants monthly light feedings with fish emulsion or compost tea.

When the flower heads (curds) of white-headed cultivars are about the size of an egg, blanch them by shading out the sunlight. Otherwise they'll turn yellowish or brown and become, if not less tasty, certainly less appealing. Prepare plants for blanching on a sunny afternoon when the plants are totally dry, because damp heads are more susceptible to rot. Just bend some of the plants' own leaves over the head and tuck them in on the opposite side, or secure the leaves at the top with soft twine, rubber bands, or plastic tape. Use enough leaves to keep out light and moisture, but allow room for air circulation and for the heads to grow.

Unwrap occasionally to check on growth, to look for pests, or to allow heads to dry out after a rain. In hot weather, heads can be ready to harvest in a matter of days. In cool periods, the maturing process can take as long as 2 weeks.

Harvesting

Mature cauliflower heads can range in size from 6 inches to 12 inches across. Harvest when the buds are still tight and unopened. With a sharp knife, cut them off just below the head, along with a few whorls of leaves to protect the curds. Use or preserve right away.

Storage

To store plants for about a month, pull them up by the roots and hang them upside down in a cool place.

Pests and Disease

Flea Beetles (pg. 37) can do great damage to young plants. Cabbage Moth caterpillars (pg. 33) need to be controlled throughout the life of the plants. Harlequin bugs (pg. 37) can cause damage as well. Watch for Cutworm (pg. 36) damage soon after transplanting.

Prolonged wet weather can cause a number of fungal problems, but proper plant spacing and weed control should keep damage to a minimum.



Corn *Zea mays*

When to plant

Corn is very susceptible to frosts. You can lose crop if you plant too early. It's better to wait until all danger of frost is past and the soil warms up to the 60°F needed for seed germination.

Soil preparation

Corn is an extremely heavy feeder, especially on nitrogen, so it thrives in a place where soil-enriching crops like beans, hairy vetch, or clover grew the previous season, or add 20 to 30 pounds of compost per 100 square feet to the soil as you prepare it for planting.

Planting

Corn doesn't transplant well either, so if you garden in a short-season area and want to start corn indoors, use biodegradable pots to avoid disturbing the roots at transplanting time. The best way to promote complete pollination is to plant corn in blocks rather than long individual rows—a block should be at least three rows wide. If you want corn only for fresh eating, plant a minimum of 10 to 15 plants per person.

Maturation

If the weather stays cool, spread black plastic on the planting area to warm the soil more quickly. Corn can't compete with weeds, so cultivate thoroughly around the stalks for the first month of growth. After that, corn's shallow roots will spread out as much as 1 foot from the stalk; be careful not to disturb these roots, because it's easy to damage them. Instead, apply mulch to prevent weeds from sprouting.

Harvest

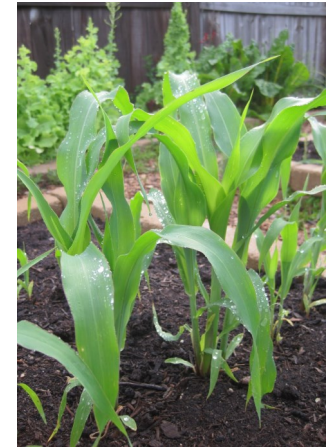
Three weeks after corn silks appear, start checking ears for peak ripeness. Pull back part of the husk and pierce a kernel with your thumbnail. If a milky liquid spurts out, the ears are at prime ripeness—rush those ears to the table, refrigerator, or freezer. Ears on the same stalk usually ripen a few days apart. A completely dry silk or a yellow or faded-green sheath means the ear is past its prime. Pull ears downward and twist to take off stalk.

Storage

Leave ornamental corn and popcorn on the stalks to dry until the first hard frost. If the weather is cloudy and wet, cut and stack stalks in a cool, dry place until the corn dries. Sweet corn varieties lose their sweetness soon after harvesting. Prepare for eating or preserving immediately after picking. Sweet corn freezes well, especially if removed from ears before freezing.

Pests and Disease

Corn Earworm is the most common pest — early plantings can sometimes avoid major damage. Japanese Beetles love feeding on corn silk which can lead to poor pollination.



Cucumber *Cucumis sativus*

When to Plant

For an early crop, start cucumber seeds indoors about 3 weeks before you transplant them in the ground. Seed or transplant outside in the ground no earlier than 2 weeks after last frost date. Cucumbers are extremely susceptible to frost damage; the soil must be at least 65°F for germination. Do not plant outside too soon!

Soil Preparation

Light, sandy soil is best. Mix in compost before planting to a depth of 2 inches and work into the soil 6 to 8 inches deep. Make sure that soil is moist and well-drained, not soggy.

Planting

Sow seeds in rows, 1 inch deep and 6 to 10 inches apart. If you are transplanting seedlings, plant them 12 inches apart. A trellis might be a good idea if you want the vine to climb, or if you have limited space. Trellising also protects the fruit from damage from lying on the moist ground.

Maturation

When planting seeds in the ground, cover with netting or a berry basket to keep pests from digging out the seeds. When seedlings reach 4 inches tall, thin plants so that they are 1½ feet apart. Water consistently; put your finger in the soil and when it is dry past the first joint of your finger, it is time to water. Inconsistent watering leads to bitter-tasting fruit. Water slowly in the morning or early afternoon, avoiding the leaves.

Harvest

Harvest regular slicing cucumbers when they are about 6 to 8 inches long (slicing varieties). Harvest dills at 4 to 6 inches long and pickles at 2 inches long for pickling. Cucumbers are best picked before their seeds become hard and are eaten when immature. Any cucumbers left on the vine too long will also get tough skins and lower plant productivity.

Storage

Cucumbers are over 90 percent water. Store wrapped tightly in plastic wrap to retain moisture. They will keep for a week to 10 days when stored properly in the refrigerator. Or can them to make pickles.

Cucumbers are very susceptible to stress and can cause bitterness to occur in your cucumbers. To minimize stress make sure they have enough water, sunlight, and try to minimize effect of extreme temperatures with row cover and mulch

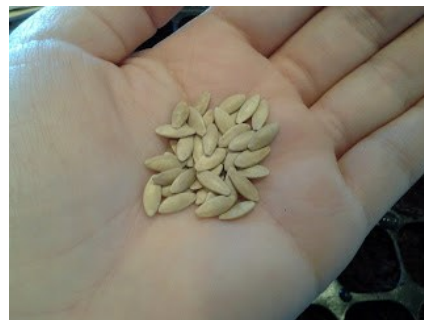
Pests and Disease

Cucumber Beetles (pg. 35) are common and can both damage plants and spread disease.

Squash Bugs (pg. 43) can infect plants at any stage.

Powdery Mildew is common in cool, wet weather — take early action to slow progress.

Bacterial Wilt is spread by insects — control Cucumber Beetles and remove wilted plants immediately!



Garlic *Allium sativum*

When to plant

Garlic is best planted in the fall, around Halloween. Spring planted garlic will generally make smaller bulbs.

Soil preparation

Well-drained, rich, loamy soil amended with lots of organic matter. Raised beds are ideal, except in very dry regions.

Planting

To grow garlic, you plant the *cloves*, the sections of the *bulb*; each clove will produce a new bulb. Leave the papery coverings intact. The largest cloves generally yield the biggest bulbs. Place cloves in a hole or furrow with the flat or root end down and pointed end up, with each tip 2 inches beneath the soil. Set the cloves about 4 to 6 inches apart. Top the soil with 6 inches of mulch, such as straw or dried grass clippings mixed with leaves. You'll see shoots start growing right through the mulch in four to eight weeks, depending on your weather and the variety you've planted. They stop growing during winter, then start again in spring. Leave the mulch in place into spring; it conserves moisture and suppresses weeds (garlic competes poorly with weeds).

Maturation

By mid-June, your garlic will begin sprouting flowery tops that curl as they mature and ultimately straighten out into long spiky tendrils. These savory stalks, known as scapes, should be removed to encourage larger, more efficient bulb growth.

Harvest

When half to three-quarters of the leaves turn yellow-brown, typically in late June or early July (depending on the variety and the weather), it's harvest time. Carefully dig up each bulb; do not pull, or you may break the stalk from the bulb, which can cause it to rot. Once it's harvested, get it out of the sun as soon as possible.

Storage

Tie the garlic together in bundles of 6 to 10 bulbs (label them if you've grown more than one variety) and hang them to cure for about four to six weeks in a shaded, dry, and preferably drafty area. When your garlic is thoroughly dry, trim the roots, taking care not to knock off the outer skin. Cut off the stalks about 1½ inches above the bulb if you plan to keep the garlic in bags. Recycled mesh onion bags are perfect for storage.

Hard neck garlic: Hardneck garlic (*Allium sativum ssp. ophioscorodon*) produces a stiff flowering stalk, called a scape, topped with bulbils (tiny bulbs) instead of seeds. A single cluster of 5 to 10 large cloves surrounds the hard stalk. Hardnecks are tolerant of cold weather and offer a range of flavors from mild to strong and spicy.

Softneck garlic: Softneck garlic (*Allium sativum ssp. sativum*) rarely produces a flowering stalk; the cloves are smaller than hardnecks and are arranged in overlapping layers. A single head may have 6 to 18 cloves or more. The soft, pliable necks are easy to braid into garlic "ropes." Softneck varieties are less cold-tolerant and therefore better suited to growing in regions with mild winters, but they do keep longer in storage than hardneck garlic.



Kale

Brassica oleracea, Acephala group Brassicaceae

When to plant

For an early crop, start seeds in a greenhouse in February, transplanting into the garden in April. Where summers are cool, sow seeds in early spring. For fall-winter crop, sow seeds or set out transplants at least 6 weeks before the first frost.

Full Sun

Soil Preparation

Loamy soil enriched with a moderate amount of organic matter for a tender crop.

Planting

Plant the seeds 1/4 to 1/2 inch deep into well-drained, light soil. After about 2 weeks, thin the seedlings so that they are spaced 8 to 12 inches apart.

Maturation

Mulch in the summer and mulch the soil heavily after the first hard freeze; the plants may continue to produce leaves throughout the winter.

Harvest

Leaves are ready to be harvested when leaves are the size of your hand. Pick about one fistful of leaves per harvest. Avoid picking the terminal bud (found at the top center of the plant) because this will help to keep the plant productive. Leave some of the larger leaves in order to ensure a large surface area for photosynthesis so the plant can continue growing. Kale leaves are sweetest in the fall, after they've been touched by a light frost.

Storage

You can store kale as you would any other leafy green; put the kale in a plastic bag and store it in the refrigerator. It should last about 1 week.

Pests and Disease

Flea Beetles (pg. 37) can do great damage to young plants. Cabbage Moth caterpillars (pg. 33) need to be controlled throughout the life of the plants. Harlequin bugs (pg. 38) can cause damage as well. Watch for Cutworm (pg. 36) damage soon after transplanting.

Prolonged wet weather can cause a number of fungal problems, but proper plant spacing and weed control should keep damage to a minimum.

Club Root is a sign of acidic soils — proper pH maintenance is vital to avoid this.



Kohlrabi *Brassica oleracea*

When to plant

For a spring crop, direct-sow seeds 4 to 6 weeks before the last spring frost. Or start seedlings for a fall crop indoors 6 to 8 weeks before the first fall frost. Full sun.

Soil Preparation

Kohlrabi grows in loose, well-drained soil. Prepare the garden bed by using a garden fork or tiller to loosen the soil to a depth of 6 to 8 inches, then mix in a 2- to 3-inch layer of compost

Planting

1/4 inch deep, 10 seeds per foot directly into the ground in the spring. Sow seeds directly in the garden 8 to 10 weeks before the first expected fall frost date

Maturation

After the seedlings are a couple of inches tall, thin to a final spacing of 6 to 8 inches. Keep plants well watered and free of weeds; put down a mulch to help accomplish both tasks. Cultivate carefully to keep from damaging the delicate, shallow roots.

Harvesting

Use young leaves in salads and stir-fries. Harvest immature “bulbs” when they are no more than 2 inches in diameter, cutting the stems 1 inch below the swollen stem. Remove the leaf stems and leaves, and use the remaining stem as you would turnips. Most varieties are ready for harvesting just 6 to 7 weeks from planting and are the most tender and flavorful when the bulbs are 2 to 4 inches in diameter. Fall crops that ripen in cool weather don't get woody as readily and can be picked a little larger, up to 5 inches.

Storage

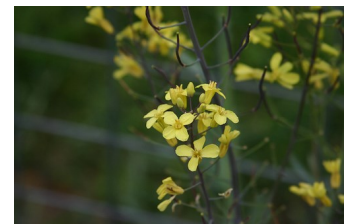
Kohlrabi will keep for several weeks in the refrigerator and for several months in a cold, moist, root cellar.

Pests and Disease

Flea Beetles (pg. 37) can do great damage to young plants. Cabbage Moth caterpillars (pg. 33) need to be controlled throughout the life of the plants.

Harlequin bugs (pg. 38) can cause damage as well. Watch for Cutworm (pg. 36) damage soon after transplanting. Prolonged wet weather can cause a number of fungal problems, but proper plant spacing and weed control should keep damage to a minimum.

Club Root is a sign of acidic soils — proper pH maintenance is vital to avoid this.



Lettuce *Lactuca sativa*

When to plant

Start romaine, iceberg, or other head lettuces indoors 4 to 6 weeks before your last spring frost date, making three small sowings at weekly intervals. Set out the seedlings successively as soon as the ground is workable. At the same time, direct-seed leaf lettuce outdoors at 2-week intervals. Part Sun.

Soil Preparation

Lettuce needs a humus-rich, moisture-retentive, but well-drained soil with plenty of nitrogen.

Planting

Broadcast the seeds and rake lightly to cover them, or sow seeds ¼ inch apart and as thinly as possible in rows 1½ feet apart. A small seed packet will plant a 100-foot row and produce some 80 heads, or about 50 pounds of leaf lettuce.

Germination rate is over 80 percent.

Maturation

When the seedlings have four leaves, thin head or romaine lettuce to 8 to 12 inches apart. Do the same for leaf lettuce unless you plan to harvest entire plants instead of leaves; in that case, 4-inch spacing is adequate. Thin butterheads to 6 to 8 inches apart.

Lettuce is 90 percent water and has very shallow roots, so keep the soil surface moist but not soggy.

Harvest

Pick lettuce in the morning to preserve the crispness it acquires overnight. Watch your crop closely, as mature plants deteriorate quickly. To test the firmness of heading types, press down gently on lettuce hearts with the back of your hand; don't pinch them, as this can bruise the hearts. Use a sharp knife to cut heads below the lowest leaves, or pull plants out by the roots. Harvest leaf types as needed.

Storage

Can last one week in the fridge.

Just before bolting, lettuce plants start to elongate and form a bitter sap. To keep this from happening, pinch off the top center of the plant. Pull up and discard any plant that goes to seed. If you are a seed saver, wait and save seeds from the last plants to bolt, since quickness to bolt is a bad trait. Seed savers should also be aware that different lettuce cultivars can cross with each other and with wild lettuce, so next year's plants may not come true from your saved seed.

Pests and Disease

Aphids (pg. 32), Leafhoppers (pg. 40), thrips (pg. 46) and leaf miners (pg. 40) can all damage lettuce leaves — proper plant spacing and weed control can help minimize damage.

Fungal diseases can beset plants in prolonged wet weather, insects can also spread disease. Proper spacing and weed control is important.



Onions *Allium cepa*

When to Plant

Plant onion seeds 4 to 6 weeks before the last average frost—or even earlier indoors or in a cold frame. When indoor seedlings are 2 to 3 inches tall, harden them off by exposing them to above-freezing night temperatures. The challenge with starting from seeds is that your crop will take up to 4 months to mature—gardeners in cold-winter areas will need to start their onion seedlings indoors. Onions like cool weather in the early part of their growth, so plant them in spring, except in mild-winter areas, where onions are grown as a fall or winter crop.

Soil Preparation

Soil needs to be well-drained, loose, and rich in nitrogen; compact soil affects bulb development. Till in aged manure or fertilizer the fall before planting. Onions are heavy feeders and need constant nourishment to produce big bulbs.

Planting

Outdoors, sow seeds thickly in rows about 1/2 inch deep. For transplants or sets, use a dibble to make planting holes 2 inches deep and 4 to 6 inches apart. Use the closer spacing if you plan to harvest some young plants as green onions. For sets, open a furrow 2 inches deep and place the sets stem (pointed) end up 4 to 6 inches apart, and then fill in the furrow.

Maturation

For direct seeding, thin seedlings to 1 inch apart, and thin again in four weeks to 4 inches apart.

Harvest

Once onion tops turn yellow, use the back of a rake to bend them over horizontally. This stops the sap from flowing to the stems and diverts the plant's energy into maturing the bulb. A day or so later, when the tops turn brown, pull or dig the bulbs on a sunny day, and leave them to dry in the sun. Lay the tops of one row over the bulbs of another to help prevent sunscald.

Storage

When the outer skins are thoroughly dry, wipe off any soil and remove the tops—unless you intend to braid them. Store in a cool, dry place; hang braided onions or those kept in mesh bags in an airy spot. Such dried bulbs will keep for about 4—8 months.

*To reduce the chances of extensive damage, scatter-plant onions throughout the garden. This interplanting can also benefit other garden plants; many *Allium* species will ward off pests—such as aphids, Japanese beetles, and carrot flies—from roses, lettuce, carrots, beets, parsnips, and members of the cabbage family.

Pests and Disease:

Thrips (pg. 46) are common on onion tops.

Onion maggots can damage roots — keep well weeded to reduce damage.



Leeks



Onion



Shallots



Garlic



Peas *Pisum sativum, Pisum macrocarpon*

When to Plant

Sow seeds outdoors 4 to 6 weeks before last spring frost, when soil temperatures reach 45 degrees F.

Soil Preparation

Early peas in particular like raised beds or a sandy loam soil that warms up quickly. Heavier soils can provide cooler conditions for a late pea crop, but you'll need to loosen the ground before planting by working in some organic matter.

Planting

Space seeds of bush or dwarf peas 1" apart in rows 2' apart. Sow early crop seeds 2" deep in light soil or 1" deep in heavy soil. Thin to 2"-3" apart. Plant vining types in double rows 6-8" apart on either side of 5'-6' tall supports. Give peas a sunny spot protected from high winds. A row cover laid on the soil will encourage soil warmth and better germination. Later crops appreciate partial shade.

Maturation

Peas supply their own nitrogen, so go easy on such fertilizers as manure. Too much nitrogen produces lush foliage but few peas.

Harvesting

Pods are ready to pick about 3 weeks after a plant blossoms, but check frequently to avoid harvesting late. You should harvest peas daily to catch them at their prime and to encourage vines to keep producing. Also, their taste and texture are much better if you prepare and eat them immediately after harvesting; the sugar in peas turns to starch within a few hours after picking.

Storage

Peas can be frozen or kept in the refrigerator for about 5 days. Place in paper bags, then wrap in plastic. If you missed your peas' peak period, you can still pick, dry, and shell them for use in winter soups.

To make good use of garden space, interplant peas with radishes, spinach, lettuce, or other early greens. Cucumbers and potatoes are good companion plant, but peas don't do well when planted near garlic or onions.



Peppers *Capsicum annuum*

When to Plant

Start seeds indoors 8-10 weeks before last spring frost date. Start pepper seeds three to a pot, and thin out the weakest seedling. Let the remaining two pepper plants spend their entire lives together as one plant. The leaves of two plants help protect peppers against sunscald, and the yield is often twice as good as two segregated plants. Seedlings are ready for the garden when they are 4 to 6 inches tall.

Soil Preparation

Loamy. Soil should be well-drained, but maintain adequate moisture either with mulch or plastic covering.

Planting

After the danger of frost has passed, transplant seedlings outdoors, 18 to 24 inches apart (but keep paired plants close to touching). Put two or three match sticks in the hole with each plant, along with about a teaspoon of fertilizer. They give the plants a bit of sulfur, which they like.

Maturation

Evenly moist soil is essential to good growth, so spread a thick but light mulch, such as straw or grass clippings, around the plants. Water deeply during dry spells to encourage deep root development. Lack of water can produce bitter-tasting peppers. **Pinch off the first flowers.** As difficult as it might be for you, pinch off any early blossoms that appear on your pepper plants. This won't harm the plants. In fact, it helps them direct their energy into growing, so you get lots of large fruits later in the season (and a higher overall yield) instead of just a few small fruits early on.

Harvest

Harvest as soon as peppers reach desired size. The longer bell peppers stay on the plant, the more sweet they become and the greater their Vitamin C content. Fully ripe peppers will turn a bright color (red, orange or yellow) - this is when they are sweetest. Use a sharp knife or scissors to cut peppers clean off the plant for the least damage.

Storage

Peppers can be refrigerated in plastic bags for up to 10 days after harvesting. Bell peppers can be dried, and we would recommend a conventional oven for the task. Wash, core, and seed the peppers. Cut into one-half-inch strips. Steam for about ten minutes, then spread on a baking sheet. Dry in the oven at 140 degrees F (or the lowest possible temperature) until brittle, stirring occasionally and switching tray positions. When the peppers are cool, put them in bags or storage containers.

Don't plant peppers where tomatoes or eggplants grew previously, because all three are members of the nightshade family and are subject to similar diseases.

Pests and Disease

Stink bugs (pg. 45) will damage fruits.

A wide range of fungal diseases can affect peppers — proper plant spacing and weed control will help — also trellis to keep plants upright.



Potato *Solanum tuberosum*

When to Plant

Plant early cultivars 2 to 3 weeks before the last spring frost or as soon as you can work the soil. Time the planting of late cultivars so they will mature before the first fall frost.

Soil Preparation

Potatoes need space, sunshine, and fertile, well-drained soil. Acid soil provides good growing conditions and reduces the chance of a common disease called scab.

Planting

Plant potatoes in rows spaced 3 feet apart. Place the seed pieces 6 inches apart, and cover them with 4 to 5 inches of soil. As the vines grow, hill soil, leaves, straw, or compost over them to keep the developing tubers covered. (When exposed to sunlight, tubers turn green and develop a mildly toxic substance called solanine.)

Leaving only a small portion of the growing vines exposed encourages additional root development.

Maturation

Once the plants blossom, stop hilling up the soil, and apply a thick mulch to conserve moisture and keep down weeds. Water deeply during dry spells.

Harvest

Blossoming plants are a sign that the first “new” potatoes are ready to harvest. Pull aside the earth around the base of plants and gently pick off cooking-sized tubers, which are delicious boiled with the skins on. Once the foliage starts to wither and die back, the tubers will be fully grown. If the weather is not too warm or wet, they will keep in the ground for several weeks. Dig them up with a spading fork before the first frost. Potatoes that are nicked or bruised during harvesting won’t store well, so eat them as soon as you can.

Storage

Store tubers in a dark place at around 40°F. Rub off any large clumps of dirt (potatoes should never be washed before storage). Treat the tubers very gently so as not to bruise or cut them. Nestle your spuds into ventilated bins, bushel baskets, or a cardboard box with perforated sides. Completely cover the boxes or baskets with newspaper or cardboard to eliminate any light. Even a little light will cause potatoes to turn green and be rendered inedible. They usually keep for several months .

Pests and Disease

Colorado Potato beetle (pg. 34) is the most common pest.

Wireworms (pg. 47) and Nematodes can damage developing tubers.

In some years, Late Blight can be a major concern — plant early to increase your chances of a good crop as late blight prefers cool temperatures.



Spinach *Spinacia oleracea*

When to plant

The secret to success with this crop is to start sowing seeds as soon as possible in spring, to make small, frequent plantings during late spring and summer, and to concentrate on fall as the season for the main crop. Sow spinach seed as early as 8 weeks before the last frost or as soon as you can work the soil. Prepare the soil the previous autumn, and you can drop the seeds in barely thawed ground. In areas with a long, cool spring, make successive plantings every 10 days until mid-May.

Soil Preparation

Spinach does best when grown in moist, nitrogen-rich soil.

Spinach plants form a deep taproot; for best growth, loosen the soil 6—8 inches deep before planting.

Planting

Spinach seed doesn't store well, so buy fresh seeds every year. Sow them ½ inch deep and 2 inches apart in beds or rows. If the weather isn't extremely cold, seeds will germinate in 5 to 9 days. Spinach produces beautifully in cool fall conditions, but it's tricky to persuade the seed to germinate in the hot conditions of late summer. Sow seed heavily, because the germination rate drops to about 50 percent in warm weather, and water the seed beds frequently—even twice a day—because watering helps to cool the soil.

Maturation

Overcrowding stunts growth and encourages plants to go to seed. To avoid crowding, thin seedlings to 4 to 6 inches apart once they have at least two true leaves. Fertilize with compost tea or fish emulsion when the plants have 4 true leaves.

Since cultivating or hand pulling weeds can harm spinach roots, it's best to spread a light mulch of hay, straw, or grass clippings along the rows to suppress weeds instead. Water stress will encourage plants to bolt, so provide enough water to keep the soil moist but not soggy. Cover the crop with shade cloth if the temperature goes above 80°F.

Harvest

In 6 to 8 weeks you can start harvesting from any plant that has at least six leaves 3 to 4 inches long. Carefully cutting the outside leaves will extend the plants' productivity, particularly with fall crops. Harvest the entire crop at the first sign of bolting by using a sharp knife to cut through the main stem just below the soil surface.

Storage

Wash well to fully remove dirt that clings to the hairs on the leaves. Spinach will last in the refrigerator for a week.

Pests and Disease

Aphids (pg. 32) and Flea Beetles (pg. 37) can damage leaves.

Warm, humid conditions can encourage fungal diseases — keep plants well spaced and weeded.



Summer Squash *Cucurbita*

When to Plant

Plant seed outdoors when the soil temperature has reached 60° or about a week after the last frost. Full Sun.

Soil Preparation

Squashes like well-drained, fertile soil that's been amended with lots of compost.

Planting

Plant the seeds 1 inch deep 24 inches apart. Squash needs room to spread, so space your rows generously or trellis.

Maturation

For all type of squash, frequent and consistent watering is recommended. Water most diligently when fruits form and throughout their growth period.

Harvest

Harvest squash when small and tender for best flavor. Most varieties average 60 days to maturity, and are ready as soon as a week after flowering. Harvest when fruits are 4 inches or longer.

Storage

Squash can last in the fridge up to 10 days.

Freezing: Wash it, cut off the ends, and slice or cube the squash. Blanch for three minutes, then immediately immerse in cold water and drain. Pack in freezer containers and freeze.

Pests and Disease

Cucumber Beetles (pg. 35) are common and can both damage plants and spread disease.

Squash Bugs (pg. 43) can infect plants at any stage.

Vine Borers are unpredictable, but can be serious problems.

Powdery Mildew is common in cool, wet weather — take early action to slow progress.

Bacterial Wilt is spread by insects — control Cucumber Beetles and remove wilted plants immediately!



Common Summer Squash

Zucchini



Yellow Zucchini



Patty Pan



Tomato *Lycopersicon esculentum*

When to Plant

At 6 to 8 weeks before the average last frost, sow seeds ¼ inch deep and 1 inch apart in well-drained flats. When the second set of leaves—the first true leaves—appear, transplant to individual pots or deep containers (such as plastic cups), burying the stems deeper than they stood previously.

Soil Preparation

Loamy soil. Make the planting holes larger than normal for each seedling; Two weeks before transplanting seedlings outdoors, till soil to about 1 foot and mix in aged manure, compost, or fertilizer.

Planting

Spacing between planting holes depends on how you grow your tomatoes. If you're going to stake and prune the plants or train them on trellises, space the seedlings 2 feet apart. If you plan to let them sprawl, space them 3 to 4 feet apart. Cover the bottom of the hole with several inches of sifted compost mixed with a handful of bonemeal. For magnesium, which promotes plant vitality and productivity, sprinkle 1 teaspoon of Epsom salts into each hole.

Maturation

Avoid wetting the foliage, since wet leaves are more prone to diseases.

Harvest

Leave your tomatoes on the vine as long as possible. If any fall off before they appear ripe, place them in a paper bag with the stem up and store them in a cool, dark place. The perfect tomato for picking will be firm and fully colored, regardless of size, with perhaps some green remaining around the stem. A ripe tomato will be only slightly soft.

Storage

Never refrigerate fresh tomatoes. Doing so spoils the flavor and texture that make up that garden tomato taste. To freeze, core fresh unblemished tomatoes and place them whole in freezer bags or containers. Seal, label, and freeze. The skins will slip off when they defrost.

*Unless you plan to preserve a lot of your crop, 3 to 5 plants per person is usually adequate. Unused seeds are good for 3 years. *

Pests and Diseases

Aphids (pg. 32) are common on tomato plants, particularly when young.

Caterpillars (hornworms and fruit worms) can be controlled with Bt or spinosad if needed.

Control fungal diseases with weekly sprays of Serenade. If needed, spray with copper to slow the spread of disease.

Do not use tobacco products around tomato plants — it can infect plants with Tobacco Mosaic Virus — a serious and difficult to control disease.



Turnips *Brasica rapa*

When to Plant

Plant seeds outdoors 3 weeks before the last frost in spring. The soil must be at least 40° F for germination, which takes from 7 to 14 days. Fall crops of turnips are often sweeter and provide a longer harvest period than spring plantings. For a fall harvest, plant in midsummer about 2 months before the first frost. Plant rutabagas for fall harvest only. Full Sun.

Soil Preparation

Turnips thrive in well-drained, deeply worked soil on a sunny site.

Planting

Sow spring crops ¼ inch deep and fall crops ½ inch deep. Broadcast the seeds, and later thin them to 3 to 4 inches apart, or plant seeds in rows spaced 12 to 18 inches apart.

Maturation

Keep the soil evenly moist to promote fast growth and the best flavor. When plants are 5 inches tall, apply a mulch at least 2 inches thick. No extra fertilizer is necessary in well-prepared soil.

Harvesting

Harvest greens when they're large enough to pick. If you plan to harvest both leaves and roots from a single planting, remove only 2 or 3 leaves per plant. Small roots are the most tender, so pull when they are 1 to 3 inches in diameter, after about 5 weeks. It's easy to harvest small turnips growing in light garden soil simply by hand pulling them. For large storage roots, though, try loosening the soil by inserting a spading fork beside the row first.

Storage

To store the roots, twist off the tops, leaving ½ inch of stem. Place undamaged roots in a cool, dark place, such as a basement or root cellar. Don't wash off soil that clings to roots; it helps protect roots in storage. They will keep for several months. You can also leave your fall crop in the ground until early winter (or throughout winter in mild climates) by covering them with a thick mulch. When planted after onions, potatoes, and other vegetable of summer, turnips are sometimes called a "mop up" crop because of their ability to utilize soil-borne nitrogen left from the previous crop.*

Pests and Disease

Flea Beetles (pg. 37) can do great damage to young plants. Cabbage Moth caterpillars (pg. 33) need to be controlled throughout the life of the plants. Harlequin bugs (pg. 38) can cause damage as well. Watch for Cutworm (pg. 36) damage soon after transplanting.

Prolonged wet weather can cause a number of fungal problems, but proper plant spacing and weed control should keep damage to a minimum.

Club Root is a sign of acidic soils — proper pH maintenance is vital to avoid this.



Winter Squash *Cucurbita*

When to Plant

Plant seed outdoors when the soil temperature has reached 60° or about a week after the last frost. Full Sun.

Soil Preparation

Squash likes well-drained, fertile soil that's been amended with lots of compost.

Planting

Plant the seeds 1 inch deep 24 - 48 inches apart. Winter Squash needs lots of room to spread, so space your rows generously or trellis.

Maturation

For all type of squash, frequent and consistent watering is recommended. Water most diligently when fruits form and throughout their growth period. Weed very well early on as vining crops will make access difficult in mid to late summer.

Harvest

Harvest winter squash when fully sized and colored. Most varieties take 100+ days to mature — usually not ready until September or October.

Storage

Winter squash will store very well in cool, dry conditions. Butternut and Acorn squash will store well into the next spring. Delicata and Spaghetti squash will not store well past December.

Pests and Disease

Cucumber Beetles (pg. 35) are common and can both damage plants and spread disease.

Squash Bugs (pg. 43) can infect plants at any stage.

Powdery Mildew is common in cool, wet weather — take early action to slow progress.

Bacterial Wilt is spread by insects — control Cucumber Beetles and remove wilted plants immediately!



Common Winter Squash

Butternut



Pumpkin



Acorn



Spaghetti



Delicata

Seeking Seed: Definitions

Open-Pollinated

Open pollination refers to pollen transfer via wind, insects, birds, bats, or humans. This leads to plants adapting to local conditions, climates, or developing desirable traits such as insect resistance or tastier fruit. Plants can only exchange pollen with plants of the same species. Our ancestors developed the open-pollinated varieties we know and love today through continual selection and seed saving from plants exhibiting desirable traits. Through time the varieties were stabilized, and will breed true-to-type (the seeds of the plant will be like the parent plant).

Heirloom

There is not a definite definition for heirloom. Heirloom vegetables are those developed using traditional plant breeding, and a minimum “age” for a variety to be an heirloom is pre-world war II. Other seed catalogs dedicated to preservation consider heirlooms to be seeds with a documented history—stories, letters, and such that show how the seed was passed down from generation to generation.

Hybrid

You’ve more than likely seen the F1 symbol on a seed packet. This denotes that the seed inside is produced from two inbred parental lines. So two different “purebreds” are crossed, and their offspring is a hybrid. The seed you hold, once it grows into the vegetable you desire, will produce its own seeds. These all hold unique sets of genes. So, you will not be able to produce the same plant you had before—it does not breed “true to type”.

The F1 generation is super strong and possesses many desirable traits. However, the traits of the hybrid will not be carried on into the next generation.



Understanding seeds is a first step in understanding reproductive plant biology and how to grow and save your own seed.



Isolating different pepper plant varieties in cages for true-to-type seed.

FOOD FOR THOUGHT

Some farmers avoid hybrid seeds. Seed companies that produce hybrid seeds have the ability to keep the parent plants secret. Since hybrid seeds cannot be saved, they are continually needing to buy seed and often do not know the parents plant.

Seeking Seed Cont.

GMO

A genetically modified organism has been “modified” to include a gene or genes from a foreign source. As plants only breed with other plants of the same species, it requires forceful insertion of foreign genetic material in a laboratory, using various biotechnology techniques.

Biotechnology claims to be the answer to global food shortage, promising plants genetically modified to produce more, and produce better. The problem is, there is not extensive testing on how species with forcefully inserted genetic material will act overtime, or how these various genes will react in an animal or human body. For example, a soy bean with inserted brazil nut genes could potentially cause allergic reactions in people with tree nut allergies.

Biotechnology is extremely expensive, and the seed costs more for farmers. Often the seeds require specific and increased use of dangerous herbicides and pesticides. Weeds are beginning to build a resistance to these chemicals and are becoming ‘Super Weeds’.

Most garden vegetable seeds available to backyard growers are not GMO. However, due to lack of regulation or labeling requirements, there is no way to know for sure without expensive genetic testing from third parties. This is a serious issue, as farmers who grow organic seed crops to catalogs may actually be selling seed contaminated with GMO if their crops have crossed with the GMO crops of a neighboring farm.

Treated

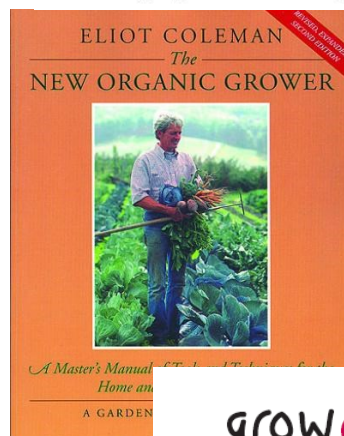
Seed coated in various chemical mixes. Fungicides and pesticides can coat seeds, protecting against common fatalities to sprouting seeds. Primers of various chemical mixes coat seeds to support germination in temperature and moisture extremes. Treated seed is required to be dyed a bright color so that it is recognizable. Treated seed is not permitted for organic growing.

WHERE CAN I BUY SEED?

Many seed companies exist that specialize in regionally-adapted varieties, organic seed, heirloom seed, and more! So many varieties beyond what you see on the shelf at Lowes exist! Seed companies also sort their offerings by heat tolerance, cold tolerance, and insect and disease resistance. Check out the sources page for some of our favorite companies. You can order online or through the mail, after thumbing through your seed catalog.



What to Buy & Where



Recommended Reads

Anything Eliot Coleman has ever written is an excellent source, he is an organic gardening guru. Start with *The New Organic Grower* for info from everything to sight selection to crop rotation.

Seed to Seed by Suzanne Ashworth details plant biology, reproduction, flower parts, and how to save seed from all our cultivated vegetable varieties.

The Organic Seed Grower by John Navazio takes seed saving to the next level, and is catered towards farmers and gardeners growing seed for market. Compelling info on the history of seed saving, catalogs, and the history of the vegetables we know and love.

Helpful Websites

www.organicgardening.com provides tips for home growers based on their *Organic Gardening* magazine. You can find information on every aspect of gardening from compost to seed saving to recipes for the veggies you grow. The site also offers forums where you can ask questions and get answers from other gardeners!

www.ext.vt.edu is your source for information from Virginia Cooperative Extension. This site is especially helpful because they specialize in understanding the climate and growing season of Virginia.

www.almanac.com offers information regarding weather patterns and seasonal cycles that is helpful for planning your garden. This site will help you understand how to use nature to your advantage.

Growveg.com has as garden planning program. It costs about \$25 for the year, but you can sign up for a month-free trial and come up with a great



Virginia Cooperative Extension

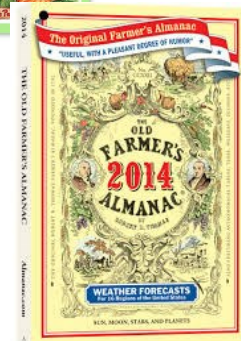
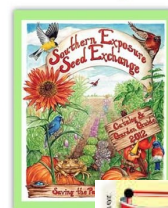


VirginiaTech
Invent the Future
www.ext.vt.edu



ORGANIC Gardening

Southern Exposure Seed Exchange



Grow Your Own SOURCES FOR ORGANIC AND UNTREATED SEED

The following catalogs carry a fair number of Organic seeds, and are all free.

Many of them also contain valuable crop growing information

PLAN TO ADD THESE TO YOUR FARM LIBRARY

Johnny's Selected Seeds 1-877-564-6697 www.johnnyseeds.com

An excellent selection of seeds for commercial growers – some varieties are available as Organic seed, almost all are available as untreated. Great growing information for all crops.

Also a great source for garden tools and supplies.

Fedco Seeds 1-207-873-7333 www.fedcoseeds.com

A wide selection of seeds – many “organic” – plus potatoes and organic growing supplies.

High Mowing Seeds 1-802-472-6174 www.highmowingseeds.com

100% certified organic seeds.

Seeds of Change 1-888-762-7333 www.seedsofchange.com

100% certified organic seeds. Ask for the “Professional Seed Catalog”

Seed Savers Exchange 1-563-382-5990 www.seedsavers.org

Mostly organic seeds – many unusual and all open pollinated varieties. Colorful catalog.

Baker Creek Heirloom Seeds 1-417-924-8917 www.rareseeds.com

Delightful collection of unusual and rare, all open pollinated seeds.

Territorial Seed Company 1-800-626-0866 www.territorialseed.com

Wide selection of unusual and standard vegetable and flower seeds. Some organic seed, but most is not – be sure to insist on untreated seed.

Southern Exposure Seed Exchange 1-540-894-9480 www.southernexposure.com

Heirloom and open pollinated vegetable seeds – many organic, all untreated.

Tomato Growers Supply 1-888-478-7333 www.tomatogrowers.com

Totally Tomatoes 1-803-663-0016 www.totallytomato.com

These two catalogs carry a wide range of tomato, pepper and eggplant seeds. Be sure to insist upon untreated seeds when ordering or inquiring about varieties.

**Appalachian Sustainable Development
P1096 Ole Berry Road, Abingdon, VA 24210 276-623-1121 www.asdevelop.org**

Seed & Plant Spacing

Crop	Planting Distance in Feet or Inches	Row Spacing in feet or inches	Approximate yield per 10 feet of row	Approximate no. of row feet to plant per person	Transplants or seed required per 10 feet of row
Asparagus	18"	48-60"	3 lbs	15-20'	7-8 crowns
Beans, bush	1-2"	24-36"	3-5 lbs	20-50'	1 oz
Beans, pole	4-12"	36-48"	6-10 lbs	10-30'	1 oz
Beans, lima	3-4"	24-36"	3-5 lbs	20-30'	1 oz
Beets	2-3"	12-24"	8-10 lbs	10'	1/8 oz
Broccoli	12-24"	24-36"	4-6 lbs	10-20'	5-8 or
Brussels Sprouts	18-24"	30-36"	3-4 lbs	10'	5-7 or
Cabbage	12-18"	30-36"	15-40 lbs	10-15'	5-8 or
Carrots	1-2"	15-30"	7-10 lbs	10-20'	1/5 oz
Cauliflower	12-24"	24-36"	8-10 lbs	10-15'	5-8 or
Chard, Swiss	6-12"	18-30"	8-12 lbs	5-10'	1/5 oz
Collards	12-24"	24-36"	8-15 lbs	10-15'	5-7 or 1/10 oz
Cucumbers	12-18"	48-72"	8-10 lbs	15-20'	1/10 oz
Eggplant	18-24"	30-42"	10-12 lbs	3-6'	5-7 or
Kale	6-18"	18-36"	4-8 lbs	10-15'	6-10 or 1/10 oz
Kohlrabi	4-6"	12-36"	4-8 lbs	5-10'	1/10 oz
Leeks	2-6"	12-30"	10-20 lbs	3-6'	1/10 oz
Lettuce (Bibb)	6-10"	12-24"	4-8 lbs	15-20'	1/40 oz
Lettuce (leaf)	3-6"	12-18"	5-10 lbs	10-15'	1/40 oz
Muskmelons	24-36"	60-90"	15-25 lbs	8-12'	3-5 or 1/8 oz
Mustard	2-4"	18-30"	3-6 lbs	5-10'	1/10 oz
Okra	8-18"	36-48"	5-10 lbs	5-10'	7-10 or 1/5 oz
Onions (sets)	2-4"	12-24"	7-10 lbs	15-25'	30-60
Peas (English)	1-3"	12-30"	2-6 lbs	40-60'	1/2 oz
Peppers	12-24"	30-36"	5-18 lbs	5-10'	7-May
Potatoes, Irish	10-18"	24-42"	10-20 lbs	75-100'	1 lb
Pumpkins	2-4'	5-8'	10-20 lbs	10'	1/20 oz
Rutabaga	3-6"	15-30"	8-12 lbs	5-10'	1/8 oz
Sweet Corn	6-12"	24-36"	7-10 lbs	40-60'	1/2 oz
Spinach	3-6"	15-30"	4-6 lbs	30-40'	1/8 oz
Squash, summer	18-36"	36-60"	20-80 lbs	5-10'	1/10 oz
Squash, winter	2-4'	3-10'	10-80 lbs	10'	1/10 oz
Sweetpotatoes	12-18"	36-48"	8-12 lbs	75-100'	10-Jul
Tomatoes	18-36"	36-50"	15-45 lbs	10-15'	7-Mar
Turnips	2-3"	12-24"	8-12 lbs	10'	1/8 oz
Watermelons	3-4'	5-10'	8-40 lbs	10-15'	1-2 or 1/2 oz

When To Plant

Name	Cool Crop	Warm Crop	When to Plant	Days until Harvest
Bean (bush)	No	Yes	May-August	55
Bean (pole)	No	Yes	May-June	60
Beets	Yes	Yes	March-July	45-60
Broccoli	Yes	No	May-August	70-120
Brussels Sprouts	Yes	No	April-June	90-120
Cabbage (early)	Yes	No	April-June	55-75
Cabbage (main season)	No	No	May-June	70-90
Cantaloupe	No	Yes	May-June	65-100
Carrots	Yes	Yes	April-August	65-90
Cauliflower	Yes	No	May-June	60-80
Corn	No	Yes	May-July	60-100
Cucumber	No	Yes	May-July	50-75
Eggplant	No	Yes	May	80-100
Kale	Yes	Yes	April, August	55-60
Kohlrabi	Yes	No	April-May	50-70
Leek	Yes	No	April-May	75-150
Lettuce	Yes	No	April-September	40-90
Onion (from sets)	Yes	No	April-May	50-70
Peas (edible pod)	Yes	No	April-May; July	70
Peas (shelling)	Yes	No	April-May; July	60-90
Peppers	No	Yes	May-June	60-85
Potatoes	Yes	Yes	April-June	90-150
Pumpkin	No	Yes	May-July	90-110
Radish	Yes	No	April-September	20-75
Spinach	Yes	No	April-May, September	45
Squash (summer)	No	Yes	May-August	45-50
Squash (winter)	No	Yes	May	85-12
Tomato	No	Yes	May-June	60-100
Watermelon	No	Yes	May-June	75-120