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## Vegetables

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According to a [survey](#) conducted by the Gallup Organization in 1996-1997, about 26 percent of U.S. households have a vegetable garden. Vegetables are grown to provide nutritious food and for many, vegetable gardening is a relaxing, therapeutic hobby.

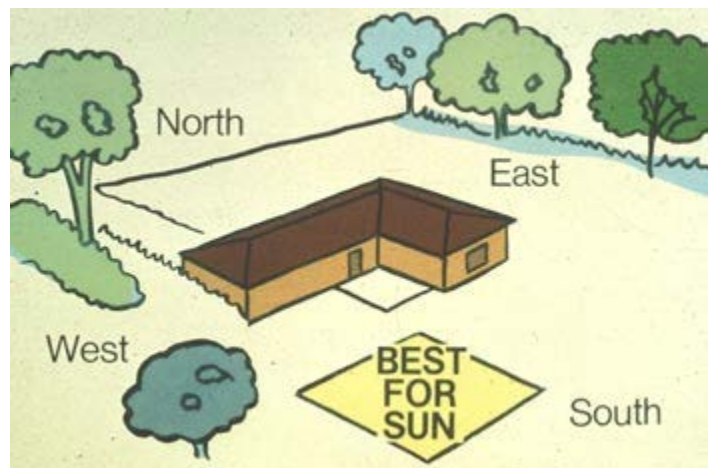
Technically, **vegetables are foods we obtain from the leaves, stems, roots, or tubers while fruits are the product of a ripened ovary.** This strict botanical definition of a fruit makes tomatoes, peppers, okra, and even pumpkins fruits. A better definition of a vegetable is a part of a plant eaten cooked or raw, usually with the main part of the meal. Fruits are generally consumed as dessert. Even this definition has some gray areas, however, as a few vegetables, such as rhubarb and pumpkins, are used as fruits in dishes such as rhubarb crisp and pumpkin pie.

Fresh vegetables are an important part of our [diets](#). They provide vitamins, minerals and complex carbohydrates for energy. Members of the onion and cabbage families contain important anti-cancer compounds that are being researched. Vegetables provide bulk (fiber) to our diets; yet tend to be lower in calories than other food groups since they are low in fat. Many people, especially children are inspired to eat more fresh vegetables when they grow their own.

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### Site Selection

A successful garden takes more than just buying a few seeds and transplants at the local garden store. First, a site must be chosen for the garden. Properties with small yards may be limited to where a garden can be located. If there is no space for a separate vegetable garden, plant vegetables among ornamental plants since many are attractive plants. Some people call this edible landscaping. When selecting a site consider the amount of sunlight that reaches it, the type of soil, availability of water, wind protection and slope. The soil should be fertile, deep, loose and well drained. Avoid heavy shade, heavy clay or excessively sandy soils, soils with hardpans, or hard shale layers that make growing a garden difficult. Most soils benefit from the addition of organic matter such as sphagnum peat moss, compost, composted manure, leaves, and grass clippings.



Plants need light to grow and make food through photosynthesis. Select a site that gets at least six hours of sunlight each day. If the site is shaded, it is better for plants to receive morning sun so the foliage dries quickly, reducing the chance of disease. Try to set your vegetable garden beyond the drip line of trees and shrubs. Generally, leafy vegetables and root crops grow better in partial shade than those that produce fruit.

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### Soil

A well-drained, fertile soil is best for growing vegetables. Plant roots absorb water and nutrients from the soil and anchor and support the plant. Plant roots also need oxygen in the soil. When a soil becomes waterlogged all of the oxygen in the soil has been replaced by water and plants will not grow well.

This can be a major problem with heavy clay soils. In contrast, sandy soils drain quickly and do not hold water well. Organic matter helps improve both sandy and clay soils. Soil organic matter consists of plant, insect and animal remains. These materials continuously decay, improving soil structure and adding nutrients to the soil.



Organic matter incorporated into a sandy soil helps hold moisture and nutrients. In clay soils, organic matter aids drainage by breaking apart clay particles so air and water can move through the soil. Adding organic matter to any soil makes it easier to work the soil.

Although good drainage is important, access to water is important as well. Most locations need a source of water to irrigate the plants. When selecting a garden site, make sure it is close enough to an outside faucet to make irrigating easy. Vegetables need consistent water throughout the growing season. One to 1-1/2 inches of water per week is a general recommendation, unless rain is received. However, the amount of water required in your garden depends on the temperature, soil type, crops grown and whether mulches are used to reduce evaporation.

Unless the soil is very sandy and drains fast, it is better to apply water in larger quantities at less frequent intervals as plant roots will grow deeper into the soil as they seek water. Light frequent sprinkling tends to form cause roots to grow shallowly near the soil surface if the watering is not deep, and plants may become stressed during periods of drought. Shallow watering also allows soil salts to build up where soil salts are present, particularly the western US, and most vegetables do not grow well when soil salts are prevalent.

In some areas of the country, hot, dry winds blow all summer. The wind can stress plants, tear, and damage them. Summer winds usually come from the west or southwest. A hedgerow, fence or building on the west side of the garden will help break the wind. Choose a site where the windbreak does not shade the garden until late afternoon as vegetables need sunshine for growth. A temporary windbreak such as a strip of rye or wheat, or borders of tall sunflowers can be planted to reduce/divert winds blowing across gardens.

A level or gently sloping site is easiest to garden. If a hillside is used for planting, make sure rows across the hill, not up and down. If rows run up and down the hill, rain and irrigation water may cause soil erosion.

Do not make the seeded totally smooth and fine. Very fine textured soils (as well as those high in salt content) tend to form a crust at the soil surface after watering, that makes it difficult for seedlings, especially those of dicot plants, to emerge. To prevent crusting, apply a very light layer (1/2 inch) of grass clippings or other mulch material after planting. Planting fast germinating seeds, such as radishes, with slower germinating seeds to help break up any crust that might form.

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## Tools

For a small garden, a basic set of well built tools should last many years. You will need a spade (shovel) or spading fork for turning over the soil. A rototiller or plow is useful for large gardens. Use a hoe to break up the soil after it is turned and to hoe weeds. A garden rake is handy for smoothing the seed bed and for very shallow cultivation. A trowel or a hand cultivator will help you transplant small plants. Finally, a yardstick or measuring tape, stakes, string and labels help you make straight and properly spaced rows, ensuring that individual plants have room to grow.

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## Planning the Garden

Make a garden plan before ordering seeds or planting. The size of the garden and amounts of specific vegetables depends on many factors, including the amount of space available, the number of people in your family, the kind of vegetables they want to eat and previous gardening experience. If the plans for the produce include canning, freezing, or drying vegetables, look for cultivars which preserve well.

Variety and cultivar are two words gardeners often hear. A variety is a subdivision within a species. They are a group of individuals within a species that are distinct in form or function from other similar arrays of individuals. For example, there are three different kinds of peas - English peas, field peas and sugar peas. Each is a different variety and is used for a different purpose.

A second kind of variety is the cultivated variety or cultivar. These varieties are developed for a specific plant type or use. The names on pea seed packages, such as 'Little Marvel,' 'Snow Bird,' or 'Sugar Snap' pea, are cultivar names. The names often are informative of the cultivar such as its suitability for freezing, or whether it grows up a pole or is a bush. There are hundreds of cultivars of many vegetables.

Many discount, garden and grocery stores sell flower and vegetable seeds each spring, but carry only a few cultivars of most plants. There are many mail order companies that carry a wide selection of seeds.

In choosing vegetable cultivars for the home garden, consider:

- **Disease resistance** - Plants tolerant or resistant to common diseases will require fewer fungicide applications.
- **Plant type** - Determinate (bush) or indeterminate (vining). Bush type plants take less space and still yield well.
- **Shape, color, flavor**
- **Use** - Fresh, frozen, canned or dried. Some cultivars preserve better than others.
- **Those recommended for your area.** Ask at the local Cooperative Extension office for a current list of suggested vegetable cultivars for your state. Friends and neighbors might offer their experiences and suggestions as well.



Buy or order seed well in advance of the planting date. Some people like to save seed from year to year. Depending on the crop this can be good or bad. Do not save seed from hybrid plants, they do not produce true-to-type plants. Some crops, such as cucurbits (cucumbers, winter and summer squash and melons), are highly cross pollinated. Seed from these plants should not be saved unless the flowers have been hand pollinated. Members of the bean family, tomatoes and peppers are often self-pollinated. Cultivars that are not hybrids can often be saved successfully.

Once a decision had been made on what to plant, one must determine when to plant. This depends on whether the vegetables are cool season or warm season crops. Cool season crops need to grow and mature before temperatures get too hot. The first vegetables to be planted in a garden will be hardy cool season crops that can be planted early in the spring as soon as the ground can be worked. Broccoli, cabbage and radishes are a few of the vegetables that can withstand freezing temperatures, hence the name hardy.

The second group to be planted include the less hardy or half hardy cool season crop such as carrots, spinach and beets. Plant these two to four weeks before the final spring frost is expected. The plants in this group do best if planted after the soil has begun to warm, but they can tolerate some freezing without injury.

Warm season crops are planted last and include tender and very tender plants. Tender plants, such as sweet corn and snap beans, should not be planted until after the last spring frost. These plants grow best during warm weather and are easily injured by frost. Even if you plant them early and they escape frost injury, they do not grow well until the soil warms in the spring. Wait at least one week after the last expected frost to plant very tender crops. These plants (such as peppers, pumpkins, melons, and okra) love the heat and need hot weather to grow well.

Many people like to plant tender vegetables earlier than recommended. These plants must be protected from frost. Milk jugs and cartons can be used to protect the plants. Remove the cap, cut the bottom off and set the plastic milk jug over the young plant. There are other products, such as Wall O' Water® and floating fabric row covers, which can be used to gain time at the beginning or end of the gardening season.

Rotate your crops. If there was a garden previously on your site, try to determine what vegetables were planted where. Plant diseases and insects often stay in the soil and can infect future crops. Often plants in the same family are susceptible to the same diseases. Some major plant families include:

- Solanaceae (Nightshade family) - tomato, potato, pepper, eggplant
- Leguminosae (Pea family) - snap bean, pea, peanut, dry bean
- Cucurbitaceae (Squash family) - summer squash, winter squash, cucumbers, melons, pumpkins, gourds, chayote
- Cruciferae (Mustard family) - broccoli, cabbage, brussels sprouts, cauliflower, kale, Chinese cabbage

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## Planting Tips - Getting the Most Garden for the Space Available

Even if the garden space available is very small, there are several planting methods you can use to squeeze more plants into the garden. Planting in single rows is the most common method of planting. Mark the rows by stretching a string or piece of twine between two stakes. Straight rows make the garden neat, permit better spacing of plants, and make it easier to maintain. Use a hoe handle to make shallow trenches for small seeds or use the blade of the hoe for larger seeds. Plant seeds evenly spaced in the row and cover two to four times their diameter. While single row planting is the most common planting method, it does not use space efficiently.



## Wide Row Planting

This method uses space more efficiently than single row planting. Seeds are broadcast in rows 10 or more inches wide, separated by normal pathways. To use this method, prepare a smooth seeded and mark off rows using a garden rake. A garden rake works well because it is usually 10-12 inches wide. The seeds are then thinly broadcast seeded in the row so the seeds have 1 to 2-inches of space between each. Cover the seed or lightly rake it into the soil. When seedlings emerge, thin them so they are the recommended distance



apart. Wide rows allow more intensive cropping. Plants growing close together shade the ground, restricting the growth of weeds and conserving moisture. Crops easily grown in wide rows are beets, carrots, chard, dill, lettuce, onions, peas, spinach and turnips.

## Companion Planting

Some crops can be planted together in the same row to save space or mark the rows. Radishes, for example, can be planted thinly in rows of carrots, lettuce and beets. The radishes germinate quickly to mark the rows before other vegetables come up. They grow fast and are ready to harvest before the other vegetables need the space.

Companion planting is also the term for planting different plants close together to benefit each other. Some people believe certain plants repel insects and help other plants to grow better. In many cases scientific research has shown that companion planting does not work well and may reduce yields due to crowding and other problems. However, there are some experimental findings where specific combinations of plants have shown positive results.

## Interplanting

Slow starting or late maturing plants can be planted between or within rows of early spring vegetables. For example, lettuce, spinach, radishes and peas can all be interplanted with tomatoes, peppers, summer squash and corn. By the time hot weather arrives, the early crops are ready to harvest and remove, leaving plenty of room for the long season plants.



## Stagger Planting

Most gardens are capable of producing vegetables for a long period of time. Some planting practices result in the gardener being swamped with lettuce and radishes for a few days and then not have any. To provide a long term steady production of several types of vegetables, consider staggering the plantings. By planting very short rows of early spring vegetables, you

can spread the harvest over several weeks. Simply plant a few seeds every 7-10 days for a continuous harvest.

### Succession Planting



As early season vegetables are harvested the space can be used to grow another crop of vegetables. When short season crops finish bearing, remove them and put a new planting in their place. For example, green beans can follow lettuce, or summer squash can follow spinach.

Minimum Soil Temperatures for Vegetale Seed Germination			
32° F Cool Season	40° F Half Hardy	50° F Warm Season	60° F Warm Season
Endive Lettuce Onion Parsnip Spinach	Beet Broccoli Cabbage Carrot Cauliflower Celery Parsley Pea Radish Swiss Chard Turnip Seed Potato	Asparagus Sweet Corn Tomato	Beans Cucumber Eggplant Melons Okra Pepper Pumpkins Squash

Optimum Soil Temperatures and Days for Germination at Optimal Teperatures				
70° F	75° F	80° F	85° F	95° F
<b>Celery</b> (10-14)	<b>Asparagus</b> (21)	<b>Bean, Lima</b> (7-10)	<b>Bean, Snap</b> (7)	<b>Cantaloupe</b> (4- 10)
<b>Parsnip</b> (14-21)	<b>Endive</b> (10-14)	<b>Carrot</b> (12-14)	<b>Beet</b> (7-14)	<b>Cucumber</b> (7- 10)
<b>Spinach</b> (7-14)	<b>Lettuce</b> (7-10)	<b>Cauliflower</b> (5-10)	<b>Broccoli</b> (5-10)	<b>Muskmelon</b> (4-10)
	Pea (7-14)	<b>Onion</b> (10-14)	<b>Cabbage</b> (5-10)	<b>Okra</b> (7-14)

		<b>Parsley</b> (11-28)	<b>Eggplant</b> (10) <b>Pepper</b> (10) <b>Radish</b> (5-7) <b>Sweet Corn</b> (7-10) <b>Swiss Chard</b> (7-14) <b>Tomato</b> (7-14) <b>Turnip</b> (7-14)	<b>Pumpkin</b> (7- 10) <b>Squash</b> (7-14) <b>Watermelon</b> (4-10)
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Numbers in parentheses are days for germination.

### Vertical Supports

Growing plants vertically using stakes, cages, or trellises will help you fit even more plants in your garden. Staked or caged tomatoes require about 1/4 to 1/2 the space as those grown on the ground. Supporting plants off the ground can reduce some disease and insect problems.

It is a good idea to plot your garden on paper before planting. Remember the space saving ideas such as companion cropping, wide rows, intercropping, succession planting and plant supports. Tracing paper can be used to plan successive plantings over the entire season. Draw your garden outlines first on graph paper and note which way is north. It is a good idea to plant the rows going east and west so the sun reaches all plants equally.

Check seed packets, catalogs, or gardening books to determine the garden area space each type of vegetable needs. Many vegetables are similar in size from cultivar to cultivar. Others may vary, such as bush pumpkins and regular vining pumpkins, or bush and vine type tomatoes.

Any permanent (perennial) plantings already in the garden, such as rhubarb and asparagus, should be at one side of the garden so they are not in the way when preparing the soil. Long season crops, such as parsnips, should be planted near the perennial crops so they are not in the way when planting succeeding crops.

Plan to plant tall crops such as corn, asparagus, sunflowers, staked or caged tomatoes and pole beans on the north side of the garden so they do not shade the short plants. An exception is on exposed sites where a windbreak is needed. Sunflowers or corn planted on the south or west side can provide a windbreak. Be sure to plant shade tolerant crops next to tall crops. Note: Since corn is wind pollinated, it is best to plant it in three or more short rows side by side. If planted in one or two long rows, pollination and therefore kernel set may be poor.

Your finished garden plan should indicate:





- What crops you are going to grow
- Approximate planting dates
- Where each row will be
- The distance between crop rows

All planned plantings can be drawn on one sheet, or a separate plan can be made for a fall garden. As the days grow cooler in the fall, the same vegetables you planted in early spring can be planted again. See your local Cooperative Extension office for more information on planting a fall garden.

## Improving the Soil

For optimum plant growth, the soil must supply nutrients and allow for the penetration of water and oxygen to the roots. Depending on the soil type or location, the garden may be prepared at different times of the year. In the northern US, heavy soils often benefit from fall plowing, tilling or spading, which exposes the soil surface to freezing and thawing during the winter months. Cover cropping in the fall helps control erosion especially on sandy soils. Cover crops should be plowed or tilled early in the spring to work the vegetation uniformly into the soil. Cover cropping adds organic matter to the soil and protects exposed soils from winter wind and water erosion.



Another alternative is to add fertilizer and organic matter, just as compost, to the soil before spading or rototilling the garden. Some nutrients are leached out of the soil by rain or irrigation water; others are lost each time a crop is harvested. There are many different types of fertilizers you can use in your garden.

Granular fertilizers are the most commonly used types of fertilizers in home gardens. They can be spread on the soil and worked in with a spade. A complete fertilizer contains nitrogen, phosphorus and potassium (the nutrients most commonly needed in a garden). An analysis, or percentage of the nutrients in the fertilizer, will always be on the container. The analysis will be three numbers such as 5-10-5, 20-20-20, or 4-10-6 (sometimes there will be a fourth number if the fertilizer contains a special nutrient.) The numbers on the bag indicate in order, the percent of nitrogen, phosphorus as phosphorus pentoxide (P<sub>2</sub>O<sub>5</sub>) and potassium as potash (K<sub>2</sub>O). In 100 pounds of 5-10-5, there are 5 pounds of nitrogen (N), 10 pounds of P<sub>2</sub>O<sub>5</sub> and 5 pounds of K<sub>2</sub>O. This totals 20 pounds of nutrients. The other 80 pounds represent filler material. Use the fertilizer that comes nearest to the needs of all crops such as 10- 10-10, 18-46-0 or 5-10-5. Before purchasing, use the percentages to figure the actual cost of the nutrients to get the best buy. Since nitrogen is the most expensive ingredient, it is used to compare costs.

The amount and type of fertilizer added to the garden depends on many factors such as past fertilizer use, previous crops and soil type. To find out which nutrients and how much will be needed to add to the soil, the soil in your garden tested. A soil test determines the level of nutrients in the soil and the amount of fertilizer that needs to be applied for good plant growth. A soil test also determines the pH of your soil. pH is a measure of the hydrogen (potential Hydrogen) content in soil, with pH of 7.0 considered neutral.



A slightly acid soil with a pH from 6.0 to 6.7 is ideal for most vegetables. A pH above 7.0 is considered alkaline and sulfur may be recommended to lower it. In the eastern U.S., soils tend to be acid, while many dry western soils are alkaline. A low pH of 4.5 to 5.5 causes vegetables to grow poorly. Dolomitic lime is usually recommended to raise the pH of the soil. Lime should be applied three to six months prior to planting. Elemental sulfur can be applied to lower the pH of the soil. It should also be applied a few months to a year prior to planting for best results.

Organic matter such as animal manure, compost, grass clippings and tree leaves also can add nutrients to the soil. Organic matter can:

- Improve soil structure
- Improve drainage
- Help hold nutrients in the soil so they are not leached away

Cow, sheep, horse, pig and chicken manures all can be used to add organic matter and nutrients to the soil. Do not use cat or dog manure, because they may harbor parasites that can be transmitted to humans. If you are planting immediately after applying manure, use composted manure. Composted manure will not burn the plant roots with excess nitrogen and does not smell as much as fresh manure. Apply uncomposted manure and organic material and incorporate into the soil several months before planting so these types of manures will decompose prior to planting.

Compost is partially decomposed organic material such as yard and food waste. Many home gardeners start a compost pile where microorganisms, such as bacteria and fungi, break down lawn clippings, leaves, kitchen scraps, etc. into humus. As compost decomposes in the soil, nutrients are released slowly. Compost generally will not supply all the nutrients required for optimum growth, but usually supplies most of the plant micronutrients. To make sure your plants get all the nutrients they need, use a combination of organic (manure, compost) and inorganic (fertilizer) sources.

Before spading or tilling the garden, spread compost, manure and/or fertilizer over the garden so it can be worked into the soil. The garden should be spaded or rototilled to a depth of 6-10 inches. Deeper cultivation is better because it loosens the soil so plant roots can become more extensive.

Avoid working wet soil, as it compacts and forms large clods when clay particles are present. The clods are hard to break up, and compacted soil can keep plant roots from growing well. To see if the soil is too wet, take a handful of soil and try to form a ball with it. If it forms a ball that does not crumble apart when pressed, it is too wet. If the ball crumbles when pressed, it is dry enough to work. Use a rake or hoe to break soil clumps into a relatively fine seedbed. Do not work the soil too fine or it will form a crust making it difficult for seeds to emerge.

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## Planting

For best results, plant vegetables at the recommended soil temperature. In most of the US, cool season vegetables are planted early in spring for an early crop, and in mid-to late summer for fall crops. In parts of the US where winters are mild and have little freezing, cool season crops are planted in the fall and winter months. Warm season vegetables should be planted after danger of frost has



passed. With the garden plan in hand, measure and mark the rows so they are straight and the plants in each row have adequate space.

Direct seeded vegetables generally need to be thinned for optimum growth. Proper spacing within and between rows promotes faster growth and larger, better quality produce. Gently pull excess plants or snip them off with scissors so nearby plant roots are not damaged.

Some crops do best when started as transplants, slips, sets or tubers. In transplants are not purchased, start them inside under lights, in a bright sunny window, or outdoors in a cold frame or hot box. Adequate light is very important for good transplant production. Too little light results in weak, spindly plants that perform poorly in the garden. Another way to produce short, stocky plants is to brush them lightly with your hand or have an oscillating fan blow a gently across the plants for part of each day. Brushing or air movement helps simulate the wind the plants would be exposed to outdoors, helping the plants produce stronger, thicker cell walls that result in sturdier plants.

Transplants should be started early enough that they can be hardened off for a few weeks before the actual transplanting date. To harden plants, gradually expose them to full sunlight, cooler temperatures, and wind for a few hours each day. Gradually increase the exposure over a two week period until the plants can tolerate full sun and wind. Gradually decrease the frequency of watering and fertilizing, but do not allow the plants to wilt or become nutrient deficient.

When purchasing transplants, select short, stocky plants of recommended cultivars. Transplants should already have been hardened off and ready to plant. Plant transplants at recommended distances. Most plants should be planted at the same level they were growing in the pot. Tomatoes can be set deeper, since they root easily along the stem. If plants are in peat pots, tear off the top edges of the pots and remove the bottoms of the pots so the roots can grow. If exposed, the top edge of a peat pot acts as a wicks, drawing water out of the soil and killing the new transplants due to lack of water available for the roots. Remove all other pots before planting. Lightly firm the soil around the transplants and water them. A water-soluble starter fertilizer solution high in phosphorus helps seedlings become established and grow vigorously. Keep transplants watered, protected from harsh winds and shielded from bright sun until they are well established.

When the properly amount of space most from pole rows or plants three mound of formed for hill as large Seeds ensure seed has taken up water, it can not dry out or it will die.



plants are directly seeded in garden, they should be spaced to reduce the thinning needed later. Use saving techniques to get the your garden. Vine crops and beans can be planted in hills (a hill is a group of growing in a cluster). Thin to plants per hill. Sometimes a soil 3-6 inches high is better drainage. Yields from planted crops are usually not as those planted in rows. must be kept moist to proper germination. Once a

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## Mulch

Mulching reduces the amount of water your garden needs. There are two types of mulch, organic and inorganic. Examples of inorganic mulches are clear and black plastic film. Commercial growers often use plastic mulches to conserve moisture, warm the soil and control weeds. Organic mulches include grass clippings, dry leaves, compost and newspapers. Home gardeners more commonly use organic mulches.

Many garden plants are subject to injury by herbicides used on lawns. When lawns have been treated with herbicides to control weeds, grass clippings from treated lawns should be not applied to gardens unless they have been collected and composted. After two subsequent cuttings, lawn clippings may again be immediately utilized in gardens.

In addition conserving water, mulches help smother weeds, lessen soil compaction, reduce soil erosion, help keep fruit (tomatoes, cucumbers) and leafy crops (lettuce, spinach) clean and increase yields. Organic mulches insulate the soil from heat and cold and, when incorporated, increase the organic matter content of the soil.



Organic mulches should be applied at the correct soil temperatures (which in turn affect the growth of different crops) because of the insulating ability of mulches. If the soil is cool when mulch is applied, the soil remains cool. Apply mulch to cool season crops before the soil gets too warm. Warm season crops, such as tomatoes, peppers and squash, like warm soil. Mulch after the soil has warmed to avoid stunting these plants.

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## Controlling Weeds

Weed control should begin soon after the garden is planted. Weeds are easiest to control as weed seedlings. At this stage, scraping the soil with a hoe cuts the weeds off so they dry out and die. Once weeds get a foothold, they are hard to control. Allowing weeds to grow can result in crowding and shading of vegetables, reducing vegetable yields.

Shallow hoeing a day or two after watering or a rain is a good time to stop weeds. Hoe in the morning before it gets hot. The afternoon sun will dry out and kill the uprooted weeds. Controlling weeds also prevents disease and insect infestations, as some weeds harbor pests that attack garden plants. A small, weed-free garden can out-produce a large, unkempt one, both in quality and quantity of vegetables.



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## Controlling Insects and Diseases

Insect pests can be a nuisance in the garden because damaged plants produce fewer vegetables. Careful monitoring of plants is necessary to keep ahead of insect problems. Prevention or reduction



of insect damage is often necessary to raise high quality vegetables. Many gardeners deal with insects through a pest management program. Pest management is different from pest eradication. Over the years, scientific research coupled with observations has shown that a war against insect pests is never completely won. Insect pests can be dealt with or managed for a short time to enable a garden to be highly productive.

Cultural practices can help reduce the number of insect pests in the garden. Healthy, vigorously growing plants usually are less subject to attack by insects. However, certain vegetables are naturally more vulnerable than others. Use these methods to prevent insect damage in your garden.

- Use plant "collars" around transplants to prevent cutworm damage. Recycle juice cans, milk cartons or other similar containers and place them around the stem of plants to prevent insect attack. Be sure the container is large enough to allow the stem to grow. Cutworms like to hide in the soil around the base of plants during the day. Check the soil next to the plants before placing collars to be certain a cutworm is not hidden inside the perimeter of the collar.
- Rotate vegetable crops. Many insects overwinter in the soil. Do not grow the same family of vegetables in the same place as the year before.
- Remove or turn under all garden plants at the end of the growing season. Plants left in the garden can serve as infestations sources of insects and diseases for subsequent plantings. Remove heavily infested plants and put them in the trash or compost pile. A properly constructed compost pile should heat up enough to kill insects and diseases.
- Purchase transplants free of insects and diseases.
- Use floating row covers to protect against some insect pests.

Insect pests have natural enemies such as predators, parasites and insect diseases. Cabbage loopers and imported cabbageworms attack cole crops such as broccoli, cabbage and cauliflower. These pests are easily controlled, however, with a naturally occurring bacteria, *Bacillus thuringiensis*, commonly referred to as Bt. As an insecticide, Bt kills the larval (caterpillar) stages of many butterflies and moths after the caterpillars have eaten Bt, but Bt is not equally effective against all species. Certain strains of the Bt bacteria are also used for control Colorado potato beetle and bean beetles.

Horticultural oils and insecticidal soaps are other materials that are not toxic to people, pets and wildlife yet are excellent for controlling insect pests in the garden. Most usage of the oils is for scales on fruit trees, but some have shown to be effective repellants on certain insect pests. Insecticidal soaps are effective against softbodied pests (aphids, spider mites).

Not all insects are harmful for vegetable production. Many insects are beneficial because they control other insects. Common beneficial insects that are predators of other insects include the ladybird beetles (lady bugs), preying mantids, dragonflies, predaceous flower bugs, big-eyed bugs, spined soldier bugs and damsel bugs. Certain very small wasps, such as *Trichogramma* spp., attack insect eggs. A number of fly and wasp species are common parasites that live on or in other insects. Insects can also be infected and die from diseases caused by viruses, bacteria and fungi.

The **honeybee is probably the most beneficial of all insects**. Without honeybees to pollinate many of our crops there would be very little fruit to eat or vegetable seeds to plant. Read the label before using any pesticide to learn how to lessen damage to bees and other beneficial insects.

Mechanical control refers to actions or devices used directly against insect pests. Mechanical control can be as simple as picking insects or their eggs off plants or hitting them with a



flyswatter. Other examples of mechanical control include insect traps, barriers and screens that keep insects from reaching plants.

Lightweight floating row covers, such as Reemay®, can keep insects off plants. Air, water and sunlight pass through the fabric but insects cannot. The covers also help hold in heat so plants grow quickly. Row covers must be removed on insect pollinated crops, like squash and melons, at flowering for pollination to occur.



Chemical pesticides are sometimes necessary to control heavy infestations of pests. Check with your local Cooperative Extension office for current recommendations. Chemical control can be safe and efficient when applied properly and label directions are followed. When using any product for pest control, always read and follow the directions on the product label carefully. Do not use more than the label recommends. Your best approach with insect pests may differ with each and every pest problem. For a good pest management program, follow these steps:

- Check plants often. Look at them closely and try to identify any problems.
- If the problem is an insect, identify the insect.
- Determine the potential for damage caused by the pest.
- Determine your options for controlling the pest and the pros and cons of each.
- Use the "best" combination of control methods, follow label recommendations for chemicals and waiting periods until harvest.

The best pest management program will vary with each crop, season, gardener and soil type.



Diseases are caused by bacteria, fungi, viruses and other organisms too small to see with the naked eye. Cultural practices can help reduce diseases in your garden.

- Select disease resistant cultivars. Plant breeders work hard to develop plants that need fewer pesticides. Read descriptions in seed catalogs or on seed packages to find out

which cultivars are tolerant of, or resistant to, the diseases which are expected to be problems. Water plants early in the morning so the foliage dries more rapidly. Increased humidity in the evenings means the foliage does not dry well and favors disease development.

- Water the soil at the base of the plant, not the foliage. Soil splashed on leaves can spread diseases.
- Use mulch to reduce diseases spread by soil splashing.
- Rotate your vegetable crops. Diseases can overwinter in the soil and attack plants.
- Remove all diseased plant parts before they can infect other plants in your garden. Do not put diseased plant material on the compost pile unless you know the compost pile will heat up enough to kill the disease organisms. Monitor the pile with a thermometer.
- Check with your local Cooperative Extension office for current information on fungicides.

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## Harvesting and Storing Garden Produce

If one hasn't grown a particular vegetable before and is unsure when the vegetable should be harvested, check the produce at a grocery store or check on-line at [www.farmersalmanac.com](http://www.farmersalmanac.com). Commercial growers harvest their produce at its peak so comparing those vegetables with the garden specimen can assist in the decision.

Storing your vegetables properly will help to preserve the quality. For example, tomatoes and squash were originally grown in the tropics. They do not like cold temperatures and will exhibit symptoms of chilling injury when stored below their minimum recommended temperature. Symptoms of chilling injury are decay, pitting, discoloration, softening and poor flavor.

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## Fall Gardening

Fall gardening can extend the growing season by a few months for those located in northern states, and is the time period many people in southern states begin to plant their cool season vegetables that will be harvested during the winter months. During the summer, it may be difficult to think about more planting but a fall garden can produce premium cool-season crops. All debris from previous crops should be removed and the soil reworked. Plant seeds slightly deeper than normal (2-4x of the seed diameter) and keep the soil moist. Use a very light mulch or a board over the row to retain moisture, but remove the board as soon as germination begins. Plant your fall garden to one side of the summer garden so the rest of the space can be cleaned up as soon as frost kills warm season crops or when the harvest season for these crops is completed.

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## Preparing for the Next Season

In northern states when the ground freezes, the ground can be prepared in the fall to get a head start on the garden next spring. By waiting until after several hard freezes, spade, rototill, or plow your garden. By waiting until after several hard freezes, many insects will be killed before tilling. Remove and throw away any severely infested or infected plants. Mowing the dead plants first will make it easier to incorporate them into the soil or put them in/on a compost pile. Rough soil will collect snow

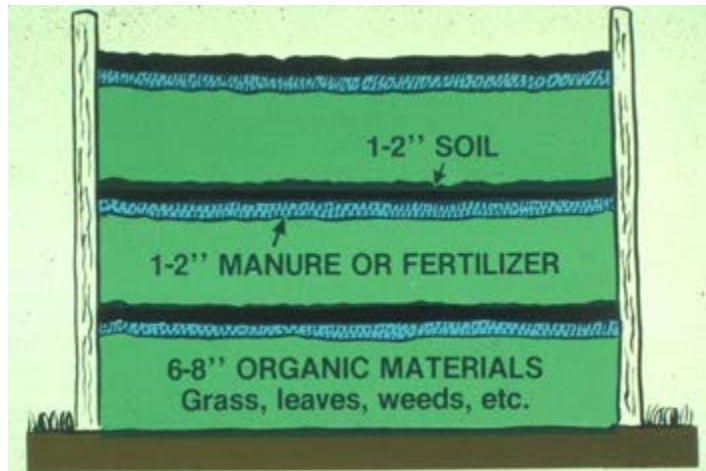


and rain for moisture next spring when final planting preparations are made in northern states.

Gardeners in southern states or in coastal areas often can grow vegetables year round because they do not have killing freezes. Plant sanitation/removal from the garden becomes even more important to limit diseases and insects, and should be done as quickly as possible.

Composting plant residue not heavily infected with diseases, insects, or weed seed provides a good source of mulch for the garden. Leaves, lawn clippings, straw, kitchen and garden refuse all are good additions to the compost pile. A nitrogen source (i.e. commercial fertilizer or manure) needs to be added if the pile is high in carbon refuse (wood chips, leaves, straw). The pile should be kept moist and turned regularly to hasten decay.

Compost can be made in a pile or bin. Fall is an excellent time to start a pile, as leaves are plentiful. Build the pile in 6-inch layers alternating green (high nitrogen) and brown (high carbon) materials. Sprinkle a small amount of soil or old compost between the layers to get a good start of beneficial microorganisms that help create compost. If green materials are not available, use 1/2 pound (1 cup) of commercial fertilizer such as 10-10-10, 10-20-10, to each ten square feet of surface over the brown layers. Sprinkle each layer with water to moisten but not soak the pile.



The minimum size for a compost pile is one cubic yard. There is no limit on how large it can be as long as it can be turned to keep it well oxygenated.

As the compost pile heats up, decomposition will occur faster if the pile is turned to incorporate air into the pile. Water may need to be added as the pile is turned so microorganisms can work effectively. If properly prepared, a compost pile heats to about 140°F and kills insects, diseases and weed seeds.

1. Allard, R. W. 1960. *Principles of Plant Breeding*. John Wiley and Sons, page 472.