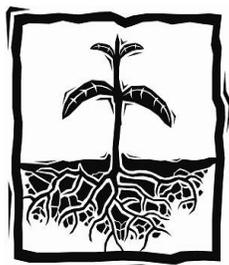


Vegetable Gardening in Colorado

This guide was created to help new vegetable gardeners get off to a good start. It tries to answer basic questions about weather, soil, organic practices, planting and maintaining your plot, and dealing with pest and disease issues. For additional information, recommended books and websites have been included at the end of the booklet. Happy Gardening!



When it comes to gardening, every climate and area has its own unique challenges. Colorado's Front Range is no exception. Low yearly rainfall rates, heavy clay soils, and rapidly shifting weather all combine to make growing vegetables here an exercise in problem-solving.

The Denver area has low humidity, high summer temperatures, and drying winds, all of which makes consistent watering a necessity. The soil contains a large amount of clay, which can make it heavy, compacted and difficult to cultivate. Although many native plants find a way to root and prosper here, most vegetables won't grow well without soil amendments.

Denver Gardening Stats

- Zone 5 (winter temperatures can reach -20 degrees F)
- Average Last Frost Date: May 10
- Growing season: Mid-May to Mid-September (100-120 days)
- Annual Rainfall: approximately 15 inches (semi-arid climate)
- Soils typically clay-heavy and slightly "salty"
- Soil pH: 7.0 (slightly alkaline, a pH of 6.4 is ideal for most vegetables)

1. Soil Amendments

The health and nutritional value of a vegetable is directly related to the health and nutrition of the soil it was grown in. In other words, your tomatoes are what they eat. Taking the time to improve the fertility of the soil prior to planting not only improves the quality of the vegetables, but can help prevent disease and insect issues and increase the size of the harvest.

Denver's soil tends to exhibit clay structure, which is too heavy and fine in texture for many plants to grow well in. Clay soils drain poorly (water moves too slowly through the soil), and lack good aeration (which is necessary for root growth). To fix, or amend this, add compost, manure, topsoil or "Clay-buster" to the soil. Ideal soil composition is dark-colored and fluffy. The darker the soil, the higher the proportion of organic matter it contains. Dark-colored, "fluffy" soil is well-drained, easy to work, and has the right amount of air space for healthy plant roots.

Clay soil is best worked when it is slightly damp. Digging soil that is either water-logged or bone-dry will be very difficult and can result in even more compaction than there already was.

Organic compost is a great place to start when amending the soil. Cover new plots with a thick layer of compost (several inches deep), then mix it into the existing soil. Adding several bags of a "Clay-buster" product is also suggested if clay soil structure is a concern. Topsoil also helps improve soil texture, and well-rotted (organic) manure improves texture and adds nutrients. If the plot has been cultivated before, add a smaller amount of compost or manure.

Types of Soil Amendments

Compost: a natural, soil-like fertilizer made of degraded plant material and food scraps.

"Clay-buster": a type of compost specially formulated to help break up clay soils. It can include rice hulls, coffee bean hulls, pumice, or any well-degraded natural material that helps keep soil particles from cementing together and allows water to drain more freely.

Top Soil: the upper layer of a soil, usually dark-colored and rich in organic material.

Manure: degraded animal waste. Cow manure is typically the easiest to find, but chicken, horse, or sheep manures are other options. Whatever type you choose, try to find an organic source. The nutrient content will vary depending on its source. Manures should be aged for at least one year—fresh manure is high in ammonia and can burn plant roots.

2. Working the Soil

Double-Digging

One method of improving the soil is double-digging. It is very labor intensive, but it simultaneously breaks up compaction, increases fertility, and improves soil structure and drainage deep into the soil. To double-dig a bed, dig a trench to a depth of one foot and set it aside. Then loosen the next foot of soil and add compost on top of it. Dig another one foot-deep trench next to the first, shoveling that trench's soil into the first trench. Keep going until you reach the last trench, and finish it with the first trench's soil. Now, water will drain neither too slowly or too quickly, plants will be able to root deeper, and planting will be much easier.



Roto-tilling & Raised Beds

Roto-tilling performs a similar function, but only loosens the first foot of soil, so there will be less improvement in drainage. Raised beds are another way to improve soil texture and drainage, while bypassing some of the heavy work of double-digging. For the best drainage with raised beds, work the existing soil underneath to loosen it before filling the beds with new soil. Any depth of raised bed works, as long as the soil underneath is loose enough for roots to grow into it.

Paths & Stepping Stones

Once you have loosened and amended the soil, avoid stepping in the planting space as much as possible. Well-placed paths or stepping stones can help prevent future compaction.

Living Soil

No matter how you choose to improve your soil, you will never really be "finished" with it. Soil is a living, dynamic thing. In nature, nutrients, minerals and organic matter are constantly being added to the soil. In a garden-setting,

however, we are trying to grow many different things in a small space, which uses up soil nutrients faster than nature can rebuild it.

3. Cover Crops

Some plants add nutrients to the soil (soil-builders), while others remove them (heavy-feeders). In order to grow well, heavy-feeders need to take-up large amounts of nutrients from the soil. Unless you make up for this loss by adding compost, manure or other amendments, or by growing a cover crop and letting the land “rest”, the soil could be depleted in just a few years.

Heavy-feeders: tomatoes, peppers, pumpkins, squash, cucumber, melons and corn.

Soil-builders: beans, peas and other members of the legume family, also several grasses and grains.

Planting cover crops can be an effective way of rebuilding the soil naturally. Cover crops (also called green manure) suppress weeds, add nutrients to the soil, and help control pests and diseases.

Summer cover crops are planted in the spring and worked into the soil in the fall. This method is best for large gardens where you can afford to sacrifice valuable planting space for a season.

Winter cover crops are planted in the fall and worked into the soil in the spring, prior to planting, making them better candidates for smaller plots. Plant winter cover crops early enough in the fall to allow for 4 weeks of growth before cold weather. In the spring, work the crop into the soil before it goes to seed, at least 3 weeks before you plant. Don't wait too long to plow the crop under—if it goes to seed it could pop up all over the garden.

Grass and grain crops provide plenty of organic matter, while legume cover crops (pea family) help fix nitrogen in the soil.



Clover

Cover Crops to Try:

- Crimson Clover
- Annual Rye
- Oats
- Buckwheat
- Field & garden peas

4. Organic Soil Fertility

The Community Garden is an organic garden, so any fertilizer or amendment you use in your plot needs to come from an organic source. There is a lot of confusion about how to define organic and about what the difference between organic and natural is. Organic and natural fertilizers are similar in composition—they are both made of natural materials rather than synthetic chemicals. To be *organic*, however, the natural materials used must also have a guarantee of purity (contain no traces of chemical residue). Many companies now have organic product lines, and there are many completely organic brands as well. If you have any doubt, read the label and look for a USDA Organic symbol on the package, which signifies that the ingredients have been certified organic by the Department of Agriculture.

The main ingredients of most fertilizers are Nitrogen, Phosphorus and Potassium (the “N-P-K” listed on the front of fertilizer bags). In addition to N-P-K, plants also need the secondary nutrients, and a large handful of micronutrients. Iron is often found to be deficient in Colorado soils, while Phosphorous levels are typically high. A common gardening mistake is to think that the big 3 macronutrients are all your plants need, and that if a little fertilizer is good, more is better. In fact, plants need many other nutrients to reach their full potential, and over-fertilizing can lead to weakened plants and water pollution.



Macronutrients:

- Nitrogen promotes green, leafy growth
- Phosphorous helps with root growth and flowering
- Potassium is necessary for overall plant health

Secondary Macronutrients:

Calcium, magnesium and sulfur

Micronutrients:

Boron, copper, iron, chloride, manganese, molybdenum and zinc

Table of Organic Fertilizers

From Colorado Extension

| Organic Fertilizer | NPK | Release Time | Pros | Cons | Application per 100 square feet |
|----------------------------|------------|----------------------|--|--|--|
| Alfalfa meal or pellets | 2-1-2 | 1-4 months | Available at feed stores | May contain seeds | Till in 2-5 pounds |
| Corn Gluten Meal | 9-0-0 | 1-4 months | High in Nitrogen | Germination inhibitor, some are GMOs | Till in 2-4 pounds |
| Cottonseed meal | 6-0.4-1.5 | 1-4 months | High nitrogen | Pesticide residues, most are GMOs | Till in 10 pounds |
| Soybean meal | 7-2-1 | 1-4 months | High nitrogen, available at feed stores | Almost half of the conventionally grown soy is GMO | 8 pounds |
| Bat Guano-High Nitrogen | 10-3-1 | 4+ months | Stimulates soil microbes | cost | 5 pounds |
| Bat Guano-high Phosphorous | 3-10-1 | 4+ months | Stimulates soil microbes | cost | 5 pounds |
| Blood meal | 12-0-0 | 1-4 months | Available at feed stores | Can burn | 5-10 pounds |
| Bone Meal | 3-15-0 | 1-4 months | Highly plant available form of phosphorus | cost | 10 pounds |
| Feather Meal | 7-12% N | 4+ months | Long term fertilizer | Cost versus speed of N release | Till in 2.5 to 5 pounds |
| Fish Emulsion | 5-2-2 | 1-4 months | Adds needed micronutrients | Some have foul smell | Mix 6 tablespoons per gallon of water |
| Fish Meal | 10-6-2 | 1-4 months | N and P source | Heat processed | Till in 5-10 pounds |
| Fish Powder | 12-0.25-1 | Immediate to 1 month | Adds micro-nutrients | Heat processed | Till in 1-2 oz. |
| Kelp Meal | negligible | 4+ months | Adds micronutrients | Insignificant NPK value | Till in 1 pound |
| Kelp Powder | 1-0-4 | Immediate – 1 month | Adds micronutrients | Insignificant NPK value | Mix ¼ - ½ teaspoon/ gallon of water |
| Liquid Kelp | Negligible | Immediate- 1 month | Adds micronutrients plus help plants with stress | Insignificant NPK value | Mix 1-2 TBS/ gal of water for foliar or mix ¼ - ½ tsp/ gal water |

5. Compost Basics

Compost can be defined as a natural soil fertilizer that adds nutrients to soil and improves soil texture. It is made up of organic matter that has been broken down by insects and bacteria to create *humus*, a rich, dark brown material that resembles soil. Compost has been shown to increase worm and microbe activity in the soil, increase yields, and even suppress soil diseases. It's also a great way to put table scraps and yard waste to good use.

The process of making compost can be as simple or as scientific as you want it to be. To achieve the best nutrient balance, it's composed of 1 part "brown" material to 2 parts "green" material.

“Browns”- dried leaves, wood shavings, small twigs and coffee grounds.

“Greens”- fruit and vegetables scraps, fresh grass clippings, garden waste and weeds that have not gone to seed.

It can take from 6 months to a year to get finished compost, depending on how broken down the materials already are and how many worms, etc. are working in the pile. Keeping the compost slightly moist and turning it with a fork every few weeks will help speed up the process.

Note: do not put meat or dairy products in compost—it attracts rodents and will increase the odor of the compost pile.

6. MULCH (your new best friend)

Mulch is defined as a protective covering of (usually) organic material placed on top of the soil. There are many types of mulch used in landscaping, but for vegetable gardening, compost and straw are the most commonly used.

Benefits of Mulch:

- Reduces evaporation
- Regulates soil temperature
- Prevents erosion and run-off
- Suppresses weeds
- Enriches the soil (compost)
- Keeps produce clean/off the ground (straw)

When growing from seed, wait to apply mulch until seeds have germinated and established themselves, leaving space around the plants. You should also leave a little space between mulch and the stems of newly planted seedlings.

Mulch is also useful for keeping weeds down and reducing compaction on paths and in unplanted areas.

Note: when using straw as mulch, be sure it's seed-free straw—if hay is used, seeds from it can germinate and cover the soil with an unintended crop.

7. Planting Basics

Planting Basics

The “last frost” date for the Denver area is May 10th, but keep in mind that this is just an average and every spring is different. Make sure that the soil has warmed enough and is sufficiently dry before planting seeds or seedlings.

Soil Temperature

Soil temperature is the key to estimating when to plant. In order for seeds to germinate, the soil must have reached a minimum temperature. This is different than air temperature—in early spring, for example, you can have a very warm day but still have frozen soil. Soil holds heat once thawed, so on a cool day it can be warmer than the air above it. The temperature needed varies from plant to plant. To test your soil temperature, insert a soil thermometer into the soil at a depth of about 4 inches.

Seed Planting Tips

- Read seed packet for specific information about sowing depth
- General Rule-of-thumb: planting depth is double the size of the seed
- Keep evenly moist until seeds have germinated and grown their first set of “true” leaves
- seedlings may need to be thinned after germination to insure adequate space for each plant and prevent diseases

Seedling/Transplant Planting Tips:

- Water seedlings before planting. This will keep the root mass together, and help the plant settle into the soil.
- Dig hole slightly bigger than the root ball of seedling (working the soil around the plant gives the roots a head start)
- Firm (but don't pack) the soil around the plant
- Plant seedling at the same soil depth it was in its container
- Water seedlings after planting to remove air pockets and settle soil
- Keep evenly moist until established

Choosing Seeds and Seedlings (“right plant, right place”)

The variety of a plant can affect how well it grows, how much it produces, how much sun and water it needs, and its ability to withstand insect pests and diseases. By choosing varieties well-suited to the local climate, you can increase your chances of having healthy plants. Additionally, some crops grow best from seed, while others grow well from transplanted seedlings.

Seeds versus seedlings

Seedlings

The best candidates for transplanted crops are plants that tolerate root disturbance and benefit from a jump on the season. These include broccoli, Brussels sprouts, cabbage, cauliflower, celery, eggplant, leeks, onions, parsley, peppers, and [tomatoes](#). The main downside of seedlings is their cost, which is significantly higher than a packet of seeds.

Seedlings need to be “hardened-off” prior to planting. Plants grown in an ideal environment, like a greenhouse, don’t have the ability to withstand harsh wind, bright sun, or changes in temperature and can go into shock. To prevent this, place them outside for a few hours a day for several days before planting, gradually increasing hours each day. On the first day, place the seedlings in the shade so that they will not be scorched or dried out by the sun.

Seeds

Some plants grow best when planted directly into the garden soil. Large-seeded plants like corn, melons, squash, beans and peas prefer not to have their roots disturbed. Root crops, like carrots, radishes and potatoes, also do not transplant well and must be planted from seed. Fast-growing plants like lettuce and spinach are also good direct-seed options. One of the benefits of planting from seed is that there are many more varieties available by seed than there are by seedling. This can be especially true of new, rare or heirloom varieties.

8. Plant Varieties

Heirlooms versus Hybrids:

Heirloom Varieties

Generally, “Heirloom” means a variety that is at least 40 to 50 years old, that is no longer available in the commercial seed trade, and that has been preserved and kept true in a particular region.

Heirloom Pros:

- seeds can be saved from year to year
- often have superior flavor
- unique, unusual plants

Heirloom Cons:

- disease susceptibility
- fruits can be thin-skinned & vary in size and shape

Hybrid Varieties

Hybrids are made by crossing two different varieties, the offspring of which produce a new, uniform seed variety with specific characteristics from both parents (like early-maturity from one parent and disease resistance from another).

Hybrid Pros:

- uniform fruit
- disease resistance
- reliable productivity

Hybrid Cons:

- seed must be purchased yearly
- some varieties bred more for shipping than flavor

Other Variety Considerations:

Determinate versus Indeterminate Tomatoes:

The fruit of determinate tomato plants ripens all within a few weeks, making them good candidates for preserving. Indeterminate plants ripen a few tomatoes at a time until frost which is ideal for fresh, daily use.

Long Day versus Short Day Onions:

Onions are sensitive to the length of night, which triggers bulb growth. Look for “long day” or “day neutral” varieties that will grow well during Colorado’s long day summers.

Varieties to Try

(from Pike’s Peak Urban Gardens)

Asparagus: Jersey varieties

Beans: Kwintus Pole, most bush varieties (Blue Lake, Tendergreen), Kentucky Wonder Pole

Beets: Detroit Dark Red, Bulls Blood, Chioggia

Broccoli: Premium Crop, Pacman, Early Dividend

Cabbage: most all, try Chinese varieties

Carrot: Mokum, Ya Ya, Ka

Swiss Chard: Ruby, Rhubarb, Bright Lights, Neon, Fordhook

leidoscope, Nelson, Danvers Half Long, Burpee A#1, Sugarsnax

Corn Sweet: Bodacious, Ambrosia

Cucumber: Cool Breeze, burpless varieties

Garlic: Spanish Roja, Inchelium Red, Chesnok Red, Chet’s Italian

Kale: Red Russian, Redbor

Lettuce: Buttercrunch, romaines, leaf lettuces, mesclun mixes

Onion: Candy, SuperStar White, Red Candy, Lisbon White Bunching, Copra, First Edition, Red Zeppelin

Peas: Sugar Ann, SugarSnap, Oregon Sugar Pod(snow pea), Garden Peas (Maestro, Wando and Marvel),

Pepper Sweet: Carmen, Green Bell (most varieties), Fooled You Jalapeño

Pepper Hot: Mexibell, Anaheim, Big Chile, Jalapeño, Mucho Nacho, Garden Salsa, New Mex Joe Parker

Potato: Russet, Yukon Gold, Red Norland

Radish: Cherry Belle, French Breakfast

Spinach: Giant Noble, Tye, Space, Melody, Bloomsdale

Squash Summer: Magda, zucchini (most varieties), yellow, crookneck,

Squash Winter: Early Butternut, Table King or Table Ace Acorn, Buttercup, Spaghetti

Tomato: Big Beef, Sweet Million or Sweet 100’s, Celebrity, Fantastic, Early Girl, Better Boy, Mortgage Lifter, Sweet Baby Girl

9. Companion Planting

In nature, ecosystems evolved over time to sustain balanced populations of plant and animal life. When we mimic these diversified systems in the garden, we can improve plant health, prevent insect and disease issues from taking over, and even increase the harvest. Other benefits of companion planting include efficient use of space and attracting beneficial insects into the garden. This is accomplished naturally by combining plants that protect or “like” each other, rather than using chemical fertilizers or pesticides. Some plant relationships are one-sided, with only one of the plants gaining from its close proximity to the other, while other combinations are mutually beneficial. Additionally, some plants only seem to help with one specific issue (like protecting against a particular insect pest), while others seem to help many plants in multiple ways.

Companion planting is as old as agriculture itself, but we’re only beginning to understand the science behind why it works. Some plants give off chemicals that are offensive to insects, keeping them away from the vulnerable plant. For example, the strong scent of a marigold flower acts as a deterrent of insect pests for tomatoes, strawberries, potatoes & roses.

Growing flowers in with your vegetables will attract beneficial insects (pest predators) into your garden, naturally regulating pest populations. Lacewings, spiders and lady beetles are common beneficial insects. Flowers will also attract birds, another source of help with insect problems.

Flowers to try in your garden:

Calendula
Cosmos
Marigold
Nasturtium
Sunflowers
Zinnia



Calendula

Some plants benefit from being grown quite close together, or can even be grown *on* each other, making the most of every inch of soil. The roots of carrot and tomato plants occupy different levels in the soil, so they can be planted close without disrupting each other. In the Iroquois tradition, corn, beans and squash were always grown together. In this mutually beneficial relationship, the corn provides a natural trellis for the beans to climb, while the beans act as an anchor for the corn, keeping it from tipping over in the wind. Additionally, the beans “fix” the nitrogen in the soil, making it available for the corn to take-up. The squash vines form a living mulch, shading the soil and preventing evaporation and erosion, increasing the ability of *all* of the plants to survive.

10. Succession Planting

(From Colorado State Extension)

Some plants grow best in the cooler weather of spring (cool season crops), while others need in summer heat (warm season crops).

Cool season vegetables grow best in the moderate temperatures of spring, and lose quality once hotter weather comes. They are often replaced with warm season vegetables in the summer, allowing you to harvest two crops from the same piece of soil. Sometimes a third crop can be planted in the fall, giving you a second cool season harvest. This method is called Succession Planting, and it's a great way to get the most out of your garden space and growing season.

Warm and Cool Season Crops:

Hardy Cool Season Vegetables:

Broccoli, Cabbage, Kohlrabi, Onions, Lettuce, Peas, Radish, Spinach, Turnips

- Can be planted 2-4 weeks after the last frost date
- Will grow in temperatures as low as 40 degrees
- Can withstand a light frost

Semi-hardy Cool Season Vegetables:

Beets, Carrots, Cauliflower, Parsley, Parsnips

- Can be planted 0-2 weeks after the last frost date
- Will grow in temperatures as low as 40-50 degrees
- Slightly tolerant of light frost

Tender Warm Season Vegetables:

Beans, Celery, Corn, Cucumbers, New Zealand spinach, Summer Squash

- Require temperatures above 60 degrees, but prefer 70-95 degrees
- Intolerant of frost

Very Tender Warm Season Vegetables:

Cantaloupe, Eggplant, Peppers, Winter Squash, Pumpkin, Tomato, Watermelon

- Grow best in temperatures of 70-95 degrees
- Temperatures below 55 degrees may stunt growth
- Very intolerant of frost, also harmed by cold winds

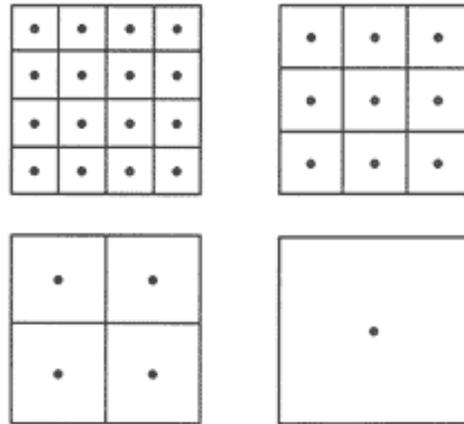
11. Space-saving Planting

Block Planting:

Also called close or wide-row planting, block-style planting can dramatically increase yields compared to traditional row-style layouts. The basic idea is to eliminate wasted space and unnecessary paths by planting vegetables in blocks instead of long, single rows. Limit the width of the blocks to about 3 feet so the centers can be reached easily from either side. Plant crops an equal distance from each other within the block.

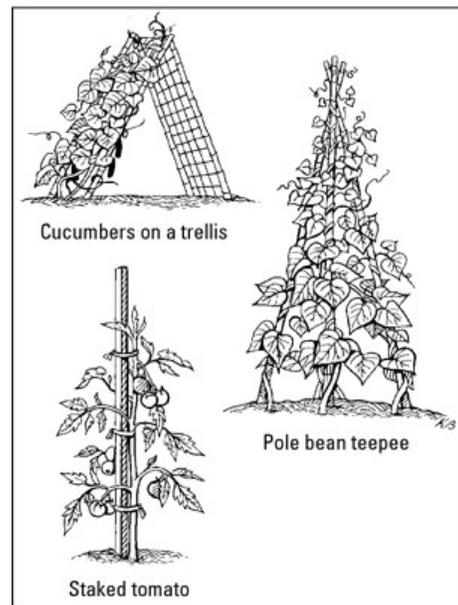
Square Foot Gardening:

Another space-saving, crop-increasing method, square foot gardening takes block planting even further, by dividing planting space up into 1 foot square increments. This method is especially good for when you want just a few of each crop, rather than huge harvests. For larger crops, like cabbage, one plant will take up the entire 1 ft sq. space. Smaller crops, like carrots, can be placed closer together, so you could grow 16 of them in a 1 ft sq block.



Vertical Gardening

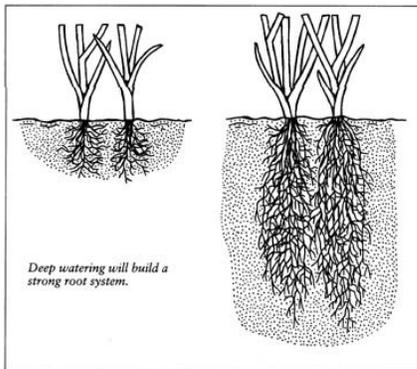
Vining plants tend to sprawl and take up a lot of square footage if left to grow on the ground. To grow more in a small space, stake them, or using a trellis or cage to train them to grow upright. It can also discourage flower and fruit rot, provide better air circulation to the plant, and improve yields. Peas, beans and tomatoes typically need some type of support, and many types of trellis systems will work well. Whatever you choose, keep in mind that vertical structures in the garden should not exceed 4 ft in height.



12. Watering Guidelines

Efficient water use benefits the environment, but it can also benefit the garden. Deep, consistent watering is more effective than constant "sprinkling". It's hard to tell how much water is actually getting to the plant's roots, because we only see the surface of the soil and so much can be lost through evaporation. Additionally, it's easy to under-estimate how long we've been watering, especially when standing out in the hot sun.

Most vegetable plants need about 1 inch of water a week. To test how much water you're applying to your plot, try placing a few shallow cups in the soil around the plants and water as usual. By measuring how much was collected in the cup, you can better gauge how long to water.



Denver Water watering restrictions apply to *lawns*, but some of their water-conserving guidelines are practical for the garden as well. They recommend avoiding watering during the hottest parts of the day and during times of high wind, in order to reduce evaporation. Up to 50% of water can be lost to evaporation between 10am-6pm, especially if it's hot or windy.

Watering Tips:

- Best times to water: mornings (7-10am) and evenings (6-8pm)
- Keep newly seeded areas and newly planted seedlings consistently moist until germinated or established.
- Use mulch where able to decrease run-off and evaporation
- Focus water towards plant's roots, not their leaves (watering foliage can encourage disease growth and increases evaporation)
- Water seedlings both before *and* after planting to: keep root mass together, remove air pockets & encourage rooting.
- Dig shallow trenches, furrows or "moats" around plants, filling them with water 2-3 times, allowing the water to soak into the soil each time.
- Keep in mind that raised beds and planting mounds will drain faster and require more frequent watering.



13. Weeding and Thinning

Weeding

"A weed is any plant growing in the wrong place." –Luther Burbank

- Many weeds, such as dandelion and purslane are edible—try tossing them in a salad instead of the compost.
- Avoid watering paths and any other unplanted garden spaces to decrease weed growth in those areas.
- Mulching around your plants can help keep weeds from germinating.
- If a weed has already gone to seed, don't compost it—the compost may never get hot enough to kill off the seeds, resulting in weed-filled compost.

Thinning

Crops like lettuces, carrots, spinach and radishes, are often sown by sprinkling the tiny seeds along a row. Most likely, more plants will germinate than there is room for. To prevent the plants from crowding each other as they mature, you will need to thin the seedlings while they're still small. Read the seed packet for each variety for specific directions on spacing.

14. Basic Integrated Pest Management (IPM)

Diagnosing plant problems can be very confusing. Plant issues can be caused by nutrient deficiencies, diseases, fungi or insects. Integrated Pest Management (IPM) is a systematic way of preventing, diagnosing and treating plant problems. The goal of IPM is to use a combination of tactics to keep pest populations at non-damaging levels.

The first step is to narrow down the source of the problem. A single symptom could indicate several different issues and those issues could need completely different treatments. Yellowing leaves, for example, could indicate over-watering, under-watering, nutrient deficiency or a host of other issues, so it's important to look at additional factors in order to figure out what the problem is. Note all symptoms (evidence of insects, etc.) to determine whether it's a cultural problem (needs more water, etc.) or an insect or disease problem. Once you have the source of the problem narrowed down, it will be easier to identify the specific culprit, making your treatment much more likely to be effective.

To solve a cultural problem, you might need to:

- Water more/less
- Add fertilizer or specific nutrients to the soil
- Move the plant to a site with more/less sun exposure
- Choose a different plant for that site next season

To solve a pest problem start by trying:

- physical pest controls/removal
- homemade organic pesticides
- organic pesticides

Pest and Disease Prevention:

Many pest & disease problems can be prevented or controlled without chemicals.

- Choose plants that are adapted to Colorado's climate and growing conditions.
- Don't bring diseased or infested plants into the garden or move them around within the garden.
- Space and thin plants properly to ensure good air flow.
- Choose disease-resistant varieties.
- Some crops can be planted strategically to miss times of high pest populations.
- Remove heavily diseased or infested plants from the garden to prevent spreading it to other plants.
- Clean tools to prevent spreading diseases.

Physical Pest Controls:

When a pest is taking over your plant, try simple and safe controls before going to organic pesticides.

- Spray pests off the plant with a blast from a hose
- Handpick pests (like caterpillars) and drop them into soapy water
- Use "beer traps" (cans with an inch or two of beer in them, buried to soil level) to catch and drown slugs.

15. Organic Pesticides

If prevention didn't cut it, and physical controls didn't work, the next thing to try is an organic pesticide. Homemade mixtures are generally milder than commercial applications and are made out of simple, natural ingredients.

Organic Homemade Sprays

Garlic Spray: puree 15 garlic cloves and one pint of water in a blender, strain the mixture through cheesecloth into a clean spray bottle, and apply to the tops and bottoms of all leaves. Re-apply every 3-4 days until problem is eliminated.

Dish Soap Spray: add a few drops of organic dish soap to a spray bottle filled with water. Spray directly on pests and affected leaves every few days until problem is eliminated. Solution should be about 2% dish soap—a concentration much higher than that can cause leaf damage. This spray is best used on soft-bodied insects like aphids, mealy bugs and spider mites.

Hot sauce Spray: red pepper is an irritant to many insects. Add four tablespoons of Tabasco or any red pepper hot sauce to a quart of water along with a teaspoon of dish soap. Blend well and spray onto plants.



Organic Pesticide Sprays

If homemade sprays aren't working, you may need to buy an organic pesticide. Horticultural oils, insecticidal soaps and botanical insecticides are all types of organic pesticides. Most are safe to use on food crops because they break down quickly and have no long-lasting effect on the environment. They should still only be used if other methods have failed, because of their impact on beneficial insect populations and other wildlife in the garden.

Horticultural Oil: a lightweight spray that can be petroleum or vegetable based. It kills by smothering, so it is only effective if sprayed directly on target pests. Note that over-spraying can damage the plant.

Insecticidal Soaps: also diluted and sprayed on affected plants, insecticidal soaps work by breaking down the outside shell of the insect,

quickly killing it. They are most effective on soft-bodied insects like aphids, thrips, white flies, spider mites and young leafhoppers.

Botanical Insecticides: naturally occurring chemicals extracted from plants. They break down quickly in the soil and are not stored in plant or animal tissue, making them usable in organic gardens. The toxicity levels in botanical insecticides are short-lived, but they vary from low to moderate. So follow instructions and handle with care. Neem is a botanical insecticide derived from the tropical Neem tree. It is used to control many types of insects, mites, and nematodes and is most effective under wet, humid conditions.

16. Beneficial Insects

Many of the bugs found in an average garden are not “pests” but predators or parasites of pests.

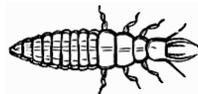
- Common insect **predators** include lady beetles, lacewings and spiders.
- Common insect **parasites** include the Tachinid flies, the Braconid and the Ichneumonid wasps.
- When insecticides are needed, choose ones that are selective (only affect target pest) and less likely to harm beneficial insects.
- For many pest predators, most of the “pest-eating” occurs during their **larval** stage, so it is important to recognize them in their immature forms.
- Planting flowers around your vegetables is a good way to attract beneficial insects into the garden (many adult beneficials feed on pollen and nectar).

Know your Beneficials

Lacewings: adults are pale green or brown and have large, distinctively veined wings. Lacewing larvae are voracious predators that feed on aphids, thrips, scales, moth eggs, small caterpillars and mites.



Lacewing Adult



Lacewing Larvae

Ladybeetles: adults and larvae feed on aphids and other soft-bodied insects. Adults are attracted to flower nectar and pollen.



Lady Beetle Adult



Lady Beetle Larvae

Syrphid Flies: adults look like small bees with striped abdomens; the slug-like larvae have pointed heads and feed on aphids in tight places where other good bugs can't go. They are active earlier in the spring than other beneficials.



Syrphid Fly Adult



Syrphid Fly Larvae

Predatory Bugs: include pirate, ambush and assassin bugs. They prey thrips, hornworms, spider mites, many insects' eggs and nymphs, and small caterpillars. They are attracted to flowers and other plantings that provide shelter.



Minute Pirate Bug



Assassin Bug

Ground beetles: large, long-legged, blue-black or brown beetles. They feed on slugs, snails, cutworms, root maggots, and Colorado potato beetle larvae.

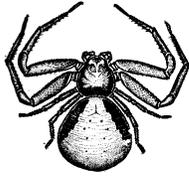


Bigheaded Ground Beetle



Common Ground Beetle

Spiders: important in preventing pest outbreaks. The spiders normally found in gardens do not move indoors and aren't poisonous. Predator spiders do not build webs, but hunt their prey.

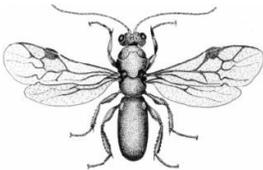


Crab Spider



Jumping Spider

Parasitic wasps are small insects that attack the eggs of pests, which is a very effective way of controlling pest populations.



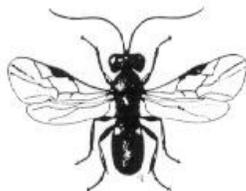
Parasitic Wasp

Tachinid Flies look very similar to house flies, and are important enemies of cutworms, armyworms, tent caterpillars, cabbage loopers, gypsy moths, sawflies, Japanese beetles, squash bugs, and sowbugs.



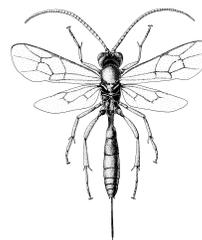
Tachinid Fly

Braconid and Ichneumonid Wasps: some are small and attack small insects such as aphids. Others live in the eggs of various pest insects. Larger parasite wasps attack caterpillars or wood-boring beetles.



Braconid Wasp

Braconid Wasp



Ichneumonid Wasp

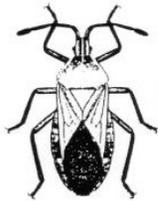
17. Common Insect Pests

Army Cutworm: causing the most damage in early spring, army cutworms feed on many garden plants, cutting the plants off near the soil line. By keeping the garden free of weeds in the fall (when they lay their eggs), serious problems can often be avoided. Over-seeding to allow for some damage is another method.



Cutworm Larvae

Squash Bugs: cause damage to the leaves and fruits of winter and summer squash and zucchini. Their feeding sites destroy pockets of plant tissue and severe infestations result in girdling and plant wilt. They seek shade, so selective leaf pruning and bare soil can make your plants less desirable.



Squash Bug Adult

Tomato/Tobacco Hornworm: quickly defoliate tomatoes, potatoes, peppers, and eggplants. Their green coloring makes them difficult to spot, so you're more likely to notice the signs of them (their droppings, or their feeding damage) than the pests themselves. Handpicking and dropping them in a bucket of water is a simple cultural control.



Hornworm Larvae

Psyllids: very damaging to tomato and potato plants, they can cause fruit to stop forming or ripening, and also premature fruit drop and sprouting. Affected tomato leaves yellow along veins and edges. Affected potato leaves thicken and curl. Spraying horticultural oil in early spring may kill eggs and over-wintering adults. Insecticidal soap can help control an already established population.



Psyllid Adult

Flea Beetle: their chewing causes “shot-hole” damage in leaves, mostly affecting plants in the fragile seedling or transplant stage. Established plants can usually withstand fairly high populations.



Adult Flea Beetle

18. Common Plant Diseases

Aster Yellows: this disease is transmitted by aster leaf hopper and affects over 500 plants, including lettuce, onions, beets and carrots. Symptoms include yellowed, twisted growth and atypical stem and flower formation. The worst symptoms can start in late July and continue until frost. Prevention is the best method: keep weeds and grasses down and pull infected plants (do not compost).

Blossom End Rot (BER): a leathery, brown to black area on the blossom end of a fruit, BER affects tomatoes, peppers, squash & eggplant. The result of a calcium deficiency, factors leading to BER can include: extreme temperature fluctuations, drought stress, root damage and water-logged soil. Prevention methods include: even irrigation, well-drained soil, planting at the proper time, and avoiding excessive nitrogen fertilization.

Early Blight: this fungus is an issue during hot summer months for tomato plants, producing brown to black spots on leaves, which yellow then drop. To control, remove all diseased plant material and avoid overhead irrigation.

Mosaic Viruses: these viruses can cause a mottled appearance on the leaf, flower or fruit of the plant, as well as curled or distorted thickened leaves. Common mosaic viruses include Cucumber Mosaic Virus and Tomato Spotted Wilt Virus; both are common diseases of tomato plants. Affected plants should be destroyed.

Powdery Mildew: easily diagnosed by its dusty white spotted leaves, powdery mildew typically appears in late summer and in times of high humidity. Cucumbers and members of the squash family are the most susceptible vegetables, but it can be found on nearly anything. Proper spacing and thinning are good prevention measures. To control, remove infected leaves, keep plot clean of debris, and improve airflow around plants. Neem oil products can also be helpful when combined with cultural controls.

Verticillium and Fusarium wilts: these common soil-borne fungal diseases most often affect tomatoes, peppers and eggplants. Wilting starts in the upper or lower leaves of the plant and worsens until the entire plant is wilted and stunted. Choosing VFN-resistant plants can be a simple way to bypass these issues. "VFN" refers to hybrid varieties that are resistant to Verticillium wilt, Fusarium wilt, and soil nematodes.

19. Harvest Tips

The easiest way to tell if a vegetable is ripe is to taste-test. Here are a few rules-of-thumb to help you know when to start tasting:

- To help determine ripeness, note the color, size, and firmness of the fruit or vegetable.
- The amount of time from planting to harvest can vary widely from variety to variety, so keep the seed packets/seedling tags as a reminder of each variety's estimated "days to maturity."
- The taste, texture and nutritional value of most vegetables peak *just* before they reach maturity.
- In hot weather the garden will literally grow overnight! Inspect plants several times a week and harvest them at their best.

Recommended Sources:

Much of the information in this booklet can be found (and explained in greater detail) at Colorado State University's Extension website. The books and other websites that were referred to are also listed here and are a great source for additional information on specific gardening topics.

Books

Planting techniques:

Carrots Love Tomatoes
Louise Riotte

Great Garden Companions
Sally Jean Cunningham

Square Foot Gardening
Mel Bartholomew

Rocky Mountain Gardening:

Month by Month Gardening in the Rocky Mountains
John Cretti

Rocky Mountain Garden Survival Guide
Susan Tweit

Organic Gardening/Pest Control:

The Organic Gardener's Handbook of Natural Pest and Disease Control
Rodale, Fern Marshall Bradley, ed.

Rodale's Ultimate Encyclopedia of Organic Gardening
Rodale, Fern Marshall Bradley, ed.

Websites

CSU Extension Homepage: www.ext.colostate.edu

CSU Extension Bulletins: www.ext.colostate.edu/pubs/pubs.html#garden

CSU Extension "PlantTalk": www.ext.colostate.edu/ptlk

Denver Water Tips: www.denverwater.org/Conservation/TipsTools/Outdoor/

Organic Gardening Magazine: www.organicgardening.com