APPENDIX

1. Why Garden?

- **Health:** freshness, avoid agricultural chemicals, more nutrients in organic produce (see chart)
  Economics: less wage labor needed to purchase food

- **Ecological:** reduce transportation costs of commercially produced food, pesticides, vast acreage used for commercial farming freed up for returning to a balanced ecosystem, cleanses grey water

- **Spiritual:** physically experiencing our Oneness with Earth, our kinship with plants

Garden Layout

(Aims: to establish quickly and maintain easily)

- Alfalfa sprouts, mushrooms – in kitchen basement
  Culinary herbs (rosemary, sage, marjoram, basil, thymes, etc.) just outside kitchen door, in herb spiral

- Clipping beds (chives, lettuce, parsley, arugula, nasturtium, spinach, etc.) along edges of beds

- Long-bearing, plucking beds (brussel sprouts, chard, peppers, celery, bunching onions, etc.) just behind clipping beds

- Plants which grow vertically or have high light requirement (tomatoes, beans, summer squash, okra, carrots, peas, beats, asparagus, etc.) in narrow beds

- Long maturation, single harvest veggies (corn, melons, onions, turnips, potatoes, cabbages, grains, etc.) in broad bed, closely spaced for self-mulching

- Fences and trellises – peas, chayote, jicama, kiwis, beans, cucumbers, NZ spinach, grapes, etc.

Creating Garden Beds

- Instant mulch bed
  - Spread hay 8-10" thick directly over ground.
  - Pull hay back from small areas to be planted, and fill with good soil.
  - Plant seedlings or seeds.
  - Water well.
  - Slightly-less-instant Option: Scrape up the turf and topsoil from a wide path around the bed and heap it onto the bed site; continue as above.

- Double-dug bed
  - Mark the area to be dug with a line.
  - Beginning at one end, take off the turf and topsoil (a spade's depth) from a foot-wide section and remove to the other end of bed.
  - Loosen a second spade's depth of soil, and cover it with the turf and then topsoil of the next foot-wide section.
  - Continue down the bed, loosening subsoil and covering with the next section's turf and topsoil.
  - Cover the last section with the turf and topsoil from the first section.

- Keyhole beds

  Improve access in small areas with minimum space; create microclimate
  - Plants frequently accessed in center rows, single-harvest and tall vegetables to the rear.
  - Compost can be fed into keyhole (or you can place a large slab of rock or wood, or mulch, in the keyhole and create a place for quiet communion with your plants).

- General tips for all types of beds
  - Don't monocrop! Every living thing functions better with a little variety in its life.
  - Make beds no wider than double your reach, so that it is never necessary to walk on them.
  - Dig a little gutter along the edges of your beds; this will allow water to run off in heavy rains, and will allow water to quickly penetrate to root areas during light rainfall. It also is a collector for the rich soil/mulch mixture which accumulates during heavy rains.
  - Edge your beds with whatever is handy – rocks, logs, boards, bricks.

- Paths
  - I like to cover mine with hay, and then use the broken-down hay with its accumulated soil as mulch in the beds next year.
  - Paths can also be covered with ground bark, leaves, planks, or bricks, or mowed. Chamomile is a wonderful pathway plant as it is durable and yields a sweet fragrance when walked on.

Plant Propagation

Almost all flowering and cone-bearing plants can be propagated sexually by seeds and also asexually by cuttings, division, grafting, or layering; as well as from bulbs, corms, rhizomes, offsets and runners.

- **Cuttings:** Use for both softwood cuttings made from current year's growth & hardwood cuttings from older wood. Tomatoes do very well this way. Also can use leaf cuttings (succulents, begonias, African violets) and root cuttings (quackgrass is notorious). Need high humidity & porous rooting medium (sand, peat moss, vermiculite, sphagnum moss, perlite or combination)

- **Division:** Divide root clumps when they push up new small crowns around the base of the mother plant. (iris, aster, rhubarb, aloe)

- **Grafting:** Mostly used for fruit trees, to attach a branch (or entire tree) which produces desired fruit to hardy root stock of less desirable fruit

- **Layering:** Bend a section of a living shoot or branch into the ground, covering with several inches of soil, or wrap the branch in moist sphagnum moss covered tightly with plastic wrap. Leave for 6 months or until roots are formed.

- **Runners:** (naturally occurring layering) – strawberries, vinca, spider plants

Saving Seed

(cold, dry storage best – in refrigerator in sealed packages)

- **Tree seeds:** dry for 1-3 weeks on screen or canvas: for cones, dry for 2-12 weeks
- **Berries or grapes:** crush fruits (with rolling pin or in blender), wash off residue, dry. Or place fruits in water & allow to ferment for 2-3 days, then separate seed and dry.
- **Biennials:** (roots, vegetables, parsley, cabbage, Brussels sprouts) won't produce seed until second year. Save roots in cool storage and plant out the second year to get seed, or just leave a plant in the garden in mild climates.
- **Seeds to be dried on plant:** beans, peas, corn, root vegetables, spinach
- **Seeds from soft fruit** (tomatoes, cucumbers, eggplant, squash): leave on plant until fruit is overripe. Then, ferment in water, remove residue, dry (like berries; see above).

*Compiled and edited by Benjamin Fahrer (2006), Occidental Arts and Ecology Center.

2. The Prime Directive of Permaculture

The only ethical decision is to take responsibility for our own existence and that of our children. **Make it Now.**

"Permaculture is a whole design science that is reflective of natural patterns and promotes mutually beneficial relationships Rooted in ethics, the concepts and themes in Permaculture helps us rediscover how to be a positive contribution to the earth, ourselves, and humanity."

The Ethical Intention of Permaculture

- **Earth Care.** Care of the Earth. Allowing provisions and resources for all life systems to continue and multiply.
- **People Care.** Care of People. Allowing provisions for people to access those resources necessary to their existence.
- **Fair Share.** Return the surplus and the setting of limits to population and consumption. By governing our own needs, we can set resources aside for the earth and others.

Permaculture Principles

- **Work With Nature:** rather than against the natural elements, forces, processes, agencies and evolutions, so that we can assist rather than impede natural developments. (Use gravity, use native species, use the sun, wind, etc.)
- **The problem is an opportunity:** Everything works both ways. It is only how we see things that make them advantageous or not. Everything is a positive resource.
- **Make the least change for the greatest possible affect:** Make work a source and not a sink of your energy
- **The yield of the system is theoretically unlimited:** The only limit on the number of uses of a resource possible within a system is in the limit of the information and the imagination of the designer
- **Everything is connected:** Everything gardens and has an effect on its environment;
- **Relinquishing Power:** the role of beneficial authority is to return function and responsibility to life and people.
- **Unknown good benefit:** If we start with good intentions, other good things follow naturally
- **Succession of Evolution:** natural design follows a pattern of evolution that is working towards stability and resiliency. Our own designs can follow suit.
- **Cyclical Opportunity:** every cyclical event increases the opportunity for yield to be increased. Increasing cycling is to increase yield.

- **Functional Design:** All functions are supported by many elements, while each element performs many functions. Function stacking

- **Stability:** is created by a number of beneficial connections between diverse beings.

- **Information as a resource:** Information is the critical potential resource, Bad information can result in a poor design, likewise good information increases opportunity for a good design.
  Relative Location: Through proper placement of elements we can save time and energy

Roots of Permaculture Practice

Thoughtful and protracted Observation (T.A.P.O): Observation that takes place over an extended period of time with thoughtful intention to our interactions with elemental forces, patterns, and cycles of the natural world.

Start Small then Expand: Implement in phases and with the understandings of your actions. Being aware of scale and scope of project. Remembering that every action causes reaction.

Whole Systems Thinking: everything is connected to everything else in some way, shape or form.

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3. Building Fertile Soil

Healthy soil = healthy plants: when you build and maintain fertile soil rich in organic matter, you literally lay the groundwork for thriving plants that can develop quickly, resist pests and diseases, and yield a bountiful crop. Can synthetic chemical fertilizers provide a shortcut to the healthy soil = healthy plants formula? After all, plants' needs are fairly basic: air, water, light, warmth, and a balance of nutrients and minerals. So why not put some seeds in the ground, apply the appropriate chemicals, and reap the harvest?

That's one possible approach to gardening—synthetic chemical fertilizers, such as the N-P-K (nitrogen-phosphorous-potassium) formulations sold in garden supply stores, do provide most of the nutrients plants need in an easy-to-use form. But these chemicals have a number of shortcomings. Because plants can only absorb a limited amount of nutrients at a time, much of these water-soluble products may be wasted and end up as runoff during rain or watering (nitrogen fertilizers are a major source of water pollution). Many chemical fertilizers provide a quick burst of nutrients, but may leave little for the plants to draw on over the course of the growing season. And because petroleum products are needed to produce the fertilizers, they use up valuable non-renewable resources. Finally, chemical fertilizers don't build or maintain healthy soil; much like taking a vitamin rather than eating your fruits and vegetables, they provide the chemicals but none of the added benefits that other soil inputs offer.

Fortunately, you can choose from a wide variety of inputs that will help you create healthy, fertile soil. Organic soil amendments such as compost, manure, cover crops, and fertilizers derived from non-synthetic sources can improve soil quality while providing a source of nutrients that lasts through the growing season. You can make or grow some of these amendments in your own garden to keep your costs low.

Organic Matter

Think of a natural system, such as a forest or meadow: it thrives year after year by recycling available nutrients. Leaves fall and break down; grasses and flowers grow, bloom, and fade; animals die and decompose–all life adds organic matter to the soil. This is the cycle you're trying to recreate in your garden.

Each time you harvest crops or pull weeds, you make a "withdrawal" from the soil's pool of nutrients and organic matter; if these aren't replaced, the soil is eventually robbed of the resources plants need to flourish. Organic matter, made up of decomposed plant and animal material, can help replenish nutrients and at the same time improve soil structure, making it easier to work and a more hospitable place for plants to thrive. Here are some readily available sources:

1. Compost is rich in organic matter, and making compost is a great way to recycle weeds, kitchen scraps, leaves, manure, and other material that would otherwise have to be hauled to the dump. If you don't have a compost pile, consider starting one this fall, when there's a lot of garden and yard waste available (see page 3 of this information sheet for tips on making compost). If making your own compost isn't practical, there are commercial composts available at garden and landscape suppliers. If you've been adding compost to your garden on a regular basis, you may be able to gradually decrease the amount you add to the soil, or try other soil-building techniques such as growing cover crops (see below). On the other hand, if you're just breaking ground or have heavy clay soils, you'll want to add lots of compost. Approximately two inches of fine-textured compost spread evenly over the beds and worked into the soil before planting is about right.

2. Manure from cows, horses, poultry, and other livestock is another good source of organic matter and nutrients. It should be aged at least six months or put through the compost pile before being used in the garden. Some manures (especially poultry manure) generate too much heat when fresh and will damage plants if not aged. Apply cattle or horse manure in a two-inch layer and work it into the soil before planting. Poultry, sheep, rabbit, and goat manures should be applied at a much lower rate, due to their higher nutrient content. If you're not growing cover crops, you can also cover your beds with manure following the harvest to rebuild organic matter and protect the soil from winter rains.

3. Cover crops grown in your garden beds add organic matter to the soil, limit erosion during winter rains, and suppress weeds. In the Santa Cruz area, winter cover crops such as fava or bell beans, vetch, and rye grass can be planted from October through early December. Between March and May, before they set seed, the plants should be harvested and composted or worked into the soil to break down. (Note: if you remove and compost your cover crops, be sure to add compost to the beds in which they were grown.)

3. Leguminous cover crops, such as fava beans and vetch, host a type of bacteria on their roots that fixes nitrogen from the air. These crops are known as "green manures" because they add this nitrogen to the soil when the crops break down. It takes from two to four weeks for cover crops to decompose once they're tilled in, depending on soil temperature (the organisms that decompose cover crops don't become active until the soil temperature rises to 55º F). Check with your garden supply store for seed mixes and seeding rates.

4. Various mulches can also boost the soil's organic matter levels—these include sawdust, tree bark (such as redwood mulch), straw, and leaf mold. When used as a surface mulch, all of these amendments make effective weed barriers and help hold moisture in the soil, but they also temporarily tie up nitrogen as they decompose. If you plan to use these materials as a soil amendment, it may be best to compost them and return them to the soil in the form of finished compost so that they won't compete with plants for nutrients.

Organic Fertilizers

Although organic matter (especially compost) provides many of the nutrients plants need, other purchased organic fertilizers can further enrich the soil and correct nutrient deficiencies. You can find out what nutrients your soil needs by having a soil test done; be sure to find a lab that can recommend organic amendments. Organic fertilizers are available from garden and farm supply stores and mail order companies.

1. Nitrogen (N) sources: Plants need nitrogen to develop healthy leaves and stems; nitrogen-deficient plants will look yellow and grow slowly. Blood and bone meals, fish meal and emulsion, hoof and horn meal, soybean, cottonseed, and kelp meals all contain significant percentages of nitrogen. These can be dug into the soil prior to planting or used as a side dressing to nourish heavy-feeding plants such as corn and brassicas. Because it escapes so readily from the soil in the form of a gas or through leaching, nitrogen should be replenished each year with organic matter and/or fertilizers.

2. Phosphorous (P) sources: Plants need phosphorous to grow, flower, and develop healthy root systems. Rock and soft phosphates, bone meal, and cottonseed meal all provide high percentages of P. Unlike nitrogen, phosphorous lasts a long time once added to the soil.

3. Potassium (K) sources: Plants need potassium to strengthen plant tissue, make vegetation more disease-resistant, and develop chlorophyll. Sources include wood ashes, cottonseed meal, granite dust, and greensand. Wood ashes will also "sweeten" your soil by raising the pH, making it less acidic. Avoid contact between freshly

spread ashes and germinating seeds or new plant roots, as the ash may burn plant tissue. Potassium, like nitrogen, turns over quickly in the soil system and must be replenished.

4. Other minerals: In addition to the three major nutrients described above, plants need sulfur (S), magnesium (Mg), and calcium (Ca), and minor amounts of other minerals, or trace elements. These can be found in such inputs as greensand, soil sulfur, lime, and kelp meal.

Fertilizers from organic sources may be especially important for soil low in organic matter, or during the first seasons that you reduce or eliminate the use of synthetic chemical fertilizers. As the soil's texture and fertility improve with regular additions of organic matter and you build a pool of soil nutrients, you should need fewer inputs of purchased fertilizers.

The question of how much and what type of fertilizers to use will depend on your soil. One rule of thumb is to use 4 lbs of N, 10 lbs of P, and 6 lbs of K per 1,000 square feet on soil that has medium levels of phosphorous and potassium, or on untested soils.

Calculate the number of pounds of nutrient available by multiplying the number of pounds of material by the percentage of the nutrient in question: a 50-pound bag of fertilizer that is 5% nitrogen will contain 2.5 pounds (50 x .05 = 2.5) of nitrogen. Because they usually last through the cropping season, most organic fertilizers don't require repeated applications.

Preparing Garden Beds

Carefully prepared beds will make the most of rich, fertile soil. Double digging, a technique in which the soil is loosened to a depth of two shovel blades (about two feet), is one of the most effective ways to create raised beds (so called because the turned soil mounds higher than the surrounding paths). For detailed instructions on how to make raised beds, consult How to Grow More Vegetables Than You Ever Thought Possible on Less Land Than You Can Imagine or Lazy-Bed Gardening: The Quick and Dirty Guide (see Resources).

Soil that has been double dug and amended with compost and organic fertilizers provides ideal growing conditions: roots can penetrate deep into the loose, aerated soil, drawing on a large area for water and nutrients. Once formed, the beds should not be walked on—limiting foot and wheelbarrow traffic to the paths ensures that the soil in the beds retains its light, airy texture.

Beds don't need to be double dug every year. They can be renewed by forking in a layer of compost (an inch or more) over the bed's surface prior to planting crops in the spring.

Making Compost: The Basics

Compost builds healthy soil which in turn produces healthy, strong plants. By using compost, you are feeding the soil creatures, from the tiniest bacteria to the longest worm, that in turn make nutrients available to plants. All organic materials—whether leaves, bones, coffee grounds, or heaps of dead weeds—will eventually rot. However, a random stacking of organic materials won't necessarily result in great compost. For efficient decomposition, a compost pile needs a good balance of the Basic Four: Greens + Browns + Moisture + Air. "Greens + Browns" is a simplified reference to balancing the nitrogen-rich materials (grass clippings, vegetable trimmings, green weeds) with the carbon-rich materials (fallen leaves, straw, sawdust). "Moisture + Air" reminds us that fast decomposition requires both a good moisture content and ample oxygen for the decomposer organisms in the pile. Other variables that affect the composting process include the particle size of the compost materials, the volume of the pile, and the number of times the pile is turned.

- **Greens = Nitrogen Materials**
  For gardeners, green weeds, green crop residues, and vegetable trimmings are readily available sources of nitrogen materials. Young, green plants, such as new spring grass, are very high in nitrogen. But as a grass plant grows older and browner, it loses some of its nitrogen or uses it to produce seeds. To capture the most nitrogen for your compost pile, pull out finished crop plants and weeds while they are still green. If you let them languish in your garden, they not only lose some of their nutrient value, but also can serve as hosts to mildew, insect pests, snails, and slugs. Cover green materials with a tarp to retain moisture and nitrogen until you are ready to build your pile.

- **Browns = Carbon Materials**
  "Brown" materials, such as straw, leaves, dry grass, and sawdust, can be thought of as carbon sources for the compost pile. Brown materials can be stored easily in a bin for later use. For example, you can stockpile fallen leaves or dry weeds in autumn and layer them with fresh green materials the following spring.

- **Greens + Browns**
  Beginners can use this rule of thumb: layer 50% green to 50% brown by volume. Layers can be two to eight inches thick, depending on the particle size and moisture of the materials. For example, layer four inches of brown leaves on top of four inches of green weeds and repeat. Layering is a good way of estimating equal proportions.

- **Moisture**
  A compost pile should ideally be 40% - 60% moisture, or about as moist as a wrung-out sponge. The easiest way to ensure consistent moisture throughout the pile is to water each brown, dry layer as you go. Straw, leaves, and sawdust can be moistened in a wheelbarrow and then drained to remove excess water. If you water the pile itself, use a hose sprayer for good coverage and take special care to wet the corners and the edges of the pile. Make sure to cover the pile with a hole-free, plastic tarp before winter rains start. Rain will waterlog the pile, and it can also leach away nutrients. Too much moisture can result in compaction and a loss of oxygen in the pile. If the pile seems too wet, turn it to aerate it and add some bulky materials. Too little moisture can result in piles that decompose slowly and don't heat up. If a pile seems dry, turn it, examine it for moisture, and add water as needed. Sometimes a pile will have dry pockets where a layer was not watered enough. Always expect that the outside 8-12 inches of material will be drier and less decomposed than the inside.

- **Building Air into a Pile**
  The best decomposers for composting are aerobic (oxygen-requiring) bacteria. If a pile lacks oxygen—because it is either too wet, too dense, or too big—anaerobic bacteria will take over, producing their characteristic "rotten egg" smell. Without oxygen, a pile will still decay, but aerobic bacteria bring about faster decomposition that retains more nutrients and creates a pleasant odor. Build air into a large pile in the following ways:
  - Loosen the soil that will lie under the pile;
  - Add bulky materials like cornstalks to the bottom of the pile;
  - If using wet, finely textured materials such as grass clippings, layer them with bulky materials to avoid compaction; Turn the pile at least once.

Size of Materials

The size of your materials determines how fast they will compost. Materials with small particle sizes, such as grass clippings, have more overall surface area exposed for bacteria and other decomposers to munch on. For this reason, chopping large materials (especially woody stalks) will speed the composting process. Use a sharp spade

to chop garden weeds and crop residues. A lawn mower will work for leaves, but you may need a shredder for woody prunings that are thicker than a pencil. If all your materials are very fine (for example, lawn clippings), however, the layers can compact and become matted.

Volume and Containers

A large, properly built pile is self-insulating and can sustain temperatures of 140º to 160º F for ten days to two weeks. These high temperatures will kill most weed seeds and diseases harmful to plants and humans.
To heat up properly, a pile must measure at least three feet square and three feet deep. Some experts say that piles should be closer to four feet on a side, but not much larger than five feet tall and five feet wide (and any length). A small pile will also make usable compost, but it won't sustain high temperature long enough to kill a significant number of weeds seeds and disease organisms.4 Building Fertile Soil.
Some people like to contain their piles in wood, wire, plastic, or brick enclosures. Check the Resources section for compost publications—they describe ways to build a variety of compost bins.

Turning

Turning a compost pile speeds the composting process and produces a better end product. It reintroduces oxygen to the pile, remixes brown and green materials, and lets you troubleshoot any problems and remedy them immediately.

Organic Matter Fuels Decomposition

Although it makes up only a small percentage of your soil, organic matter provides the fuel that drives the decomposition process. Invertebrate decomposers, such as earthworms and beetles, first reduce organic matter to smaller particles and incorporate it into the soil. Then bacteria, fungi, and other microorganisms break it down into its chemical constituents, which become available for plants to use as they develop.

Carbon dioxide released from the organic material combines with water to form carbonic acid, a weak acid which acts as a solvent to free calcium, potassium, magnesium, and other minerals from the soil. Because decomposition is an ongoing process, the nutrients in organic matter are available over the course of the growing season, providing a long-lasting source for plants. But as you cultivate the soil and harvest plants, the soil's organic matter levels decrease, which is why it's critical to replace lost organic matter in order to maintain productive soil.

Besides supplying nutrients, organic matter improves soil structure: the organisms that break down organic material secrete gluey substances that bind soil particles together in a crumb-like structure, creating air spaces where roots and water can penetrate. The spongy quality that organic matter imparts to soil also helps it retain moisture, thereby reducing water needs.

When Is It Done?

Signs that your compost pile is ready for use include a cool temperature inside the pile, the presence of worms, beetles, and sowbugs, and an earthy smell and rich brown color. Most pile take about four to six months to mature if they are not turned.

Using Finished Compost

Your finished compost may not look like the finely textured, stick-free stuff available in bags at the garden center. Fear not. Sticks and other materials that haven't thoroughly composted will continue to decompose in the soil. There is no need to sift compost that is going into a garden bed. For propagation mixes and seed beds, however, always use your most finished, stable compost that has been sifted through a 1/4-inch screen.

What Not to Compost and Why

- Meat, dairy products, and greasy foods are likely to attract pests.
- Cat, dog, and human feces can contain harmful pathogens.
- Pernicious weeds, especially those with rhizomonous root systems (e.g., bermuda grass), may not be killed in the composting process.
- Diseased or bug-infested plants should be kept out of slow, cool piles and should be added with discretion to the center of hot piles (when in doubt, keep it out).
- Weeds with mature seed heads should be kept out of slow, cool piles to avoid spreading.
- Needles from conifers are very slow to break down and can often be quite acidic (a few are okay).

Resources

Golden Gate Gardening: The Complete Guide to Year-Round Food Gardening in the San Francisco Bay Area and Coastal California, Revised Edition, by Pam Peirce. Seattle, WA: Sasquatch Books. 2002.

Home Composting. Santa Cruz: Ecology Action. (Information available free by contacting Ecology Action, 831.426-8935, or download publications from the web site, **www.compostsantacruzcounty.org**)

How to Grow More Vegetables Than You Ever Thought Possible on Less Land Than You Can Imagine, by John Jeavons. Berkeley: Ten Speed Press. 2002.

Let It Rot! The Home Gardener's Guide to Composting, by Stu Campbell, 3rd edition. Storey Publishing Co., N. Adams, MA. 1998.

Rodale's Successful Organic Gardening: Vegetables, by P. Michalak and C. Peterson. Emmaus, PA: Rodale Institute. 1993.

Start with the Soil, by Grace Gershuny. Emmaus, PA: Rodale Institute. 1993.

The Soul of Soil: A Guide to Ecological Soil Management, by Grace Gershuny and Joseph Smillie. White River

Junction, VT: Chelsea Green Publishing Co., 1999.

The Sustainable Vegetable Garden: A Backyard Guide to Healthy Soil and Higher Yields, by John Jeavons and Carol Cox. Berkeley, CA: Ten Speed Press, 1999.

*This material is written, produced and distributed by staff of the Center for Agroecology and Sustainable Food Systems at the University of California, Santa Cruz.

4. For the Gardener: Cover Crops for the Garden

Before you hang up your spade and fork for the season, think about treating your garden beds to a fall planting of cover crops. Cover crops are grown not to feed the gardener, but to feed the garden—often referred to as "green manures," cover crops boost soil fertility, cycle nutrients, and improve soil structure. They'll also help protect your soil from erosion by blanketing it with a protective cover of vegetation.

Cover crops fall into two categories:

1. legumes, which include clovers, bell and fava beans, Austrian peas, and vetches,
2. grains and grasses, such as barley, ryegrass, brome, fescue, and oats. Thanks to the mild climate on California's Central Coast, we can grow both legume and grain/grass cover crops during the fall and winter.

For those averse to using animal-based fertilizers such as bone and blood meal to amend their soil, cover crops provide a good alternative. According to staff of Santa Cruz's General Feed and Seed store, some gardeners successfully use cover crops as their only soil amendment.

Roots and Shoots at Work

Cover crops create an abundance of lush growth that in the spring will translate into lots of organic matter for your soil or compost pile. Organic matter is that essential part of the soil made up of decaying plants and animals; soil organisms, such as fungi, bacteria and worms, break down organic matter and make its nutrients available to growing plants. Whether turned under in the spring or made into compost, cover crops will act as a slow-release fertilizer, feeding the organisms that will help feed your vegetables and flowers.

Cover crops also shield the garden's surface from rain damage. As raindrops hit the ground, they can disrupt soil structure, breaking down the soil's crumb-like texture and causing compaction. And even if you don't see gullies running through your garden beds, fall and winter rains can gradually carry away exposed topsoil and critical nutrients.

While cover crops send out greenery above ground, their roots are also at work. Grasses and grains produce large, fibrous root systems that improve soil structure and effectively take up nitrogen and other nutrients. These crops also add organic matter to the soil during the winter and spring, since they constantly slough off roots as the plants develop. Legumes have relatively simple root systems that support nitrogen-fixing Rhizobium bacteria (see page 2) and penetrate deep into the soil to loosen hard-packed beds. When the cover crop root systems decompose, they release nutrients back to the soil.

A Cover Crop to Fit Your Needs

As a rule of thumb, legume cover crops provide more nitrogen to the soil, while grasses boost soil organic matter more effectively. Some crops control erosion better than others, and some grow better under poorly drained or low fertility conditions.

At the UCSC Farm and Garden, we've found that a legume/grain mix provides the best combination of cover crop features.

"In the fall, we plant a mix of bell beans, purple vetch, lana vetch and barley," says UCSC Garden manager Orin Martin. "The beans and vetch are both excellent nitrogen-fixing crops, and the barley gives the vetch a support to climb on. The barley roots also work the topsoil into a fine, friable loam—essentially doing much of the work of digging for you. The deep tap roots of bell beans penetrate and loosen heavy clay soils, and retrieve nutrients—particularly trace elements—from the subsoil." Staff of the Farm and Garden also plant cereals such as oats and annual rye as cover crops.

Sowing the Crop

In the Monterey Bay region, cover crops can be planted from mid to late fall (mid October through early December). Earlier sowings (before mid November) are easier to establish and less vulnerable to bird predation. If birds are eating your newly emerging crops, you may need to cover the beds with bird netting until the plants are well established. If you sow later in the season, you may want to sow more seeds as a hedge against bird damage and the cool, wet conditions that can limit germination.

To plant a cover crop, prepare the beds by removing finished crops, loosening the topsoil, and raking or tilling the top few inches of soil into a fine seedbed (water the bed first if the soil is dry). One way to plant a bell bean/barley/vetch mix is to sow the beans first in furrows 2 inches deep, with the beans 4–6 inches apart in the row, and the rows spaced 8–12 inches apart. Cover the beans, then broadcast the smaller vetch and barley seeds over the beds and rake them in lightly—make sure they're covered with soil. If you're planting a crop of fava or bell beans only, you'll probably want to use more beans (see below). Unless you're sure that a good rain is on the way, water the cover crop in to get it growing. In a year of normal rainfall the plants should need little supplemental watering.

How much cover crop seed to use will depend on the type of crop you plant and the size of your garden. Here are some recommended seeding rates for 1,000 square feet of beds (enough for 20 beds measuring 5' x 10'):

- 3–4 pounds of a typical green manure mix (50% bell beans, 30% Austrian peas, 20% common vetch)
- 2 pounds of a legume/grass blend (65% bell beans, 35% barley)
- 3–5 pounds of bell beans (Vicia faba)
- 3 pounds of purple vetch
- 4–8 pounds of annual rye grass (Lolium sp.)

You can greatly increase the nitrogen-fixing capacity of your legumes by coating them with a legume inoculant, a fine powder containing the bacteria that fix nitrogen (see sidebar, below). Most clovers are pre-inoculated, but check when you buy your seed supplies.

If you don't get a chance to plant a cover crop, there are other ways to protect your beds. A heavy mulch of organic material such as straw or aged manure will act as a physical cover, protecting the beds from rain damage. These materials will also break down during the course of the season and add organic matter to the bed.

Back to the Soil

Between March and May, when the average daily soil temperature tops 55°F and decomposing organisms become more active, you can cut down the cover crop.

"Bell beans should be skimmed off with a sharp spade—leaving the roots in the soil—when thirty to fifty percent of the flowers are in bloom, before they start to direct nitrogen to seed formation and become too high in carbon," says Martin. The vetch/rye mixture should also be skimmed at approximately fifty percent bloom, usually in April or May. If the crop gets too woody (high in carbon), it will break down more slowly and delay your planting time.

The cut crops can be handled one of two ways: either chopped up with a sharp spade, mower, or weed whip (roots should be chopped, too) and worked into the top foot of soil with a spade or rototiller, or gathered up and added to your compost pile. The first method leaves your beds looking a little lumpy for a while, but bacteria, fungi, worms, and other soil organisms will break down the incorporated cover crops in several weeks, unless the soil is too cold. The deeper the crops are dug in, the slower they'll decompose. "Cover crops should be allowed to break down thoroughly before you plant your main crop, although potatoes, dahlias, and other tubers can be planted directly into the dug-in cover crop," says Martin.

If you choose to harvest your cover crops rather than dig them in, they'll provide a good source of "green" material for your compost pile (balance it with an equal volume of "brown" material, such as straw or dry leaves). But remember that by removing the cover crops from your beds you also remove nutrients and organic matter from the soil that must be replaced.

"If you take cover crops from a bed to use for compost, it's important to add finished compost back to that bed before you plant your spring crops," says Martin. "Otherwise, you may actually be reducing the amount of organic material in the soil." Martin notes that by composting cover crops, you end up with a product that has a broader, more complete nutrient base than the cover crops provide by themselves.

Summer Cover Crops

If your soil could use a boost in organic matter during the summer season, consider planting a summer cover crop. Buckwheat is a fast-growing crop that suppresses weeds, attracts beneficial insects, and creates wonderful tilth when worked into the soil. It grows to maturity in 30–45 days and can be used to protect the soil prior to planting late-season crops such as fall vegetables.

Buckwheat can either be sown in furrows or broadcast over the bed and carefully raked in. The recommended seeding rate is 3 lbs. per 1,000 square feet—if you broadcast the seed, use double the rate. The crop should germinate following one or two irrigations. Once established, irrigate 1"–1.5" per week for good growth.

Nitrogen Fixation

Legume crops such as bell beans "fix" nitrogen from the air via Rhizobium bacteria, which live in association with the legume roots. As they develop, the roots secrete chemical compounds that attract Rhizobium bacteria and stimulate the bacteria to multiply. Root hairs curl around the bacteria, which enter the hairs via an infection thread formed by the plant. The thread penetrates the root cortical cells, which develop into a distinct structure called a nodule. You can see these nodules when you harvest your cover crops—look for the pink, knobby growths on the roots.

Within the nodule, the bacteria multiply and differentiate into bacteroids, capable of producing a chemical that can convert nitrogen from the atmosphere into a form that the plant uses to make proteins. In return, the bacteria receive food in the form of sugars synthesized by the plant during photosynthesis. When the cover crops decompose, the nitrogen within the nodules becomes available for growing crops to draw on.

Sources

You can buy cover crop seed and legume inoculants at garden supply stores in Santa Cruz and Monterey Counties, or through mail-order garden supply companies. For information on cover crops best suited to your climate and soil type, consult your local University of California Cooperative Extension agent, Master Gardener information line, or garden supply store. Then give your garden a fall meal—you'll reap the benefits all year long.

References

1. Building Soils for Better Crops, by Fred Magdoff and Harold Van Es.
   Sustainable Agriculture Network Series #4, 2000.

2. Start with the Soil:
   The Organic Gardener's Guide to Improving Soil for Higher Yields, More Beautiful Flowers, and a Healthy, Easy-Care Garden, by Grace Gershuny. Emmaus, PA: Rodale Institute. 1997.

3. The Soul of Soil:
   A Soil-Building Guide for Master Gardeners and Farmers, Fourth Edition, by Joseph Smillie and Grace Gershuny. Chelsea Green Publishing. 1996.

This material is written, produced and distributed by staff of the Center for Agroecology and Sustainable Food Systems at the University of California, Santa Cruz. For more information about CASFS resources and activities, call 831.459-3240, or write CASFS, University of California, Santa Cruz, CA 95064. The Center's web address is casfs.ucsc.edu

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5. Composting Your Organic Kitchen Wastes with Worms

Introduction

Every home kitchen generates food scraps for disposal. Throwing these scraps in the garbage can create odor problems and adds to the volume of waste going to the landfill. Disposing of kitchen scraps in a garbage disposal is convenient, but it adds to the burden of the waste-treatment system and throws away a potentially valuable resource. Furthermore, garbage disposals are not recommended for homes that rely on a septic system for waste disposal. A viable alternative to disposing of food scraps in the landfill or the sewer system is to compost them. The resulting material is a useful addition to gardens and potted plants.

What Is Composting?

Composting is a process by which organic materials, such as kitchen scraps and lawn trimmings are converted from an unstable product, which is likely to further decompose and create objectionable odors, to an increasingly more stable product that will store well without being offensive. A diverse population of microorganisms and invertebrates, called decomposers, performs this process. Various decomposers have different temperature and food requirements, thus the makeup of the population present in a compost system continuously changes as conditions change. Most people think of composting as a pile of organic materials that slowly decomposes and creates heat. This is called thermophilic composting because it relies primarily on high-temperature tolerant microorganisms. Another form of composting is called vermicomposting.

Vermicomposting

In vermicomposting, the primary agents of decomposition are worms. They convert raw organic wastes to a nearly stable humus-like material. The main process by which organic materials are converted occurs as the wastes pass through a worm's gut and are digested by the worm. Worms stir and aerate the waste pile, so that turning is not required. Worms can stabilize organic materials faster than microorganisms because they grind the material, thus increasing its surface area and speeding decomposition by microorganisms. The material that results from the vermicomposting process is called vermicompost. Material that actually passes through the gut of a worm is called castings. Vermicompost contains a large fraction of castings, but some of the material will have decomposed from microorganisms alone, without passing through a worm.

The most common composting worm species in North America is Eisenia fetida. Common names for this worm include tiger worm, brandling worm, red wiggler, and manure worm. This worm is a litter dweller; i.e. it likes to live in piles of organic matter such as leaf litter. Earthworms, such as the night crawler, are burrowing worms that live deeper in the earth. They are not composting worms.

Creating the Correct Environment for *Eisenia fetida*

Successful vermicomposting requires a worm bin that provides the appropriate environmental conditions for worms. Worms breathe through their skin and require an environment that is moist, but not so wet that they drown. The material in which they live should feel like a damp sponge and release a few drops of water when squeezed. Various worm species have different temperature requirements. Eisenia fetida, the one recommended for a composting worm bin, can survive at temperatures between 35° and 100°F but performs best between 65° and 78°F.

Worms do not have eyes, but they do have light receptors on their skin. They do not like light, and will quickly dig down into a bin to avoid it. For this reason, it is a good idea to provide a cover for your worm bin.

Building a Worm Bin

You can purchase a worm bin or you can build your own. Two things to consider when selecting a bin design are the amount of food scraps you generate and where the bin will be located. Amount of food scraps will determine the size bin you need, and location will determine whether or not the bin needs to be insulated.

A good rule of thumb for sizing a worm bin is this: you can process one-half pound of food scraps per day for each square foot of worm bin surface area. For example, a bin that is 18 inches by 24 inches (18/12 x 24/12) is 3 square feet in surface area and can process about 10.5 pounds of food a week (3 sq ft x 1/2 lb/ft sq/ day x 7 days/week = 10.5 lbs).

Worms can survive over a wide range of temperatures, but temperatures below freezing or above 100°F can kill them. If your worm bin will be in a location where the temperature is moderated such as a garage, mudroom, basement, pantry, or under a sink, then you do not need to worry about insulating it. If the bin is to be outdoors all winter, it is a good idea to insulate it or bury it in the ground to help prevent it from freezing.

A worm bin must be open enough to allow for good aeration. The bin should include a cover to minimize the attraction of fruit flies and other pests, but if a plastic lid is used, be sure and drill holes in it so air can get in. If the bin is inside or in a location where seepage would be a problem, it should include provisions to catch any liquid that might drain through. Bins can be made of a variety of materials—wood and plastic are common.

The simplest way to construct a bin is to purchase a plastic storage container, drill holes in the bottom and lay down a piece of fabric, e.g. nylon, inside the container to prevent the vermicompost from falling through the holes. The container can be placed on top of its lid with the lid turned up to catch any liquid that might seep out through the bin. If you use the lid as a catchment tray, then a piece of cardboard cut to fit directly on the top surface of the bin will make an excellent cover for the bed. If you want to use the original storage container cover for the lid to your worm bin and devise something else to use as the liquid catchment tray, be sure and drill holes in the lid to allow air into the bin. Even if you use the plastic container lid with holes on top of the bin, it is still a good idea to place a piece of cardboard directly on top of the worm bin surface to discourage fruit flies from entering the bin.

Setting Up a Worm Bin

Place a six- to eight-inch layer of bedding material in the bin. Suitable bedding materials include any non-toxic, pH-neutral material that holds water and allows air to circulate. Shredded paper, including office paper and newspaper, cardboard, and well-composted horse or cow manure all make good bedding. Glossy paper does not make good bedding. Paper and cardboard should be shredded into two-inch or narrower strips.

The bedding must be moist but it should not be dripping wet. Moisten the bedding material by soaking it in water, then drain it and squeeze out the excess moisture. The material should feel like a damp sponge.
Fluff up the material to assure that it is well aerated.

Add one-half to one pound of worms for each square foot of surface area of worm bed. Because composting worms tend to live in the upper layers where the food is being added, it is the surface area of the bed, not the bed depth, that determines the worm population. Give the worms time to burrow into the bedding material before you feed them.

To discourage worms from leaving the bed, it is a good idea to leave a light on near the bin the first few days. Worms do not like light, and will not leave the bin if a light is on. It is not uncommon for worms that have been disturbed and relocated, to crawl out of a worm bin, if it is in the dark. It can be very disconcerting to see a large population of dead worms on the floor the day after you start your bin! After a week, the worms should be settled in the bin, and it is fine to turn off the light.

Worm Food

Worms can process a wide range of organic materials as long as the materials are not too salty or too acidic. Fruits, vegetables, coffee grounds and filters, and tea bags all make good worm food. Citrus fruit and peels should only be applied in small amounts because of their high acidity. Worms and microorganisms will process chopped or ground food scraps more rapidly than they will process large-sized pieces of food, but, given time, whole foods will break down. Meat, bones, dairy products, fatty or greasy foods, and pet manure should not be placed in worm beds due to odor and pathogen concerns.

To feed the worms, bury the food in clumps, putting each feeding into one small space within the bin. Feeding once or twice a week is recommended. Just place the food in a new place each time. The bin should remain covered with the cardboard except when you are feeding.

Under optimum conditions, worms can process their body weight in food each day, that is, a pound of worms can process a pound of kitchen scraps each day. Typically, however, processing rates are not that high. An over-fed worm bed can create odor problems, so it is best not to over apply. After the worms are established and reproducing, the population density in a well-operated bin should be about one pound of worms per square foot of surface area of worm bin.

Maintaining your Worm Bin

- **Adding Bedding:** Worms need very little attention. It is a good idea to add new bedding material to the bin about every two months. This will replace the bedding that the worms have processed. A new layer of moist bedding three to four inches thick should be placed on top of the bin.

- **Harvesting the Vermicompost:** Every three to six months or when the bin begins to fill, the worms should be separated from the vermicompost if your objective is to generate more worms. Remove the worms from the vermicompost relatively early (after two to three months), and divide the worms into new bins. Giving the worms extra room will encourage high reproductive rates.

  One method for separating worms from vermicompost is to push the existing material to one side of the bin and add new bedding and food to the other side. Continue to add food only to the newly bedded side. Eventually, the worms will leave the older bedding and migrate to the side where the food is being added. At this point, the vermicompost can be removed from the older side, and additional bedding added to fill back in the empty space.

  Another method for separating worms from vermicompost involves dumping the entire bed onto a sheet of plastic and sorting through the mass. Separate the material into several piles and shine a light on the area. This will cause the worms to burrow down into it the castings and the top layer can be removed by hand. The worms will burrow down again, and within a few minutes, the top layer can be removed. This process is repeated until the worms concentrate in each pile and most of the vermicompost has been removed. At this point, new bedding is added to the bin and the worms with the remaining vermicompost are returned to the bin.

Troubleshooting a Worm Bin

Foul Odors

A well-functioning worm bin is virtually odorless. Vermicompost has a faint earthy odor. If your bin has a foul odor it is most likely due to one of the following causes:

- The bin is too wet. Do not add excessively wet food, such as watermelon rind, squashes, etc., to the bin. Mix in dry bedding and/or leave the top off to increase drying.
- Overfeeding. Stop feeding the bin for one to two weeks and see if the problem is solved.
- Food is exposed. Try burying the food under a one-inch layer of bedding. Alternatively, you can add moist bedding on top of the feed.
- Not enough air. Make sure there are adequate holes in the bin for ventilation. Fluff the bedding or add additional bedding.

Bin Attracts Flies

A vermicomposter contains living organisms other than worms. Fruit flies cause the most complaints. To avoid flies, bury the food in the bin and do not over feed it. Keeping the bin covered will also reduce fruit flies.

Bedding Is Drying Out

Too much ventilation and/or a hot, dry room can cause a worm bed to dry out. Keep a lid on the vermicomposter and/or add water to the system.

Worms Are Crawling away from the Bin

When a worm bin is drastically disturbed, such as at start up or when vermicompost is removed from the bin, it is not unusual for the worms to crawl out. This can be prevented by leaving the bin in a lit area because worms will not crawl into the light. It is unusual for the worms to crawl out of an established bin if the environmental conditions are correct.

Worms Are Dying

If the bin smells like dead fish, the worms may be dying. Typically, the bin may be too wet, too dry, too hot, or too cold or it may need more air.

Sources for Worms

An Internet search can identify many commercial worm producers that will sell you worms. It is also possible to purchase worms at a freshwater bait shop. However, remember that the typical bait worm is not a composting worm. It is recommended that you purchase Eisenia fetida.

References

Noncommercial Web-based resources

www.bae.ncsu.edu/people/faculty/sherman

This site, maintained by Dr. Rhonda Sherman, Extension Specialist, Solid Waste Management, University of North Carolina, contains extensive information on vermicomposting.

www.recyclemore.org/article.asp?key=49

This site is maintained by the California Integrated Waste Management Authority. It offers information on vermicomposting, plus links to other sites.

Nonprofit Web-based resources

http://www.wormdigest.org

This site is maintained by Worm Digest, a magazine dedicated to vermicomposting that is published four times a year. The Web site contains articles from back issues, as well as links to commercial worm producers. The magazine is based in Oregon, so most of the contacts listed are on the West Coast. However, there is a great deal of information on worm bin designs available in the back articles.

Books

Appelhof, Mary. 1997. Worms Eat My Garbage.
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Acknowledgements

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6. Vegetable Garden Planting Guide For San Diego County

Vincent Lazaneo, Farm Advisor
UC Cooperative Extension

This planting guide refers to the coastal and inland regions of San Diego County. Planting periods for some common cool and warm season vegetables are given for a year having average weather conditions. The beginning and end of a planting period can vary by several weeks from year to year. Gardeners need to exercise more judgment when planting early or late in the season. Suitable planting dates are dictated to a large extent by the amount of time a vegetable takes to grow from seed to a harvestable size and by the vegetable's climatic requirements. Seed packets and catalogs give the number of days required from seed to harvest under optimum growing conditions. The cold tolerance of some vegetables is listed below as a guide for early planting.

Hardy Vegetables:

These vegetables are not injured by light frosts and the seed will germinate at a rather low temperature. This group includes: onion sets, cabbage plants, (which have been well hardened), kale, kohlrabi, brussel sprouts, spinach, turnip, radish, asparagus, and rhubarb.

Half-Hardy Vegetables:

The seeds of this group will germinate at rather low temperatures, but the young plants are injured by frost. This group includes: lettuce, beet, carrot, chard, parsley, parsnip, heading broccoli, early potatoes, onion seeds, garden peas, celery plants, and cauliflower plants.

Tender Vegetables:

These vegetables are injured by the lightest frost and do not thrive at a low temperature even though frost does not occur. These should not be planted until all danger of frost is past. This group includes: snap bean, tomato, sweet corn, and sweet potato.

Very Tender Vegetable:

These vegetables do not thrive until the soil has become warm. The seed will rot in the ground unless the soil is warm. This group includes: eggplant, pepper, cucumber, watermelon, muskmelon, lima bean, squash, and pumpkin.

To prepare the garden for planting, rototill or spade the soil to a depth of 8 to 12 inches, then break up clods and rake the surface smooth. Organic compost and manures can best be incorporated into the soil at this time. A fertilizer containing nitrogen, phosphorous and potassium should be mixed into the soil prior to planting. If animal manures are used they should be spread evenly over the soil to a depth of one-quarter to one-half inch deep and thoroughly mixed into the top six inches of soil. Manures are best applied four to six weeks prior to planting to prevent injury. Commercial fertilizers can be used alone or in combination with manures and compost to provide adequate soil fertility. Mix commercial fertilizer into the top six inches of soil just before planting at the rate recommended on the product label. Additional applications of a fertilizer containing nitrogen are usually made periodically during the growing season to sustain vigorous plant growth.

Most vegetables fall into two groups:

1. Cool season crops

Food value is generally higher per pound and per acre than in warm season crops.

We eat a vegetative part of the plant:

- Root – carrot, parsnip, beet, radish, turnip
- Stem – Kohlrabi, white potato
- Leaf – spinach, lettuce, celery, asparagus, cabbage, onion
- Immature flower parts – cauliflower, sprouting broccoli, globe artichoke

Planting and harvesting time should be in the cool season.
Root depth is shallow to medium.
Storage temperature should be 32° F, except white potatoes (40° to 50° F)

2. Warm Season Crops

Food value is generally lower per pound and per acre than in cool season crops.

We eat the fruit of the plant:

- Mature fruit – tomato, watermelon, cantaloupe, winter squash
- Immature fruit – summer squash, cucumber, snap and lima beans, sweet corn

Planting and harvesting time should be in the warm season.
Root depth is medium to deep.
Storage generally not advisable for very long periods.

(Note: Two exceptions to the above classifications are peas
(a fruit, yet a cool season crop) and sweet potatoes (a root and warm season crop).

RECOMMENDED PLANTING DATES

Coastal Region (1 & 2)

Warm Season	
Beans, Snap & Pole	Mid Mar - Aug
Beans, Lima	Mid Apr - Jul
Cantaloupe	Apr – Jun
Corn, Sweet	Mid Mar – Jul
Cucumbers	Mid Mar – Jul
Eggplant (plants)	Apr – Jun
Melons (Casaba, etc)	Apr – Jun
Okra	Apr - Jun
Pepper (plants)	Apr - Jul
Squash, summer	Mid Mar - Aug
Squash, winter	Apr – Jun
Sweet Potato (plants)	Apr – Jun
Tomato (plants)	Mar – Jul
Watermelons	Apr – Jun

Cool Season	
Beets	Sept - May
Broccoli (plants)	Sept - Feb
Broccoli (seeds)	Aug - Dec
Cabbage (plants)	Sept - Feb
Cabbage (seeds	Aug - Dec
Carrots	Sept - Apr
Cauliflower (plants)	Sept - Feb
Cauliflower (seeds)	Aug - Dec
Chard	Sept - Jun
Endive	Sept - May
Kale	Sept - Apr
Kohlrabi	Sept - Mar
Head Lettuce	Sept - Mar
Leaf Lettuce	Sept - Apr
Onion (bulb)	
Short Day	Oct - Dec
Medium Day	Jan - Feb
Onion (green)	Sept – May
Peas (bush)	Sept - Mar
Potatoes (Irish)	Feb – Mar
Mid Aug – Sept	
Radish	Sept - May
Spinach	Sept - Apr
Turnips	Sept - May

Inland Region (3 & 4)

Warm Season	
Beans, Snap & Pole	Apr – Mid Aug
Beans, Lima	Mid Apr - Jul
Cantaloupe	Apr – Jun
Corn, Sweet	Apr – Jul
Cucumbers	Apr – Jul
Eggplant (plants)	Apr – Jun
Melons (Casaba, etc)	Apr – Jun
Pepper (plants)	Apr - Jun
Squash, summer	Apr – Jul
Squash, winter	Apr – Jun
Sweet Potato (plants)	May – Jun
Tomato (plants)	Apr – Jun
Watermelons	Apr – Jun

Cool Season	
Beets	Sept – Mid Apr
Broccoli (plants)	Sept – Feb
Broccoli (seeds)	Aug – Oct
Cabbage (plants)	Sept – Feb
Cabbage (seeds)	Aug – Oct
Cauliflower (plants)	Sept – Feb
Carrots	Sept - Mar
Cauliflower (seeds)	Aug – Oct
Chard	Sept – Apr
Endive	Sept – Apr
Kale	Sept – Apr
Kohlrabi	Sept – Mar
Head Lettuce	Sept – Feb
Leaf Lettuce	Sept – Mar
Onion (bulb)	
Short Day	Mid Oct – Dec
Medium Day	Jan – Feb
Onions (green)	Sept – Apr
Peas (bush)	Jan - Mar
Potatoes (Irish)	Mid Feb - Apr
	Mid Aug – Sept
Radish	Sept – Mar
Spinach	Sept – Mar
Turnips	Mid Sept – Apr

SAN DIEGO COUNTY COASTAL AND INLAND BIOCLIMATE REGION

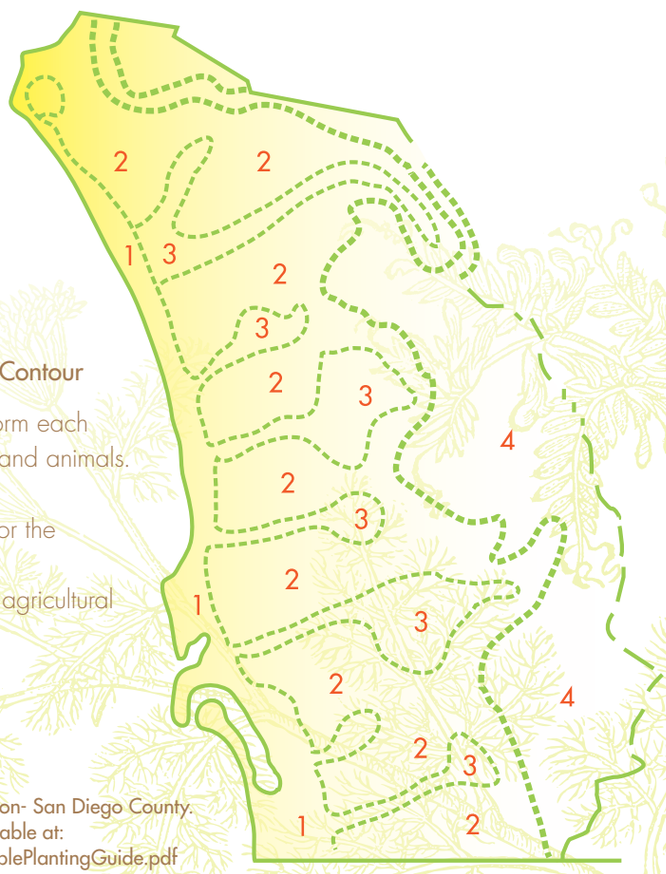
Coastal Region Subdivisions

1 – Maritime Zone/Inland Zones
2 – Hill & Mesa District
3 – Valley & Canyon District
4 – High Elevation Zone

Approximate Area = Sea Level to 2000' Elevation Contour

Bioclimates are complexities of weather that differ form each other in some characteristic of importance to plants and animals.

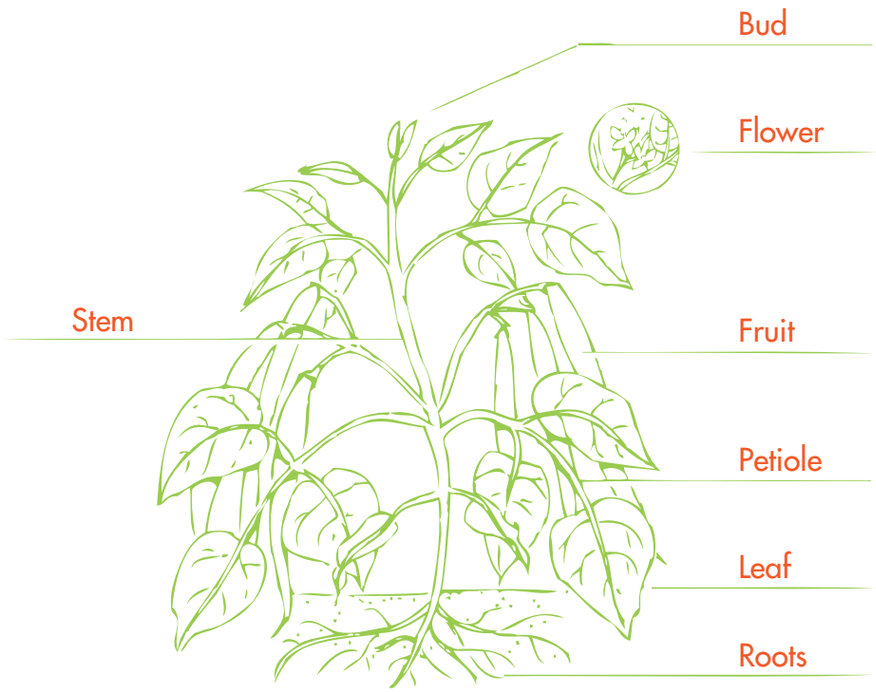
Subdivisions of California's bioclimates are named for the geographic areas with which they are most closely associated. These names are used to designate the agricultural areas of the state.



*Adapted from the University of California Cooperative Extension- San Diego County. Vegetable Garden Planting Guide for San Diego County. Available at: http://www.mastergardenerssandiego.org/downloads/VegetablePlantingGuide.pdf

7. Parts of the Plant Diagram

Roots
Stem
Leaf
Petiole
Bud
Flower



Functions:

Flower
Flowers are often showy because they are designed to attract pollinators like birds and insects who will fertilize them. The flower's job is to make seeds.

Fruit
Plants make a fleshy fruit to contains the seeds. In nature when the animal eats the fruit, it spreads the seeds inside. Each seed might grow into another plant in the right conditions.

Leaf
A plant's leaves collect sunlight for the process of photosynthesis. Photosynthesis is the process where green plants use sunlight, carbon dioxide and water to make food and oxygen. Little openings in the leaves, called stomata, collect carbon dioxide from the air and release oxygen. Tiny veins in the leaves spread water and nutrients throughout the leaf. The process of photosynthesis occurring in green plants around the world is what produces the oxygen we breathe.

Stem
A plant's stems helps support the weight of the plant and all its leaves. Water and minerals are brought up from the roots. Nutrients made by photosynthesis in the leaves is sent down and all around the plant.

Roots
A plant's roots anchor it into the ground. They also collect water and minerals from the soil and transport them up into the plant.

8. Growing In San Diego Planning For Seasonal Planting Cool Season

Developed by Marc Bailey

Very moderate Climate

- Can be grouped into 2 season planting times
- Warm Season (~March-July)
- Cool Season (~August-April)
- Coastal and inland regional differences
- Coast more moderate temperature
- More sun inland
- Very wide variety of cool season plants to grow

Cool Season Plant Groups

- Cabbage family (Brassicas)
- Leafy Greens
- Root Vegetables
- Peas
- Alliums (Onions etc)
- Plants to Build Soil

Cabbage Family (Brassicas)

- Broccoli
- Brussel Sprouts
- Cabbage
- Cauliflower
- Collards
- Kale
- Kohlrabi
- Pak Choi

Leafy Greens

- Chard
- Chicory
- Mizuna Greens
- Lettuce
- Mustard Greens
- Radicchio
- Spinach

Root Vegetables

- Beet
- Carrot
- Horseradish
- Leeks
- Parsnip
- Potato
- Radish
- Rutabaga
- Sunchoke
- Turnip

Peas

- Pole & Bush varieties
- Shelling Peas
- Snap Peas (green beans)
- Snow Pea

Alliums

- Chives
- Garlic
- Leek
- Onion
- Shallot

Others

- Artichoke
- Celery
- Fava beans
- Fennel
- Herbs
- Cilantro
- Parsley

Plants to Build the Soil

Dynamics Accumulators (not just Nitrogen)

- K, P, Ca, S, Co, Cu, Fe, Mg, Na, N

Standard Cover Crop Nitrogen fixers

- Alfalfa
- Crimson Clover
- Fava Beans
- Vetch

Others

- Chickweed (K,P)
- Comfry (K, P, Ca, Cu, Fe, Mg)
- Dandelion (K, P, Ca, Cu, Fe)
- Nasturtium (K, P, Ca, S, Fe, Mg, Na)
- Sorrels & Docks (K, P, Ca, Fe, Na)
- Stinging Nettle (K, Ca, S, Cu, Fe, Na)
- Yarrow (K, P, Cu)

Resources

- Carrots Love Tomatoes (book)
  -Mastergardenerssandiego.org
  Growing guide_Vegetables
  -pfaf.org
    - Plants for a Future- Database of Useful Plants

Organic Seed Sources

- City Farmers Nursery
- seedsofchange.com
- bountifulgardens.com
- seedsavers.org

*Adapted from Victory Gardens San Diego "University of Gardening".
For more information, visit: www.victorygardenssandiego.com

9. Cool Season Vegetables (companions)

1. Artichokes from seed early or nursery starts later in season
2. Arugula
3. Beets try Chioga or Golden Beets. Oh so sweet! (bush beans, onions, kohlrabi, broccoli, cabbage, lettuce)
4. Broccoli look for the re-sprouting varieties. You'll probably have to order seed. (dill, celery, chamomile, sage, peppermint, rosemary, potatoes, beets, onions)
5. Broccoli-Raab
6. Brussels Sprouts the key to great sprouts is to decapitate the plant at about 30 inches. (dill, celery, chamomile, sage, peppermint, rosemary, potatoes, beets, onions)
7. Cabbage (dill, celery, chamomile, sage, peppermint, rosemary, potatoes, beets, onions)
8. Carrots (Onion, leek, rosemary, wormwood, sage, black salsify, chives)
9. Cauliflower (celery, but not strawberries or tomatoes)
10. Celery (leeks, tomatoes, cauliflower, cabbage, bush beans, chives, garlic, nasturtiums)
11. Chard (cabbage family)
12. Chicory (peas)
13. Corn Salad/Lamb's Lettuce
14. Cilantro
15. Collard Greens (beans, tomatoes)
16. Chives (don't plant near beans)
17. Fava Beans amazingly delicious! (don't plant near garlic or onions)
18. Florence Fennel (don't plant near beans, tomatoes, or caraway, or wormwood)
19. Garlic (don't plant near peas or beans)
20. Horse Radish (potato)
21. Kale try walking stick kale or tree kale they are perennials. (cabbage, potatoes, beet, carrot, celery, cucumber, dill, lettuce, chamomile, garlic, mint, rosemary, sage, Tansy, thyme, nasturtium, onion family, spinach, Marigold)
22. Kohlrabi the early purple ones are stunning and sweet! (onions, beets, cucumbers)
23. Leeks from seeds or starts (celery, carrot, onions)
24. Lettuce so many to choose from. (onions, strawberries, cucumbers, carrots, radishes)
25. Mizuna Greens
26. Mustard Greens
27. Onions from seed earlier and later from sets (don't plant near peas or beans)
28. Pak Choi
29. Parsley (carrot, tomatoes, asparagus)
30. Parsnips
31. Potatoes (horse radish, kale, broccoli, cabbage, don't plant near tomatoes)
32. Radishes (mustard, nasturtium, kohlrabi, beans, lettuce)
33. Rhubarb available at nurseries later in the seasons (columbine)
34. Radiccio
35. Rutabaga sounds yucky tastes great! (hairy vetch, peas)
36. Shallots (don't plant near peas or beans)
37. Shelling Peas (carrots, turnips, radishes, cucumbers, corn, beans, potatoes, but not onions, garlic, gladiolus)
38. Spinach (strawberries)
39. Strawberries (lettuce, spinach, don't plant near cauliflower)
40. Sugar Pod Peas (carrots, turnips, radishes, cucumbers, corn, beans, potatoes, but not onions, garlic, gladiolus)
41. Sunchokes get some at the market and plant'em.
42. Turnips (hairy vetch, peas)

*Adapted from Victory Gardens San Diego "University of Gardening".
For more information, visit: www.victorygardenssandiego.com

10. Warm Season Vegetables (companions)

1. Amaranth (corn, onion)
2. Beans (beet, borage, corn, cucumber, eggplant, marigold, nasturtium, strawberry, sunflower, dislikes chives, garlic, fennel)
3. Bell Pepper (eggplant, okra, tomato, lovage, marjoram, oregano, dislikes fennel)
4. Cantaloupe (corn, marigolds, nasturtiums, oregano, squash, sunflowers)
5. Casaba (corn, sunflowers)
6. Chili Pepper (eggplant, okra, tomato, lovage, marjoram, oregano, dislikes fennel)
7. Corn (beans, squash)
8. Cucumber (beans, sunflower, radishes, dislikes potatoes)
9. Eggplant (green beans)
10. Okra (bell peppers)
11. Peanuts
12. Pumpkin (corn)
13. Squash-summer & winter (beans, corn)
14. Sunflower (dislikes beans)
15. Sweet Potato
16. Tomato (basil, bush bean, cucumber, garlic, marigold, nasturtium, mint, dislikes pole bean, corn, dill, fennel, potato)
17. Watermelon (corn, sunflowers)
18. Zucchini (corn, majoram, nasturtium)

*Adapted from Victory Gardens San Diego "University of Gardening".
For more information, visit: www.victorygardenssandiego.com

11. California Native Plants that Attract Butterflies

Regional Parks Botanic Garden – East Bay Regional Park District

This list of California native plants that attract butterflies was compiled by the late Es Anderson, a dedicated Botanic Garden volunteer who managed the annual plant sale for many years. The list was further divided into those plants that attract nectar-feeding adult butterflies and those that provide food for butterfly larvae by Judy Lundy, a lepidopterist and naturalist devoted to sharing her love of nature with school children.

Plant Name	Nectaring Species	Larval Feeders
Achillea (yarrow)	Almost all butterflies	
Aesculus california (California buckeye)	Western tiger swallowtail, echo blue	
Alnus (alder)		Western tiger swallowtail,
Anaphalis margaritacea (pearly everlasting)		pale swallowtail Painted lady, American painted lady
Arabis (rock cress)		Sara orangetips
Arctostaphylos (Manzanita)		Brown elfin
Aristolochia california (California pipewine, Dutchman's pipe)		Pipevine swallowtail
Armeria (seapink, sea thrift)	Skippers, blues	
Asclepias (milkweed)	Red admiral, western tiger swallowtail	Monarch, queen
Aster (aster)	West coast lady, painted lady, checkerspots, gray hairstreak, cabbage white, buckeye, skippers, coppers	
Betula (birch)		Tiger swallowtail, western tiger swallowtail, mourning cloak
Brodiaea (brodiaea)	Swallowtails	

Calycanthus occidentalis (western spicebush)		Brown elfin
Ceanothus (California lilac)	Buckeyes	Brown elfin, echo blue, California tortoiseshell, pale swallowtail
Cercocarpus (mountain majogany)		Gray hairstreak
Clarkia (farewell-to-spring)	Skippers	
Cornus (dogwood)	Echo blue	Echo blue
Epilobium (or Zauschneria- California fuchsia)	Anise swallowtail	
Erigeron (fleabane daisy)	Blues	
Eriogonum (California buckwheat)	Skippers, acmon blue, dotted blue, buckeye, green hairstreak, gray hairstreak, metalmarks	Skippers, acmon blue, dotted blue, buckeye, green hairstreak, gray hairstreak, metalmarks
Eriogonum latifolium (coast buckwheat)	Lange's metalmark	Lange's metalmark
Grindelia (gumplant)	Coppers, skippers	
Grasses (e.g., Muhlenbergia, Festuca)		Common wood nymph, California ringlet, skippers
Holodiscus (cream bush, ocean spray)		Pale swallowtail
Lavatera assurgentiflora (island mallow)		West coast lady
Lotus scoparius (deerweed)		Blues-including acmon blue, alfalfa butterfly
Lupinus (lupine)	Painted ladies, skippers, gray hairstreak	Blues-including Melissa blue, common blue, silvery blue, acmon blue
Malacothamnus (bush mallow)	Buckeye, red admiral	Painted ladies, skippers, gray hairstreak, common hairstreak, buckeye, west coast lady

Mimulus (monkeyflower)		Buckeye
Monardella (monardella)	Painted ladies, skippers, monarch, red admiral, western tiger swallowtail, anise swallowtail, gray hairstreak, common hairstreak	Gray hairstreak, common hairstreak
Penstemon (beardtongue)	Anise swallowtail	Checkerspots
Platanus racemosa (western sycamore)		Western tiger swallowtail
Poa (bluegrass)		Fiery skipper, blues
Populous (cottonwood)		Pale swallowtail
Populus tremuloides (quaking aspen)		Twotailed swallowtail, western tiger swallowtail, mourning cloak
Prunus (wild cherry)		Pale swallowtail, western tiger swallowtail
Quercus (oak)		California sister, duskywing, golden hairstreak, echo blue
Rhamnus californica (California coffeeberry)		Pale swallowtail
Rosa (rose)	Mourning cloak	
Salix (willow)		Western tiger swallowtail; mourning cloak; Lorquin's admiral
Salvia (sage)	Painted ladies, buckeyes, red admiral, monarch, pale swallowtail, common sulphur, silvery blue	
Sedum (stonecrop)	Painted ladies, red admiral	Elfins
Solidago californica (goldenrod)	Gray hairstreak, common hairstreak, painted lady, red admiral, monarch	
Symphoricarpos (snowberry)		Chalcedon checkerspot
Vaccinium (huckleberry)		Blues, brown elfin

*Adapted from the Regional Parks Botanic Garden. California Native Plants that Attract Butterflies. For more information visit: www.nativeplants.org.

12. Plant Nutrients

Sixteen chemical elements are known to be important to a plant's growth and survival. The sixteen chemical elements are divided into two main groups: non-mineral and mineral.

Non-Mineral Nutrients

The Non-Mineral Nutrients are hydrogen (H), oxygen (O), & carbon (C). These nutrients are found in the air and water. In a process called photosynthesis, plants use energy from the sun to change carbon dioxide (CO2 – carbon and oxygen) and water (H2O – hydrogen and oxygen) into starches and sugars. These starches and sugars are the plant's food.
Photosynthesis means "making things with light".
Since plants get carbon, hydrogen, and oxygen from the air and water, there is little farmers and gardeners can do to control how much of these nutrients a plant can use.

Mineral Nutrients

The 13 mineral nutrients, which come from the soil, are dissolved in water and absorbed through a plant's roots. There are not always enough of these nutrients in the soil for a plant to grown healthy. This is why many farmers and gardeners use fertilizers to add the nutrients to the soil.

The mineral nutrients are divided into two groups:
macronutrients and micronutrients

Macronutrients

Macronutrients can be broken into two more groups:
primary and secondary nutrients.
The primary nutrients are nitrogen (N), phosphorus (P), and potassium (K). These major nutrients usually are lacking from the soil first because plants use large amounts for their growth and survival.
The secondary nutrients are calcium (Ca), magnesium (Mg), and sulfur (S).
There are usually enough of these nutrients in the soil so fertilization is not always needed. Also, large amounts of Calcium and Magnesium are added when the lime is applied to acidic soils. Sulfur is usually found in sufficient amounts from the slow decomposition of soil organic matter, an important reason for not throwing out grass clippings and leaves.

Micronutrients

Micronutrients are those elements essential for plant growth which are needed in only very small (micro) quantities. These elements are sometimes called minor elements or trace elements, but use of the term micronutrient is encouraged by the American Society of Agronomy and the Soil Science Society of America. These micronutrients are boron (B), copper (Cu), iron (Fe), chloride (Cl), manganese (Mn), molybdenum (Mo) and zinc (Zn). Recycling organic matter such as grass clippings and tree leaves is an excellent way of providing micronutrients (as well as macronutrients) to growing plants.

Soil

In general, most plants grow by absorbing nutrients from the soil. Their ability to do this depends on the nature of the soil. Depending on its location, a soil contains some combination of sand, silt, clay, and organic matter. The makeup of a soil (soil texture) and its acidity (pH) determine the extent to which nutrients are available to plants.

Soil Texture (the amount of sand, silt, clay, and organic matter in the soil)
Soil texture affects how well nutrients and water are retained in the soil. Clays and organic soils hold nutrients and water much better than sandy soils. As water drains from sandy soils, it often carries nutrients along with it. This condition is called leaching. When nutrients leach into the soil, they are not available for plants to use.

An ideal soil contains equivalent portions of sand, silt, clay, and organic matter. Soils across North Carolina vary in their texture and nutrient content, which makes some soils more productive than others. Sometimes, the nutrients that plants need occur naturally in the soil. Other times, they must be added to the soil as lime or fertilizer.

Soil pH (a measure of the acidity or alkalinity of the soil)
Soil pH is one of the most important soil properties that affects the availability of nutrients.
Macronutrients tend to be less available in soils with low pH.
Micronutrients tend to be less available in soils with high pH.

Lime can be added to the soil to make it less sour (acid) and also supplies calcium and magnesium for plants to use. Lime also raises the pH to the desired range of 6.0 to 6.5.

In this pH range, nutrients are more readily available to plants, and microbial populations in the soil increase. Microbes convert nitrogen and sulfur to forms that plants can use. Lime also enhances the physical properties of the soil that promote water and air movement.

It is a good idea to have your soil tested. If you do, you will get a report that explains how much lime and fertilizer your crop needs.

Micronutrients

Nitrogen (N)

- Nitrogen is a part of all living cells and is a necessary part of all proteins, enzymes and metabolic processes involved in the synthesis and transfer of energy.
- Nitrogen is a part of chlorophyll, the green pigment of the plant that is responsible for photosynthesis.
- Helps plants with rapid growth, increasing seed and fruit production and improving the quality of leaf and forage crops.
- Nitrogen often comes from fertilizer application and from the air (legumes get their N from the atmosphere, water or rainfall contributes very little nitrogen).

Phosphorus (P)

- Like nitrogen, phosphorus (P) is an essential part of the process of photosynthesis.
- Involved in the formation of all oils, sugars, starches, etc.
- Helps with the transformation of solar energy into chemical energy; proper plant maturation; withstanding stress.
- Effects rapid growth.
- Encourages blooming and root growth.
- Phosphorus often comes from fertilizer, bone meal, and superphosphate.

Potassium (K)

- Potassium is absorbed by plants in larger amounts than any other mineral element except nitrogen and, in some cases, calcium.
- Helps in the building of protein, photosynthesis, fruit quality and reduction of diseases.
- Potassium is supplied to plants by soil minerals, organic materials, and fertilizer.

Calcium (Ca)

- Calcium, an essential part of plant cell wall structure, provides for normal transport and retention of other elements as well as strength in the plant. It is also thought to counteract the effect of alkali salts and organic acids within a plant.
- Sources of calcium are dolomitic lime, gypsum, and superphosphate.

Magnesium (Mg)

- Magnesium is part of the chlorophyll in all green plants and essential for photosynthesis. It also helps activate many plant enzymes needed for growth.
- Soil minerals, organic material, fertilizers, and dolomitic limestone are sources of magnesium for plants.

Sulfur (S)
- Essential plant food for production of protein.
- Promotes activity and development of enzymes and vitamins.
- Helps in chlorophyll formation.
- Improves root growth and seed production.
- Helps with vigorous plant growth and resistance to cold.
- Sulfur may be supplied to the soil from rainwater. It is also added in some fertilizers as an impurity, especially the lower grade fertilizers. The use of gypsum also increases soil sulfur levels.

Boron (B)
- Helps in the use of nutrients and regulates other nutrients.
- Aids production of sugar and carbohydrates.
- Essential for seed and fruit development.
- Sources of boron are organic matter and borax.

Copper (Cu)
- Important for reproductive growth.
- Aids in root metabolism and helps in the utilization of proteins.

Chloride (Cl)
- Aids plant metabolism.
- Chloride is found in the soil.

Iron (Fe)
- Essential for formation of chlorophyll.
- Sources of iron are the soil, iron sulfate, iron chelate.

Manganese (Mn)
- Functions with enzyme systems involved in breakdown of carbohydrates, and nitrogen metabolism.
- Soil is a source of manganese.

Molybdenum (Mo)
- Helps in the use of nitrogen.
- Soil is a source of molybdenum.

Zinc (Zn)
- Essential for the transformation of carbohydrates.
- Regulates consumption of sugars.
- Part of the enzyme systems which regulate plant growth.
- Sources of zinc are soil, zinc oxide, zinc sulfate, zinc chelate.

13. Sheet Mulching: Greater Plant and Soil Health for Less Work

Introduction

Mulch is a layer of decaying organic matter on the ground. Mulch occurs naturally in forests; it is a nutrient rich, moisture absorbent bed of decaying forest leaves, twigs and branches, teeming with fungal, microbial and insect life. Natural mulch stores the nutrients contained in organic matter and slowly makes these nutrients available to plants. Mulch also protects soil from desiccation by the sun and wind, as well as from the erosive effects of rain and run-off.

Mulch forms a necessary link in nutrient cycling vital for our soils. When mulch is absent for whatever reason, the living soil is robbed of its natural nutrient stores, becomes leached and often desiccates. Natural terrestrial environments without a litter layer are usually deserts. Non-desert plants grown in bare soil require constant fertilization, nutrient additions, and water, not to mention the work required to keep the soil bare.

"Sheet mulch" is a four-layered mulch system for use around crops. The four layers (or "sheets") mimic the litter layer of a forest floor, and optimize the weed control and fertility benefits of mulch. The sheet mulch technique described here is for use with trees or in gardens. The techniques can also be adapted for landscaping and other agricultural uses. Sheet mulch is a simple and underutilized technique protecting soil, reducing weed competition, and restoring fertility.

Benefits of Sheet Mulch

- Improves nutrient and water retention in the soil
- Encourages favorable soil microbial activity and worms
- Suppresses weed growth and competition around crops
- Reduces labor and maintenance costs as compared to bare soil culture
- Provides crops with organic matter and nutrients
- Improves plants vigor and health, often leading to improved resistance to pests and diseases
- Enhances soil structure

Basic Techniques of Sheet Mulching

Once you get the hang of it, sheet mulching can be used almost anywhere. It may be used either in establishing a new garden or tree planting, or to enrich existing plantings. Below is described sheet mulching to cover an area such as a garden on a small scale, then, how to sheet mulch around a tree. In both cases, mulch is applied to bare soil or on top of cut weeds. New plantings are planted through the mulch, or a small area is left open to accommodate established plants and trees.

The benefits of mulching justify putting the energy into doing the job right, using ample materials. Collect all of the materials (as outlined below), and complete the mulching process in one session. A reduction in maintenance and increase in plant vigor will more than pay off the initial effort.

Sheet mulch is put down in four layers to mimic natural forest mulch: well decayed compost, weed barrier, partly decayed compost and raw organic matter, as described below.

Steps for Applying Sheet Mulch

Step 1: Prepare site

To prepare the site, knock down tall weeds and woody plants with a scythe, brush cutter, or by trampling the existing vegetation so that it lies flat. A poultry or pig tractor system (Overstory #50, see link below) is an excellent method of site preparation. There is no need to remove vegetation, unless it is woody or bulky. It fact the organic matter left now will decay and add nutrients to the soil. Once vegetation in the area is flattened proceed to lay down the sheet mulch.

Step 2: Add concentrated compost and mineral amendments (Layer #1)

Whether you are mulching bare soil or weeds, "jump start" microbial activity by adding high nutrient material which stimulates soil life. This material also accelerates the decay of weeds and grass under the mulch. Suitable materials are enriched compost, poultry or stock manure, worm castings, feather meal or similar at the rate of about 2.2 kg/m2 (50 lbs/100 ft2). If the soil is overly acid, which is common in disturbed soils or those treated with conventional fertilizers, add lime. A soil analysis will indicate the need for adjustment of pH or mineral amendments. This is the appropriate time to add the recommended doses of minerals such as phosphorous and potassium.

Step 3: Water well

Now, soak the area well with water. This is essential as it starts the natural process of decomposition. Also it is much easier to soak the ground now, before the remaining layers of mulch are applied.

Step 4: Apply a weed barrier (Layer #2)

Most cultivated areas harbor untold numbers of weed seeds. There are also weed seeds blown by wind, animals and people. Soil borne seeds are lying dormant and waiting for sunlight, moisture and space to sprout. Simply pulling or killing growing weeds will not erase the weed problem: more seeds will sprout almost as soon as the soil is exposed to moisture and light. Therefore the next step in mulching is to put down an organic weed barrier. This barrier prevents the germination and eventual emergence of weeds through your mulch.
Underneath this weed barrier grasses and weeds die and quickly become food for earthworms. The worms turn and aerate the soil.

Of the four sheet mulch layers, the weed barrier has no natural counterpart on the forest floor. In the forest, weeds do not sprout because there is "no room for them," which simply means a lack of space above and below the ground, and a lack of light. By planting an area properly, there will eventually be no room for weeds. The weed barrier is needed only for establishment of the mulch, and disappears with time. If your area is planted appropriately, weeds will not emerge after the decomposition of the weed barrier.

Materials for the weed barrier that work well are: cardboard, 4 - 6 sheets of newspaper, burlap bags, old carpets of natural fiber, worn-out clothing, gypsum board, or any other similar biodegradable materials. Banana or other large leaves also work if laid down in several layers. Overlap the pieces of the material so as to completely cover the ground without any breaks, except where there are plants you want to save. Around these leave a generous opening for air circulation around the root crown. Care in laying down the weed barrier without gaps will save you the headache of emerging weeds later on.

Both water and good air circulation are necessary for healthy soil. Although the weed barrier forms a physical and light barrier, it is essential that is be permeable to water and air. Overlapped pieces of organic material as recommended above let water and air slowly permeate between and through them. If the weed barrier is applied too thickly, the soil can become anaerobic. Also, for the same reasons plastic mulches are not recommended for most situations.

Step 5: The Compost Layer (Layer #3)

This layer is on top of the weed barrier--it must be weed seed free. Well conditioned compost, grass clippings, seaweed or leaves are ideal materials to spread over the weed barrier. Any weed-free material mixture at the right moisture level for a good compost will do. This should form afairly dense layer about 8 cm (3 inches) thick.

Step 6: The Top Layer (Layer #4)

The top dressing mimics the newly fallen organic matter of the forest. It also must be weed-seed free. Good materials for this layer include leaves, twigs and small branches, hay, straw, fern or palm fronds, coffee chaff, macadamia nut shells, chipped tree prunings, sawdust, bark, coir, bagasse, etc. The top layer will slowly decompose into lower layers, and therefore must be replaced periodically; it represents reserves of compost. This layer should be about 8 - 13 cm (3 5 inches) deep. Many materials suitable for the top layer often have a pleasant cosmetic appearance. For this reason, there should be no hesitation in using sheet mulch in all cultivation from landscaping to gardening to permanent orchard crops. In fact, as you use mulch, bare soil will begin to seem ugly and undesirable.

When the soil is amended and sheet mulch applied properly, there will never be a need to turn the soil. Earthworms do the tilling. The only task left is to keep the soil covered by replenishing the mulch.

*Adapted from Agroforestry Net, Inc., P.O. Box 428, Holualoa, Hawaii 96725 USA; for more information visit
www.agroforestry.net/overstory/overstory96.html

14. Irrigation Parts-A Simple Guide

Types of pipe/irrigation systems

1. *PVC (white/purple)* - typical home garden basic sprinkler system: Sizes from 1/2 inch on up. Adapts to Polytube or Spaghetti/micro tubing. Uses "threaded" (needs polytape wrapped clockwise) or "slip" fittings (needs glue) to connect.

2. *Polytube (black/brown)* - flexible, good for creatively shaped garden beds (herb spirals etc.) Sizes 1/2 in and various metric sizes 700, 710 etc. STICK WITH ONE SIZE! Adapts from PVC easily. Uses compression or barbed fittings to connect...not glue!

3. *Spaghetti/micro-tubing (black)* - very flexible. Good for very specific watering of plants. 1/4 inch. Adapts from PVC or Polytubing easily. Uses barbed connectors...not glue

4. *T-Tape (black)* - commonly flat; can be round. Good for straight runs in garden beds. Has drip holes built in at various spacings: 8", 12" 16" for drip). Adapts from polytubing. Requires low water pressure. Has special connectors for quick attachment and quick release.

5. *Hoses (various colors)* - garden hoses, soaker hoses (drips from throughout the hose); Sizes vary. Adapts to PVC, polytube. Needs a washer; different threads than PVC. Needs an adapter

Parts, Parts, Parts!

Despites the hundreds of parts at your local home store, they break down into a few distinct types. PVC, Polytube and spaghetti tubing use all of these, just in different sizes.

1. *Pipe:* PVC, Poly, Spaghetti, T-tape, hose

2. *Connectors (same size):* Regardless of the type of pipe, they all have similar types of connectors: I's (couplings),L's, T's, and X's. Can be "slip", threaded, compression or barbed depending on the pipe you're using

3. *Adapters (from one size or type of pipe to another):* 1/2" to 3/4"; 3/4" to 1", Poly to spaghetti; PVC to Poly etc.

4. *Stops/caps/plugs:* Stops the water flow.

5. *Emitters:* Where the water comes out in drips or sprays

6. *Valves:* Shut-offs helps you send water where you want it.

7. Combinations: One part does 2 or more jobs; pipe and emitter (Netafim);

8. TWO IMPORTANT COMPONENTS! *Back flow preventer and Pressure regulator!*

Designing your system

1. Map and measure your garden space.

2. What is your main water source? Existing irrigation? hose bib?

3. Decide what type(s) of irrigation you want to use.

4. Draw a layout including the parts you think you'll need.

5. Make a list of the parts and tools you'll need

6. Buy parts

7. Lay out or put the system together "dry" to check it before you glue (if necessary) anything.

Useful Tools: PVC Pipe cutter, pliers or channel locks, rags, polytube hole puncher, scissors

Useful thoughts: If you like tinker toys, erector sets or building anything, you'll love irrigation! Whatever is done can be undone!

*Developed by Bob Greenamyer - Victory Gardens San Diego