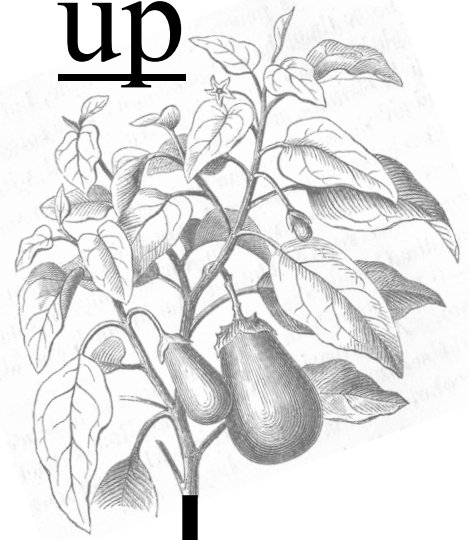
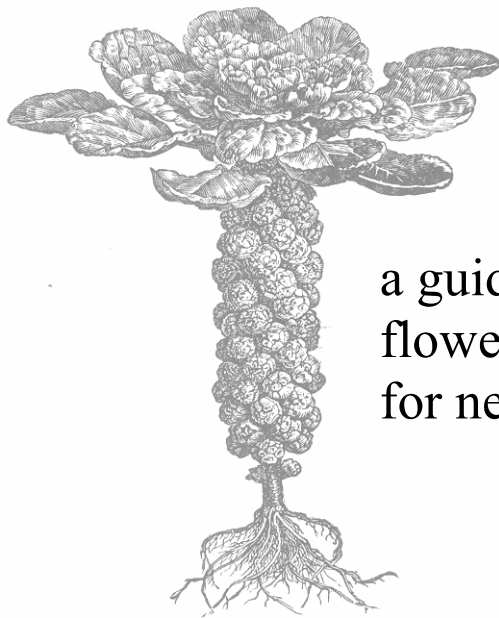


up



from the ground



a guide to basic **organic** vegetable,
flower, and herb gardening
for new gardeners

By Robin Mittenthal
mittenth "at" gmail.com
Version 1.12, April 2008

Table of Contents

Introduction to the guide

How to use this book	4
An important note for all users of this book	4
Why write yet another guide for gardeners?	4
About the illustrations	5

Getting started as an organic gardener

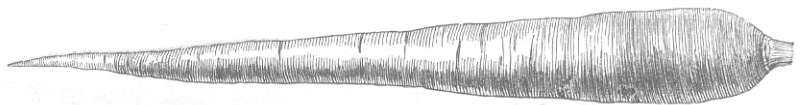
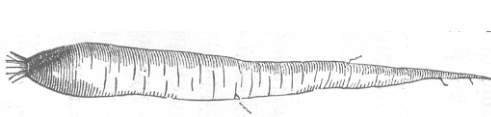
The absolute minimum amount you need to know	6
Why garden?	7
What does "organic" mean?	7
Why garden organically?	9
Weeds	9
<i>Weeds – an introduction</i>	9
<i>Why are weeds such a problem?</i>	9
<i>What makes a plant a weed?</i>	10
<i>How to manage weeds</i>	10
<i>Hand weeding</i>	11
<i>Weeding with a hoe</i>	11
<i>What to do with weeds once you've pulled them out</i>	11
<i>How obsessive should you be about weeding?</i>	11
<i>Grass weeds – a special case</i>	12
<i>Weeds through the season</i>	12
<i>Perennial crops and weeds</i>	12
Where should the garden be?	12
How big should the garden be?	12
Planning what to grow	13
Your first few days in the garden	16
The garden through the season	16
<i>Spring and early summer – getting started with planting</i>	16
<i>Summer and early fall – planting and harvest</i>	16
<i>Fall – preparing for frost and dealing with it when it comes</i>	17
<i>Late fall -- preparing the garden for winter</i>	17
<i>Winter and early spring – resting and planning</i>	18
Getting seeds and plants	18
<i>Getting seeds</i>	18
<i>Getting transplants and other non-seed plant materials</i>	19

Glossary

Beds	20
Compost	20
<i>What is compost?</i>	22
<i>Why compost?</i>	22
<i>Conditions needed for composting</i>	22
<i>Choosing ingredients for the compost pile</i>	23
<i>Some materials for possible use in composting</i>	24
<i>Building a compost pile</i>	24
Fertilizer	25
<i>An introduction to elements essential for plant growth</i>	26
<i>Why use organic fertilizers?</i>	26
<i>Buying organic fertilizers</i>	27
<i>Applying organic fertilizers</i>	28
Floating row covers	29
Garden plans	31
Hybrid vs. open-pollinated plants	32
Laying and removing plastic mulch	33
Mulch	32
<i>Materials to use for mulch</i>	34
Pests	36
Preparing a bed for planting	38
<i>Why do any special preparation?</i>	38

Timing of preparation.....	39
Steps in bed preparation	39
Preparing a new garden plot.....	41
Season extension techniques	42
Soil	43
<i>What is soil?</i>	43
<i>Minerals</i>	43
<i>Organic matter</i>	44
<i>Living organisms</i>	45
<i>A quick note on soil health and soil erosion</i>	45
Soil amendments	45
<i>Soil amendments are not fertilizers</i>	45
<i>What soil amendments are, and why you should use them</i>	46
<i>How much soil amendment to apply</i>	46
<i>How to apply soil amendments</i>	46
<i>Mulch can count as a soil amendment</i>	46
Starting plants inside.....	47
Thinning.....	48
Tools.....	49
<i>The three essential tools – spade, hoe, and garden rake</i>	49
<i>Very useful tools and other tools</i>	49
Transplanting	51
Watering	54
<i>Hand watering</i>	54
<i>Overhead watering with sprinklers</i>	55
<i>Surface level watering with drip hoses or soaker hoses</i>	55
<i>Buying hoses</i>	55
<i>More watering tips</i>	55
Weed guide	56
<i>A few notes on identifying weeds</i>	56
<i>Grass weeds and non-grass (broadleaf) weeds</i>	56
Resources for more information	105

Quick reference guide to vegetable planting	61	Greens (includes lettuce and spinach)	83
Crop pages	66	Herbs.....	86
How to use the crop pages	66	Kale	90
Artichoke, Jerusalem	66	Kohlrabi.....	91
Asparagus.....	67	Leeks	91
Beans.....	67	Melons (includes watermelons)	91
Beets.....	68	Okra	92
Broccoli	69	Onions.....	93
Brussels sprouts	69	Parsnip	93
Cabbage	70	Peas	93
Cauliflower	70	Peppers.....	94
Carrots	71	Potato, Irish.....	96
Celery, celeriac, and lovage	71	Potato, sweet	97
Chard, Swiss.....	71	Pumpkin	97
Collard greens	72	Radish	98
Corn, sweet	72	Rhubarb	98
Cucumber	72	Squash, summer (includes zucchini).....	98
Eggplant.....	73	Squash, winter	99
Flowers	74	Tomato.....	101
Fruits	79	Turnip.....	104
Garlic.....	80		



Introduction to the guide

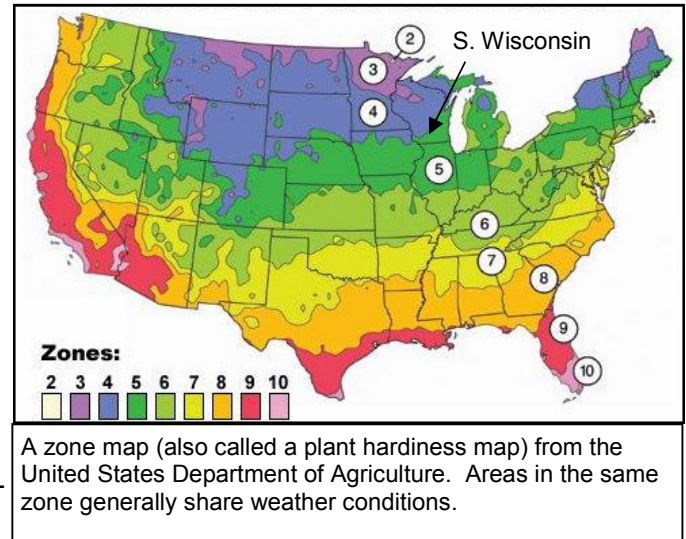
How to use this book

If you have never gardened before at all, you would do well to read the section titled ***getting started as an organic*** gardener, and especially the page titled **the absolute minimum amount you need to know**. If you have some gardening experience, use the table of contents to skip to the page(s) on the subject(s) you need help with.

Throughout the book, terms that are shown in the table of contents are indicated in ***bold italic*** type,

An important note for all users of this book

While much of the gardening information in this book could be applied anywhere in the world, it is important to note that the specifics of weed and pest species, planting dates, and other location and weather-related information included here represent prevailing conditions in southern Wisconsin and, more generally, zone 4 on the map at right. Failure to adjust planting dates to your location could, for example, result in losing your crops to frost. See ***sources for more information*** for tips on finding equivalent information for your location.



Why write yet another guide for gardeners?

People have been writing how-to books and pamphlets about gardening for thousands of years. Some of those guides are very good, and today, just about anything you might want to know about gardening is available on the internet. So why write yet another new manual for gardeners? There are several reasons. First, many garden guides provide either too much information about the work of gardening (so much that the novice gardener is overwhelmed), or too little (assuming knowledge of “basic” practices that are actually quite complicated). Second, most books provide too little information about the planting and care of popular crops to ensure successful growing. Third, many manuals tell you to do things but don’t explain why; this manual attempts to give brief, common-sense explanations for *why* you should do what you are asked to do. Fourth, many books, pamphlets, and web sites talk casually about the use of poisonous compounds that environmentally conscious and health-minded gardeners find unacceptable. Finally, it may perhaps be useful to provide a non-copyrighted manual in electronic format that others can expand, shrink, or otherwise modify to suit their needs and geographic locations.

The information presented in this garden represents a combination of the author’s personal experiences as a gardener and farmer, information collected from various publications put out by state agricultural extension services across the upper Midwest, and the organizational structure of a number of old gardening manuals. The author is grateful both to nation’s dedicated extensionists, who are a rich and often underused resource for gardeners, and to the long-dead authors of those garden manuals, who were in many ways more expert than almost any gardeners are today. Besides taking great professional pride in their work, those gardener-writers (and their audiences) planted much larger gardens than we do today, relied more heavily on their gardens for food than most of us do, and

worked with what we might consider rudimentary tools. It used to be that all of the physical work of gardening was done either by horse or by hand, and it may be that that made for a different attitude toward the earth and the passage of time than does the use of rototillers and other power equipment.

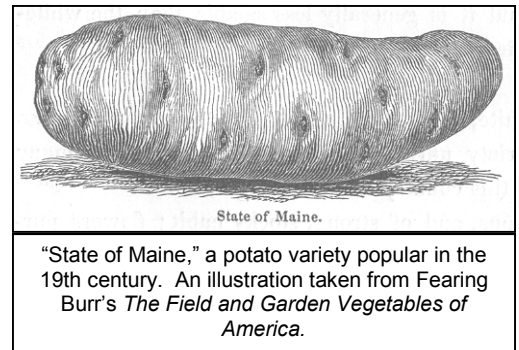
About the illustrations

The obviously amateurish illustrations in this manual were done by the author. The beautiful, professional-looking illustrations and photos used throughout were scanned from the garden manuals mentioned above. All of these were published at least 80 years ago, thereby freeing the author to use their pictures. Most of the illustrations were taken from the following five books:

W.S. Blatchley's *The Indiana Weed Book*, published in 1912 in Indianapolis by the Nature Publishing Company.

Fearing Burr's *The Field and Garden Vegetables of America*, published in Boston by J.E. Tilton and Company in 1865.

E.D. Darlington and L.M. Moll's *How and What to Grow in a Kitchen Garden of One Acre*, edited and published in New York by W. Atlee Burpee and Company in 1907. (W. Atlee Burpee founded the Burpee seed company, which is still in business today. This book was enormously popular. It went through sixteen editions between 1888 and 1907, and many more after that.)



Peter Henderson's *Gardening for Pleasure*, first published in New York by the Orange Judd Company in 1887, and reissued in 1915.

Getting started as an organic gardener

The absolute minimum amount you need to know

If you read nothing else from this guide, read the following 14 steps and give gardening a try. You may find that you don't like it, or you may find that you like it enough to want to read more of the guide. Good luck!

1) Think about the vegetables and herbs you enjoy eating and the flowers you enjoy looking at. Make a list of those you enjoy most, and think about which are hardest to find or most expensive to buy in stores – those are the ones you'll want to grow. Sweet corn, winter squash, and watermelons are popular choices, but be aware that they take up *a lot* of space (winter squash, for example, should be planted at least 180 cm/6 ft apart). Other vegetables take more space than you might think – tomatoes, for example, should be planted at least 60 cm (24 in) apart. Some plants that get big (cucumbers and pole beans, for example) can be trained up structures called trellises so they take less space.

2) Divide the crops you want to grow into cool-season crops (which do best in the spring and the fall) and warm-season crops (which do best in the summer). Common cool-season crops include beets, broccoli, cabbage, carrots, cauliflower, collard greens, kale, lettuce and other salad greens, peas, potatoes, radishes, spinach and turnips. These crops can survive cold weather (even some frost).

Popular warm-season crops include beans, corn, cucumbers, eggplant, okra, peppers, pumpkins, squash, tomatoes, and watermelons. These crops need very warm weather to grow and cannot survive frost at all.

3) Further divide the crops you want to grow into crops that can be grown from seed in the garden and those that are usually planted in a house or greenhouse and moved (or transplanted) into the garden as small plants. Of the crops listed above in step 2, broccoli, cabbage, cauliflower, collard greens, eggplant, kale, peppers, and tomatoes are almost always transplanted by new gardeners. Cucumbers, pumpkins, and watermelons are sometimes transplanted and sometimes not (buying or growing your own plants can protect the young plants from pests and cold weather that they would meet in the garden). Other plants are grown from seed.

4) Using your lists from steps 2 and 3, above, figure out which plants you need to buy as seed and which you will buy as transplants. In late winter, go to a garden store or use a mail or internet catalog to buy the seeds you need. You will buy the transplants when you need them later. If you are a new gardener, it is recommended that you plan to buy transplants at a nursery or garden store rather than growing them yourself.

5) In April, or as early after that as you can, find a garden spot (or take whichever one you've been given). If you have a choice, your garden location should be flat and exposed to full sun all day.

6) Use whatever tool(s) you have handy to break up the soil throughout your garden. If at all possible, add some fertilizer and soil amendments. Talk to an experienced person at a good garden store for suggestions about what to buy, emphasizing that you want to grow organically.

7) Mark off the areas you plan to grow in with sticks. Leave paths in between that are at least 30 cm (12 in) wide.

8) Use your tool(s) to prepare smooth beds where the topmost soil is very fine (no large lumps).

9) Using the directions on the seed packets you bought, start planting seeds of cool-season crops (again, this can happen as early as the beginning of April for many crops). Leave space for the warm season crops, which will not get planted until late May or early June (or plant very quick-growing crops that will be finished by early June).

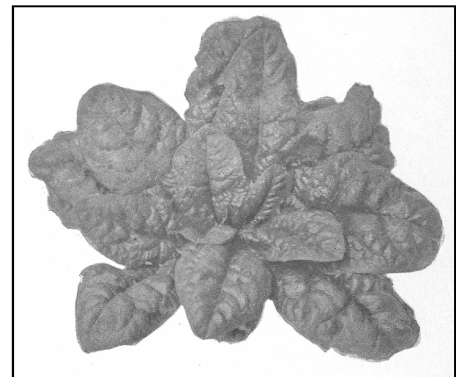
10) Weed your garden regularly (at least once a week), and put down leaves, straw, newspaper, and/or cardboard around your crops to keep weeds from growing. Harvest crops as they mature.

11) When all danger of frost has passed (in late May or early June), buy transplants of warm-season crops and plant them in the garden as quickly as you can after buying them.

12) Continue weeding and harvesting through the summer, watering your garden thoroughly (for one hour or more) once a week if it has not rained.

13) As cold weather approaches in October, begin replacing warm-season crops with cool-season crops as the warm-season crops begin to die.

14) Harvest your garden for as long as you can.



Spinach. One of the greatest delights of the home garden.

Why garden?

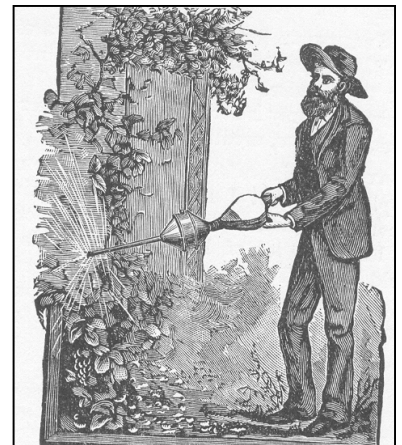
There are as many reasons to garden as there are gardeners. With a little land, a few seeds and tools, and some fertilizer, anyone willing to put in the time and effort can grow a wide variety of delicious and nutritious vegetables (and perhaps some fruit, too). Growing your own vegetables can cost significantly less than buying them (unless you pay yourself to work in the garden), and the food you grow may be more nutritious than equivalent produce purchased at grocery stores. We live in an age in which food marketing is all about cholesterol, fiber, and this or that type of fat. Gardening helps you turn away from this absurdity and return to the idea of eating whole, nutritious, delicious *food*, as opposed to whatever “nutrients” the latest scientists, marketers, and journalists have told us might be best (or worst) for our health. Similarly, in an era in which many Americans are almost completely sedentary (or go to great lengths to “exercise”), gardening is a form of activity (strenuous or not-so-strenuous, as you choose) that has a useful end product and doesn’t require wearing lycra tights. For those overwhelmed by the pace of modern life, gardening can provide a focused, mindful break from constant noise and rush. For others, the feeling of stewardship of a piece of land, of soil and plants, is important. For those with children, gardening can be an excellent way to introduce children to the natural world and to food production and preparation. Finally, many just plain find it enjoyable. What more reason do you need?

What does “organic” mean?

Weeds compete with desirable plants for light, water, and nutrients. Insects, bacteria, fungi, viruses, and other creatures eat the leaves, stems, seeds, and fruits of those same desirable plants. Weeds and pests have always been among the greatest challenges for gardeners and farmers, and for most of human history, the only way to deal with them was to use simple, nonchemical methods – hoeing or hand pulling of weeds, for example, removing the eggs, larvae or adults of crop-destroying insects, or pulling up plants that were obviously sick with some kind of disease.

Over time, particularly in the 19th century, a number of compounds were developed or discovered naturally occurring in plants and animals that served to kill insects, fungi, and other living things. Though there was some awareness of the toxicity of these compounds to humans (many of the substances used were based on arsenic and other poisons), they still seemed like a godsend and were widely used in agriculture.

In the 20th century, more sophisticated understanding of chemistry and biology (together with a huge research push, including the effort to make poisonous gases for use in World War I and World War II) led to the development of much more potent chemicals, including the first herbicides, or compounds that kill plants. As with the simpler chemicals that came before them, these new compounds – now known collectively as “pesticides” – were eagerly embraced by farmers and gardeners. In addition to better controlling insects and diseases, they offered the promise of simplifying weed management, which is some of the most difficult work of growing food. Together with the breeding of new crop varieties and the widespread use of so-called “synthetic” fertilizers (which are made through the petroleum-based capture of nitrogen from the atmosphere and the extraction of other nutrients through mining of the earth’s crust), pesticides led to the “Green Revolution” of the latter half of the 20th century, a time of dramatically increased global food production. This huge increase in food production has helped to feed a global population that went from under two billion in the year 1900 to more than six billion in the year 2000.



A 19th century gardener casually spraying his vegetables with chemicals that we now know are bad for your health.

As time has passed, however, pesticides and synthetic fertilizers have been shown to have a number of unintended consequences. Pesticides can (and, it has been shown, often do) kill or harm organisms other than the target pest, and may remain on our food and in the environment for many years before being broken down into harmless chemicals. Many insects, plants, and other organisms have also become resistant to widely used pesticides, resulting in a neverending arms race between pests and pesticide manufacturers. Both pesticides and fertilizers can end up in ground water and surface water, killing fish, causing algal blooms, and otherwise damaging important habitat. Synthetic fertilizers have also encouraged a simplistic concept of soil fertility – the idea that plants need only be provided with nitrogen, phosphorus, and potassium -- at the expense of long-term soil health.

For these and other reasons, large numbers of farmers, food processing companies, and consumers have moved and are moving toward a model of agricultural production known as “organic.” The term “organic” has both informal and formal meanings. To many food consumers today, it refers to something more-or-less vaguely “natural” (grown without pesticides, for example) that’s somehow better (or less bad) for the environment and your health than something that isn’t organic.



The symbol used on food products to indicate that the products were grown and processed in compliance with the United States Department of Agriculture’s definition of what it means to be

The formal definition of “organic” does have a lot in common with this idea, but there’s more to it than simply the absence of synthetic pesticides. To organic farmers, food processing companies, scientists, and government regulators, the term “organic” refers specifically to food production that follows the rules of the United States Department of Agriculture’s National Organic Program, or NOP. NOP provides very specific guidelines about both chemicals and practices that are allowed in the production and processing of foods that end up being certified as organic by the USDA and other certifying agencies. It’s worth noting that the NOP *does* allow the use of some substances – including pesticides – that *are* toxic to humans and/or other organisms, but which are believed to be less harmful to human health and the environment than analogous chemicals used in so-called “conventional” agriculture. One example of such a substance is pyrethrin-based insecticides, which are derived from flowers (especially chrysanthemums). While pyrethrins are toxic to humans, they break down quickly in the environment into harmless compounds.

Other formal aspects of “organicness” have to do with the use of food additives and preservatives, for example, and with how animals are treated, rather than with what chemicals are used in food production. To determine whether or not a particular compound or practice is or is not considered organic under the NOP, check the NOP web page (<http://www.ams.usda.gov/NOP/NOP/NOHome.html> as of 12/06). In particular, you may want to look at what’s called the *National List of Allowed and Prohibited Substances*, which tells you what synthetic substances you may and may not use in an organic farm, garden, or food processing setting.

It is perhaps worth noting that some farmers, food consumers, and others do not like the NOP very much – they feel it does not go far enough in specifying an environmentally and socially responsible set of practices for agriculture and the food industry (the NOP says little, for example, about how agricultural workers should be housed, paid, or otherwise treated, such that they can still be exploited in organic food production and processing just as they have long been in the conventional system). However, the NOP is an evolving program and it may in the future tighten regulations about what is permitted in the production of “organic” foods. For now, the NOP represents a substantial step away from the mainstream food system of the last 50 or so years.

Why garden organically?

For starters, it's possible to ask "why *not* garden organically?" Much of the damage to the environment caused by "conventional" production methods results from growing large, continuous areas of the same crop. Backyard gardeners who grow only a few plants of many different kinds often have few pest problems without doing anything at all. Those backyard gardeners who use lots of pesticides are those who unwilling to pull weeds, have a low tolerance for cosmetic damage to their vegetables and fruits, or otherwise seek a great deal of control over what grows and what does not. If you are willing to pull weeds (or use non-chemical tools to prevent their growth), are willing to tolerate some cosmetic damage to your produce, and are willing to accept that in any given year some crops may not do well, you have the attitudes needed to get along just fine as an organic gardener.

Why else garden organically? Well, there's no question that many of the compounds used in conventional agriculture are poisons. If you don't have these poisons around and don't use them in your garden, you and your children, neighbors, and pets will not be touching, inhaling, or consuming them (at least not on the foods you grow yourself). You will also not be contributing to the total environmental load of these compounds.

If you use organic **soil amendments** such as compost, fertilize with organically approved **fertilizers**, and generally pay attention to your **soil**, you may also end up with "better" **soil** than that of many conventional gardeners. Good soil has many earthworms and other organisms in it, is loose, is easy to dig in, is easy for your plants' roots to grow through, and is able to hold large amounts of water and nutrients and make them available to your plants. Conventional gardening and farming methods can be very harmful to the soil.

It should be emphasized that the use of organic methods DOES NOT *automatically* make a gardener or farmer a better steward of the environment than a conventional gardener or farmer. There are conventional farmers and gardeners who do an excellent job of caring for their soil and plants and who use pesticides as little as possible. At the same time, there are organic farmers and gardeners who do a terrible job of caring for their soil and plants and who shouldn't be allowed to grow house plants, let alone food. It is not the intention of this book to dissect the relative merits of organic and conventional production, but only to provide guidance in basic, sustainable organic gardening.

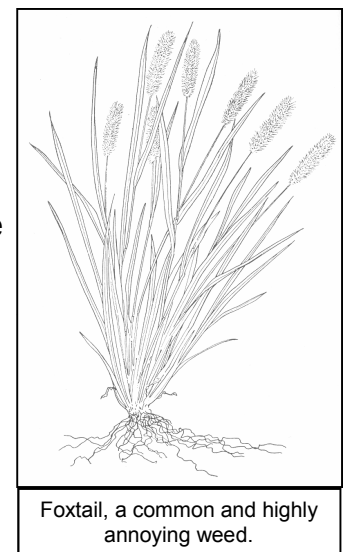
Weeds

Weeds – an introduction

If you aren't willing to put in the time and energy to manage weeds, you just can't be a successful organic gardener. Sorry. On the bright side, with some **mulch** and a modest, regular time commitment to weeding, you can keep ahead of the weeds.

Why are weeds such a problem?

You won't be able to see most of them, but if you dig a shovelful of soil out of the ground, there are almost certainly thousands of weed seeds in it. Scientists and farmers call this large mass of seeds the "weed seed bank." Each of the seeds in this bank is alive and waiting for the right conditions to germinate and grow. Unfortunately, when conditions are right for your tomatoes, okra, or peas, they are also right for at least some of those weed seeds, and you need to take action to keep the weeds



from outcompeting your desired plants.

To make matters worse weedwise, most gardening involves what are called *annual* plants, which must be grown from seed every year. While annual plants often grow quickly, they start out small and often do not compete well early in their lives with other plants that are trying to claim the same sunlight, water, and soil nutrients. Some plants are particularly poor at competing with weeds. Onions and their relatives, for example, have only a few narrow leaves that allow a lot of light to reach the ground around them. Light striking the ground encourages weeds to grow. Some other annual plants like tomatoes get large and have a plant structure more suited to shading out competitors, but they take long enough to reach their “adult” size that for much of the season there is a lot of exposed ground around for weeds to grow in. The saying “Nature abhors a vacuum” certainly applies to weeds – if you don’t prevent it somehow, any open, exposed soil *will* grow weeds.

Unfortunately for gardeners, some of the seeds in the weed seed bank can (and do) wait for years, or even decades, before germinating. As a result, even if you do a perfect job of weeding your garden (thereby preventing weeds from growing, flowering and adding new seeds to the bank), you will still have weeds every year. If you weed regularly, however, you should have less and less trouble with weeds as the years go by.

What makes a plant a weed?

In one sense, a weed is anything you don’t want in your garden. Weeds range from the harmless and easy to manage (so-called “volunteer” tomatoes, for example, that grow from the seeds of fruit you didn’t harvest the past year) to the nasty (such as Canada thistle, which can take over and ruin your garden unless you take aggressive steps to control it). One person’s weed may be another person’s treasure (the herb chamomile is one example of this – some people love it and some hate it).

Weeds in poetry

“Up there came a flower,
the people said, a weed.”

-Tennyson

How to manage weeds

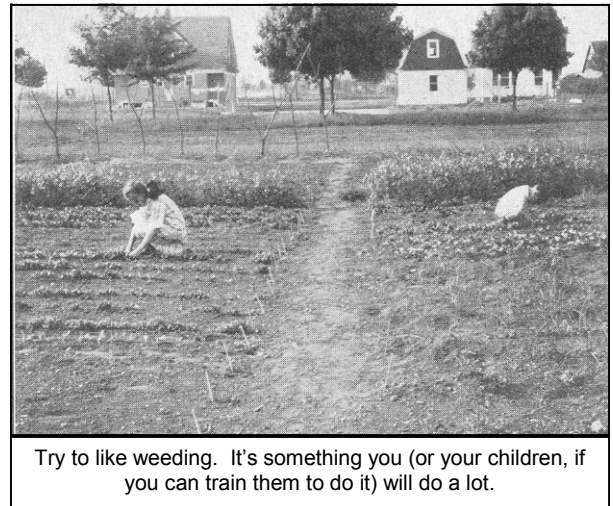
The single best way to manage weeds is not to allow them to grow in the first place. Having soil exposed encourages weeds to grow, so keeping as much of your soil covered as much of the time as possible is goal number one. While you might want to expose your whole garden at the beginning of the season to add **fertilizers** or **soil amendments**, and you will need to uncover parts of it to plant certain seeds, most of your garden can be covered most of the time with **mulch** of some kind or other. See the entries under **mulch** for a discussion of different materials for mulching and how to use them. Weeds will still germinate under your mulch, but many of them will be unable to push through the mulch, and those that do make it through the mulch will be weak and easier to pull out than if they had grown from unmulched soil.

Whether you mulch or not, you will still have to deal with at least some weeds. Organic farmers use many different tools to kill or remove weeds, but in a garden your two main options are hand weeding (often with some kind of small tool to help you) and weeding with a hoe (see **tools**). *However you weed, it is critical to remove the roots of your weeds.* If you rip off or slice off only the tops, the roots will send up new stems and leaves and it will be even harder to get the roots out than it would have been before. It is often easiest to weed after a rain or after watering your garden because the roots come up more easily. However, if you pull weeds out of wet soil and let them sit in contact with the ground in your garden, you’ll be surprised by how many of them can reestablish their connection to the soil and survive. For this reason it’s important to physically remove pulled weeds from your garden (to your **compost** pile, for example), or at least to make sure that their roots can’t reach the

soil.

Hand weeding

Gardeners with small plots (and those who are very conscientious users of **mulch**) may never do anything other than weed by hand. At one level, hand weeding is simple – find a weed, pull it up. In practice, pulling weeds so that you get the roots out takes some practice, and may involve a trowel, some kind of probing tool, or even a spade for large weeds (see **tools** for pictures of these implements). Weeds can also sometimes be difficult to tell apart from your desired crops. This can happen, for example, when you are growing plants from seed and the young plants have just emerged from the soil. There may be weeds growing in with them, but you can't tell the weeds apart from your seedlings. Usually all you need to do is wait a few days to a week and let all of the plants grow a bit bigger, at which point you should be able to tell them apart and pull the weeds. *If your plants are small (or the weeds are big), you may need to use one hand to hold down the soil around your desired plants while you pull nearby weeds with your other hand.*



Try to like weeding. It's something you (or your children, if you can train them to do it) will do a lot.

Weeding with a hoe

If your garden is large and/or there are large exposed spaces (between young tomato plants, for example), you may want to use a hoe to dig out weeds (see **tools**). Using a hoe involves a chopping motion that you will need to figure out on your own. Remember, though, that your goal is to uproot weeds, *not* to just cut their stems off. If you have a hoe with a narrow head and want to try it out, you may be able to hoe out even very small weeds from close to small plants. A hoe should be kept sharp, and if you use a hoe a lot (especially in hard or rocky soil), you will need to sharpen it periodically with a file or bench grinder.

What to do with weeds once you pull them out

What you do with weeds once you've pulled or hoed them out of the ground depends on several things. If it's wet out (or likely to rain soon), weeds that you leave sitting on top of the soil may re-root themselves and start growing again, so it is important to take the weeds out of the garden, perhaps to a **compost** pile. If it's dry out, you can arrange the weeds around your desired plants and use them as a form of **mulch** to keep other weeds from growing. If the weeds have begun to produce seeds, it's important to take them out of the garden and put them somewhere other than your compost pile (some composting methods kill weed seeds, but others do not).

How obsessive should you be about weeding?

Do you need to pull every weed in your garden? No. You could spend half an hour and pull 95% of the weeds in the garden, or you could spend two hours and pull 99% of the weeds. For most of us, those one and half hours could be better spent doing other things. For reasons discussed previously, even if you could pull every weed that came up, you would still have weeds in the future, so preventing every weed from growing is not worth your time. That said, weeding is important overall, as weeds can seriously impact the production of your garden, and there are *some* weeds that you need to control as aggressively as possible (see **weeds** for a few of the worst of these), or in the end you'll have no garden left at all. Even if you do let weeds grow, you can do yourself (and your neighbors) a favor by preventing them from going to seed – just use a tool of some sort to cut off the

flowering heads *before* seeds appear.

Grass weeds – a special case

If you are creating a new garden plot from a space that previously had grass growing on it (or if you have taken over a garden that has been invaded by grass weeds), then you may have some different and potentially fairly labor-intensive weeding to do. See ***preparing a new garden plot*** for tips on dealing with grass weeds.

Weeds through the season

Weeds are not a constant problem throughout the year. Weed seeds tend to germinate in the greatest numbers in the spring and early summer. By late July or early August, new weeds are emerging in much smaller numbers (though weeds that have already emerged are still growing very quickly). If you can make it to this part of the season, you should find that the work of weeding drops off a bit and you can focus on the harvest and enjoyment (and perhaps processing and storage) of your crops.

Perennial crops and weeds

You may choose to grow some *perennial* crops, crops that grow back from underground roots for many years in a row. Some of these are *woody*, meaning that they have one or more wood-like stems that live through the winter (blackberries, raspberries, apples, and pears, for example). Others are *herbaceous*, or non-woody, and they live through the winter only as roots (rhubarb, asparagus, and some herbs fall in this category). Perennials can take several years to get established, but once they are, they have a head start each year on the weeds. Having said that, the fact that perennials sit in one place and grow large can make it difficult to pull weeds around them. Do this carefully, and your perennials will pay you back over the long term.

Where should the garden be?

If you are gardening in a community garden, you may have no choice at all about where to garden – you get a plot, and that’s where your garden is. If you do have a choice, your garden should be out in the open, fully exposed to the sun. Most vegetables, flowers, herbs, and fruits do best if they are not in the shade. The roots of trees and shrubs also compete with your garden for water. If possible, your garden should be close to a source of water. Soil matters a lot – if possible, choose a place for your garden where the soil is deep, without rocks. If you want to, you can contact a local university extension service and have your soil tested for various properties important for agriculture. If your soil is shallow or rocky, though, that’s o.k. – it can be improved. If you are near old housing (built before the 1970s), you may also want to have your soil tested for lead. Lead from paint can stay in soils for a long time and end up in your food. Exposure to lead is very harmful, especially for the brains of small children.

How big should the garden be?

The 1922 *Wisconsin Garden Book* (published by the Wisconsin State Horticultural Society) began by saying “A small garden well tilled is better than a large one neglected.” Nothing has changed in this respect since 1922 - the most common mistake of the beginning gardener is still planting too large a garden. Gardening may seem easy at the beginning of the season, but when weeds and pests appear later on, many people wish they had planted much less. Go to any community garden in the middle of the summer and you will see at least a few plots that have been abandoned by people who

just couldn't keep up with the weeds (or who otherwise lost interest in gardening). Your first year, you may want to start quite small – perhaps as small as 3 m by 2 m (10 ft by 6 ft). If you're really serious about trying this gardening thing, you might want to go to a 6 m by 6 m (20 ft by 20 ft) garden. You should probably wait until your second year to try a plot much larger than that.

Planning what to grow

(Note: this section borrows heavily from the Wisconsin State Horticultural Society's *Wisconsin Garden Book*, published in 1922)

Start by thinking about *what* you'd like to grow. Some factors to consider:

1) How much of the year is left? – If you are planning your garden during the winter, or as late in the spring as May, you can still potentially grow anything you want. As you get later in the year, however, more and more different crops are eliminated from the list of crops you can plant. Why is this? It has to do with the “days to maturity” needed for different crops. Just as a person takes about 18 years to reach physical maturity, each different crop needs at least a certain number of days to grow from seed to the point where it is harvestable. Some plants like radishes and lettuce can be harvested in as little as 30 days, but others like peppers and watermelons and Brussels sprouts may need as many as 120 frost-free days to give you a crop. If there aren't enough warm days left in the year for a plant to produce what you want, planting that plant will be a waste of space in your garden.

2) Geographic Location – All of the crops discussed in this manual *can* be grown in southern Wisconsin (and, more generally) the upper Midwest, but some of them are harder to grow than others because of the relatively short growing season in this area. Tomatoes, peppers, eggplant, melons, and squash are sensitive to cold (particularly when the plants are young) and must be protected from it in special ways and/or planted within a narrow time window. Most common fruits, vegetables, herbs, and flowers do best in full sun, so gardeners whose garden space is significantly shaded by trees or buildings will have a limited set of crops to grow even if they live far to the south of Wisconsin.

3) Space – If your garden is small (say, less than 8 m or 25 ft on a side), there are certain crops you may *not* want to grow, just because they take up too much space (and will thereby keep you from growing much else). Unfortunately, this list includes popular favorites such as corn, potatoes, melons, squash, and pumpkins (and perhaps cucumbers, though they can be trained up wood, string, or metal structures called trellises so that they take less space). These plants are fun to grow and are still discussed in this manual, but if you choose to grow them you should do so with the knowledge that they may get very, very big and will tend to shade out or literally overrun your other crops. Some compact crops for small gardens are beans, beets, cabbage, carrots, greens (lettuce, spinach, and many other types), onions, radishes, and turnips.

4) Your own desires – Some gardeners only care about growing tomatoes, while others like to have as much diversity as possible. Most gardeners fall somewhere in between. All of these strategies are fine, with the possible exception of growing only one crop year after year – this can lead to a buildup of pest and disease problems (ideally, you'll grow at least a few different crops and “rotate” them around the garden so that no crop grows in the same place two years in a row). Before you order seeds, buy transplants, or start digging in the garden, think about what you want. If there's something you really like (whether it's tomatoes, salad greens, strawberries, flowers, or something else), you'll want to plan your garden around that. Some of your choices may be driven by what's available in local grocery stores or farmers' markets and at what price. Decent potatoes and onions,

for example, are cheap and widely available in stores and farmers' markets, so growers with limited space often skip these crops (though both are fun to grow, especially if you want to try varieties with unusual colors, shapes, or flavors). Some gardeners really want to have asparagus, rhubarb, or fruit. Keep in mind that many such perennial crops do not yield anything for at least two or three years after planting. If you aren't sure how long you'll have your garden plot, don't plant these crops. In general, if you don't have any particular desires, read the **quick reference guide to vegetable planting** and the **crop pages** and try a bunch of different crops to find out what you like. Keep notes on what does well in your soils and your climate.

5) Simplicity – It is easy to feel overwhelmed in the garden. For this reason alone, beginning gardeners may do well to choose as few as four crops (perhaps peas or a flower, tomatoes, cucumbers, and lettuce), and try to grow these successfully before doing more the second year.

6) Difficulty of growing some crops -- For various reasons, some plants are harder to grow than others. Eggplant, for example, can be difficult to grow because (in some locations, at least) they need to be protected from many different pests while also being kept warm. There are many plants (garlic, tomatoes, and squash, for example) that will produce for you without enormous effort on your part, but where a little extra care and attention can make for a much better crop. In general, if you follow the planting and care suggestions in this manual, you should have success with at least some crops each year. Even professional farmers lose crops to weeds, pests, disease, or simply a lack of time needed to perform adequate care.

Once you have a list of crops you might want to grow, think about *where* and *when* you'll grow those crops. More factors to consider:

1) If you want to, you should be able to make all of the garden space “work” all the time. As soon as a crop is done producing, you can plant another different crop right away, at least as long as there is enough space for that crop and enough of the gardening season left for the crop to reach maturity. Most of your garden can produce two or even three different crops in a season. For example, beans and tomatoes (which need warm weather to grow well) can follow early crops of lettuce, spinach, radishes, or shallots (green onions) all of which are quick-growing and cold-tolerant. In general, whenever an open space appears in your garden, fill it with something else (or **mulch** it). If you don't fill it, the weeds will. See **garden plans** for help figuring out how to do this.

2) Plan for the long-season crops first, and you'll be able to fit in the shorter-season crops around them. If you choose to grow them, perennial crops like asparagus, rhubarb, and raspberries take up sections of your garden for multiple entire years. Other crops like Brussels sprouts, leeks, and parsnips tie up your garden space for just about the whole growing season (100 days or more). Figure out where these crops will go, then worry about fitting in the medium-season crops (plants like eggplant, tomatoes, broccoli that take 65-90 days to grow). The fast-growing crops (30-60 days) can then be squeezed in around the others.

3) Consider using beds. Rectangular beds are handy because they allow you a lot of flexibility to deal with plants of varying sizes. If you divide your whole garden into beds 1 m (40 in) across (and however wide you choose), each bed can be used to grow either three equally spaced rows of small crops (like salad greens), two equally spaced rows of medium-sized crops (like beans) or a single central row of a large crop (like tomatoes). You can, of course, plant things in rows (or any which way you choose), but rectangular beds with one, two, or three rows are simple and efficient. See **beds** for diagrams and additional explanation.

4) Arrange your large plants so they won't shade the others. Some plants (tomatoes, corn, and

Jerusalem artichokes, for example) can shade out others. Put these plants where they have enough room and won't block the light (often in a bed at the edge of your plot). In general, the rows in your garden should run north-south to allow light to get to all of the plants as the sun moves from east to west across the sky.

5) Leave enough room between the rows to allow you to walk and remove weeds. In general, the spaces required by the plants themselves will be fine for this, but a little bit too much space is better than not enough space.

6) Make use of vertical space. In a small garden, you have a lot of vertical space, but not much horizontal space. Stake or cage your tomatoes, trellis your peas and cucumbers (provide them with structures made of wood, metal, and/or string to grow on), and you'll have more room for other crops.

7) Rotate crops so related plants don't stay in the same place. Broccoli, cabbage, Brussels sprouts, collard greens, kale, radishes, kohlrabi, rutabagas, turnips, and cauliflower are all very closely related (they're in the same plant family, known as "Brassicaceae," or the mustard family). As a result, they take the same nutrients out of the soil and are vulnerable to the same pests and diseases. As much as you can, move these crops around your garden so that no two related crops occupy the same space for two years in a row. There are other groupings of plants that should not follow each other: Potatoes, tomatoes, peppers, and eggplant are in the family "Solanaceae" (sun-loving family); Carrot, parsley, celery, dill, and parsnip are in the family "Apiaceae" (carrot and parsley family); summer squash, winter squash, pumpkins, watermelon, cantaloupe, and cucumber are in the family "Cucurbitaceae" (gourd family); Chicory, endive, salsify, dandelion, lettuce, Jerusalem artichoke, sunflowers, and globe artichoke are in the family "Asteraceae" (aster family); Beets, chard and spinach are in the family "Chenopodiaceae" (goatsfoot family); and onion, garlic, leek, and chives are in the family "Liliaceae" (lily family).

With the above factors in mind, create a garden plan for your garden. Your garden plan may or may not be very detailed. Possible information to include:

- 1) The location of each crop, including an approximate number of plants (look at the "Quick Reference Guide for Vegetable Planting" for suggested plant spacings).
- 2) Distances between rows.
- 3) Which crops will occupy the same part of the garden at different times of the year.
- 4) Approximate planting dates, especially for plantings of lettuce, peas, radishes, and other quick-growing vegetables of which you may put in multiple successive plantings.

Can you depart from your plan? Of course! Sometimes a crop never comes up at all due to bad seed, or a crop dies before reaching maturity due to disease, insect damage, neglect, or some other factor. You need to replace that crop with something (if you don't, the weeds will fill that space), and you need to choose something to replace it with. Other times, you may just decide to change your plan for any old reason. That's fine, but just make sure that whatever crop(s) you decide to plant will have enough space and enough time to reach maturity before frost.

If all of this seems overwhelming, don't worry – the most important thing to do is just start growing *something*, even one crop! If you're not using your space as efficiently as possible, or if some crops don't do as well as you would like, who (besides you, perhaps) cares? There's always next year.

Your first few days in the garden

So. You have some kind of more-or-less detailed plan for the year, and you step into your garden plot in April (or May or June, or whenever). Where do you start? The first thing to do is just look around. What's there? Is there anything growing already, and if so, can you tell what it is? Dig some small holes in the soil – how easy is it to dig in and what does it look like? (See **soil** for information that might be helpful.) Are there any places that are wetter than others?

Once you have looked around, you need to prepare the plot for planting – see the text and diagrams for **preparing a new garden plot**. Depending on the size of the garden, the tools you have to work with, your physical fitness, and your level of experience, it may take you a number of sessions in the garden to get this work done.

The best thing you can do for yourself as the final step of your preparation is to **mulch** your garden heavily. This will keep weeds from growing as you gradually work to fill the garden up with vegetables. If you run into anything unexpected (you find that your planned garden site consists of shallow soil on top of rock, for example), try to talk to an experienced gardener for advice. If you don't know any gardeners, farmers at farmers' markets and senior staff at garden stores can sometimes be helpful. You can also consult some of the books or web sites mentioned in **resources for more information**.

The garden through the season

Spring and early summer – getting started with planting

Once your plot is prepared (see **your first few days in the garden** and **preparing a bed for planting**), mark out the **beds** or rows you plan to use, and start planting whatever crop(s) are appropriate to the season, following recommendations for spacing, fertilizer, etc. given in the **quick reference guide to vegetable planting**, or whatever other guide you choose to use. It's tempting to think that you can or should plant your whole garden at once, but because some crops cannot tolerate cold at the beginning of the season, the garden will fill up only gradually. It is realistic to think that you could have the whole garden planted by early June if you wanted to.



Planting seeds in the early spring (in this case, peas).

Summer and early fall – planting and harvest

As you move through the summer and early fall, some plants will reach maturity and you'll want to take them out, potentially replacing them with other crops (see **garden plans** for suggestions on how to plan out these successive plantings). Other plants (long-season crops like parsnips or winter squash) will just stay in place, growing all season long.

Weeding is CRITICAL (see **hand weeding** and **weeding with a hoe**). You can do a little weeding each day, or you can weed thoroughly once a week, but if you wait more than a week to weed, you're asking for trouble. **Watering** can also be important, especially if there is no rain. It is likely that in almost any year you will need to water at least a few times, particularly after planting seeds into dry soil.

Fall – preparing for frost and dealing with it when it comes

As the days get shorter and the weather gets colder in the fall, some plants will begin to die even before there is a frost. Check the weather online or in the newspaper for predictions of the first frost in your area ("frost"

occurs at or close to a temperature of 0 C/32 F). When there is about to be a frost, there are a number of things you may wish to do in your garden *before* the frost, including harvesting all remaining tomatoes, peppers, eggplant, and cucumbers, and potentially covering some of your greens or other vegetables with **floating row cover** to keep them warm. Besides protecting what you already have in the ground, you might want to consider the use of **floating row cover** or some other **season extension technique** like a cold frame to start a late crop of greens (especially spinach). With a cold frame, you can plant spinach in September and harvest it in October, November, or even early December.

Anything that is killed by frost will tell you that it has been killed – the leaves and stems will wilt and turn black, then quickly dry up. Frost-killed plants can be removed from the garden and put in your **compost**, but certain crops (pumpkins and winter squash, in particular) can be left in the garden through several more frosts, even though the plants themselves are dead.

There will usually be a number of frosts before there is a “hard” frost (a “hard” frost occurs at temperatures near -4 C/25 F). A hard frost will kill much of what remains in your garden, though certain crops (particularly kale, broccoli, and related plants) can survive a hard frost and even keep growing afterward if the weather warms up a little.

Late fall -- preparing the garden for winter

As the weather becomes consistently cold (in late October and early November, in the upper Midwest), you can work at preparing your garden for winter. There are several aspects to winter preparation: 1) cleaning and putting away tools, 2) use of **mulch** and/or planting of cover crops, and 3) planting of certain crops that will survive the winter and grow early in the spring.

Putting away hoses, sprinklers, and other **tools** should take relatively little time. Hoses and sprinklers always have some water in them, and when it freezes and expands, it can damage these tools. For this reason, hoses and sprinklers should ideally go in a place where they will not freeze. If this is not possible, put them in any sheltered place. Clean the soil off tools like spades, hoes, and rakes and put them in any sheltered place – cold alone won't hurt these tools, but exposure to wind, rain, and snow will damage the handles and loosen the heads. Dry off any **floating row covers** you may have used, fold them up, and put them away in a sheltered place. Gather up any wooden stakes and other wooden structures you have built and stack them under shelter to reduce rotting. Tomato cages and metal stakes should be pulled out of the soil but left outside – the exposure to the elements will help kill any disease-causing organisms that may be on them.

Whether you choose to mulch or plant a cover crop on your garden after your vegetables are gone is up to you (as a third option, many gardeners choose to do nothing at all, but just leave the garden exposed over the winter). Use of **mulch** is recommended – you could cover your whole garden with as much as 15 cm (6 in) of mulch in the form of newspaper, straw, or leaves, possibly putting compost, manure, or another **soil amendment** underneath the mulch. Mulch will protect the soil from erosion caused by wind and water over the winter, protect perennial plants like asparagus and flowers from the damage caused by cold, prevent weed growth in the spring, and enrich the soil in the long term as it is incorporated in. Use of cover crops is more common on a farm scale than in the garden, and beginning gardeners are unlikely to want to use them, but you could choose to plant rye grass, hairy vetch, or another cover crop in any areas of your garden that are not occupied by perennials. If planted thickly, cover crops provide many of the benefits of mulch. Hairy vetch is a legume (it takes nitrogen out of the air and makes it available for plant growth), and it enriches the soil in a way that mulch does not. Cover crops should be planted in late September or early October so they have a chance to get established before the weather become very cold. Cover crop seed can be purchased at some garden stores and from seed companies. Some of the all-purpose garden manuals and web sites listed in **resources for more information** provide additional information on this topic.

In October or early November, you may also wish to plant certain crops. While it can seem strange to put living plants in the ground when the air is cold and the soil feels colder, crops like flower bulbs (daffodils, tulips, irises, and some others), garlic, potatoes, and Jerusalem artichokes can be planted at this time. These plants can tolerate cold and wet soils, and many will actually grow a bit before going *dormant* (sitting and waiting) through the coldest part of the winter. Besides giving them a head start in the spring, planting these crops in

the late fall means that you have less work to do in the spring. Potatoes and Jerusalem artichokes will not grow in the fall, but they are difficult to store inside through the winter, and they store very well in the ground. See the ***crop pages*** for these crops for more information.

Winter and early spring – resting and planning

When you've done however much (or little) work you want to do to prepare your garden for winter, there's not much to do until January or February, which is when many gardeners start to think about what they want to grow and begin ordering seeds.

If you are interested in ***starting plants inside***, February is not too early to begin preparing for this. In March, in addition to starting plants inside, gardeners with cold frames (see ***season extension techniques***) may use them either to start an early crop of greens (especially spinach) or to start plants like broccoli that will later get transplanted outside the cold frame.

Getting seeds and plants

Gardeners can grow plants in various ways. Some plants are grown from seeds that you plant in the garden. Some plants are grown from seeds that you or someone else plants indoors while it's still too cold outside for anything to grow; these young plants (sometimes called “transplants,” or “starts,” or “seedlings”) are then transplanted into the garden after the weather is warm enough. Still other plants are not grown from seed at all, but are grown from bulbs (like garlic and many flowers) or other plant parts (like potatoes). Perennials (plants that live for many years) can also be dug up and divided into many small plants. Rhubarb is grown this way, as are many flowers and herbs.



Whatever it is that you plant – a seed, a transplant, a bulb, a piece of a large perennial plant – you have to get it from somewhere. There are many possible sources of plant materials.

Getting seeds

The simplest place for many people to get seeds is a local garden store or hardware store. As spring approaches, these stores put out displays of seeds, and you can read the packages and make decisions about what you want. This can be a good way to get started, as the varieties that are sold in these kinds of displays are usually ones that will do well in your area and that have resistance to common diseases. They may not be particularly flavorful, however, or interestingly colored, or big, or otherwise unusual.

If you are more experienced, or just feel that it's something you want to try, you might want to order seeds by mail or over the internet. There are hundreds of seed companies that do business one or both of these ways, and they sell seed of thousands of kinds of vegetables, fruits, flowers, and herbs that will not be available in your local store. Some of these companies do a better job than others of providing good service and quality products (see ***resources for more information*** for a few recommended seed companies).

When buying seed (either locally, by mail, or over the internet), you may want to try to get organically grown seed (see ***what does organic mean?***). This can be difficult, but more and more garden centers and seed companies are providing organically grown seeds. Whether or not you can find organically grown seeds, dedicated organic gardeners will want to try to avoid what are called “treated” seeds. These are seeds that have been covered with one or more chemicals, especially fungicides. These chemicals increase the shelf life of the seeds and protect the seeds once they are in the soil, but they work because they are toxic. Use of treated seeds is discouraged in commercial organic production, and if you use them you should make sure to wear gloves and/or wash your hands thoroughly after handling them. Treated seeds are often dyed a bright orange, green, or blue, but check the seed package as well.

If you become a dedicated gardener, you are likely to buy at least some seeds every year. You won’t necessarily need to buy seeds of every plant every year, however, because most seeds can be stored for at least a while. In general, most plants have seed that is good for 2-3 years. After 3 years, the germination percentage drops a lot (meaning that if you planted 100 seeds, fewer than 50 of them would grow), and it’s best to buy new seed. Seeds may not look very much alive, but they are, and too much moisture, cold or heat will kill them. Store them in tightly closed containers in a place that’s dry and as cool as you can find without ever being freezing (0 C/32 F). If you have the space, you can store seeds in a refrigerator that’s set at around 4.5 C/40 F, but make sure your seed containers are tightly closed. An unheated garage or basement also works very well. If you live in an apartment, just put your seeds in the coolest spot they can find. If it’s not cool, the next best thing is for it to be dry.

If you let your vegetables, flowers and herbs grow flowers and produce fruit and seeds, many of them will do just that. You might think that you could save these seeds, plant them the next year, and avoid buying seeds. This works for some crops and not for others, and for most beginning gardeners it’s easier just to buy seeds each year. If you’re interested in seed saving, see ***resources for more information*** to learn more.

Getting transplants and other non-seed plant materials

To get transplants, bulbs, and other plant materials, you may have as many as four choices: 1) grow them yourself, 2) buy them at a garden store, 3) buy them at a farmers’ market, or 4) get them from friends. Your first year or two, it’s probably wise to buy the plants you need at either a garden center or a farmers’ market. After that, you may want to try growing plants for yourself (see ***starting plants inside***).

Good garden stores and farmers’ markets will offer plants at around the times that are appropriate to plant them, though you should consult the ***quick reference guide for vegetable planting*** to make sure that it’s o.k. to put the plants outside where you live. Like seeds, the plants that you buy may or may not be organically grown. Some farmers’ markets offer organically grown plants, but they are still rare at garden stores.

Any plants you buy should be green (no yellow or brown leaves), not wilted, and sturdy-looking (it is easy for plants in pots to get tall and skinny, which makes them weak when you try to put them in the ground). If you are buying vegetable seedlings (or even if you are buying flower seedlings), avoid buying plants with flowers, or pick the flowers off before you transplant the plants into the ground. Flowering in a potted plant can be a sign of stress, and these young plants are not yet really ready to produce healthy flowers and fruit.

Whenever you buy your seedlings, bring them home and put them in a cool, partially shaded place. Keep them moist and plant them as soon as possible – within one to two days, if at all possible.

Glossary

Beds

A bed system for gardens. Each box on the next page shows three beds, each 1 m (40 in) wide. The beds can be raised above the surrounding area by the addition of soil, compost, and other materials from the surrounding area, but they can also simply be marked off on flat ground. Measurements in your garden *do not* need to be precise, but are given exactly here for the purposes of demonstration.

- In **box 1**, each bed is set up to be planted with just one central row of a *large crop* (like tomatoes). The rows end up 1 m (40 in) apart.
- In **box 2**, each bed is set up to be planted with two rows of a *medium-sized crop* (like beans). All of the rows end up 50 cm (20 in) apart, whether they are in the same bed or two adjacent beds.
- In **box 3**, each bed is set up to be planted with three rows of a *small crop* (like radishes). All of the rows end up 33 cm (13 in) apart, whether they are in the same bed or three adjacent beds.
- In **box 4**, the three planting schemes are combined in three adjacent beds. This simultaneous use of the three arrangements is common in gardens where plants are of many different sizes. Distance between rows is variable.

Compost

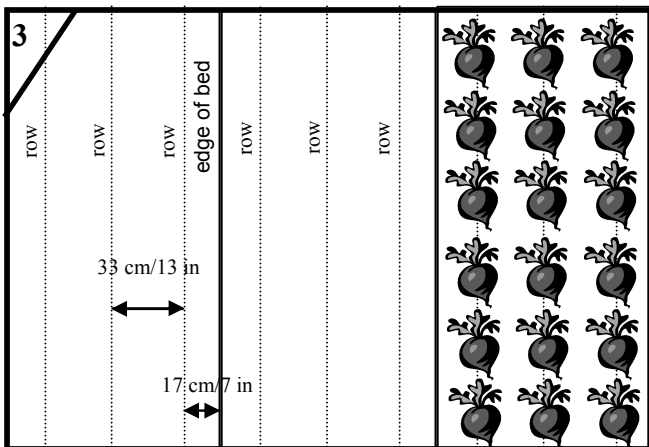
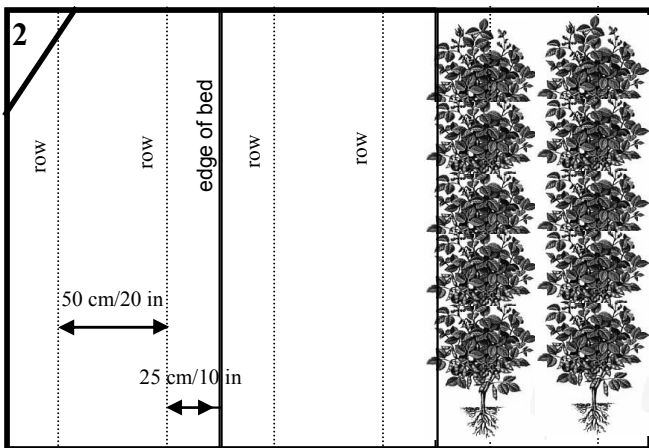
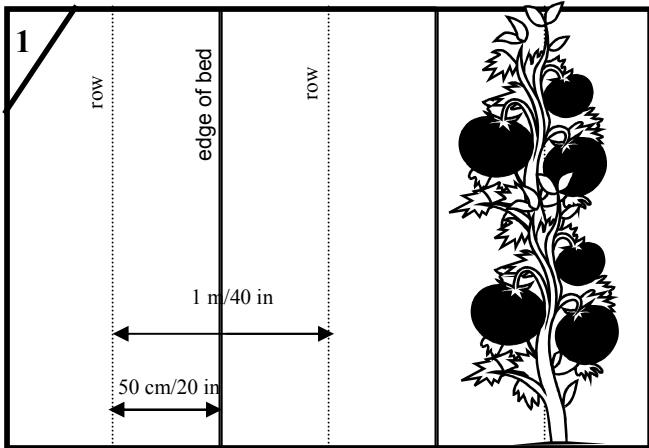
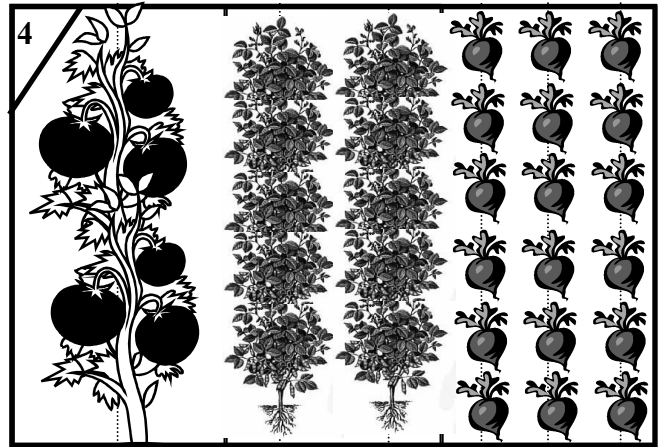
What is “compost”?

“Compost” is both a noun and a verb. As a noun, it refers to decayed organic matter, which is a fancy term for formerly living things (plant and/or animal) that have been broken down by the feeding of bacteria and other tiny creatures into something that looks more or less like soil. This organic matter (see **soil** for a discussion of organic matter) is a useful addition to soil, and compost is sometimes talked about as though it were a **fertilizer**. While it does contain nutrients plants need, compost is really more of a **soil amendment**, whose primary benefit to the soil is an increase in organic matter content rather than a significant increase in the levels of particular nutrients. As discussed under **soil**, higher organic matter yields a number of benefits – higher water retention of the soil, improved retention and availability to plants of any fertilizer that you do apply, increased numbers of soil-dwelling organisms, etc., etc.

As a verb, “to compost” or “composting” refers to the process used to make compost. In general, this process involves mixing together a variety of food wastes, yard wastes, and/or other compounds in proportions that are favorable for the growth and reproduction of bacteria. Within the compost “pile” or “heap” made of these materials, bacteria begin to feed and multiply. These bacteria occur naturally on the surfaces of many living things and do not need to be added to the pile to make composting happen. The bacteria eat and eat and reproduce and reproduce until most of the readily available nutrients are used up. This process, which can take as little as a few weeks or as long as months (depending on how much or little you manage the pile) usually results in a substantial decrease in volume of the ingredients used to make the initial compost pile. Loss of 40-60% of the volume of your initial pile is not uncommon. If you manage the pile at all well, the material you end up

Beds, continued

There is no specially designated walking space between the beds, but the layout of the rows within the beds allows enough space for the gardener to walk (and remove weeds) between the beds. Do not walk in the beds themselves, even if there appears to be space — you will compact the soil, harming the plants' roots.



N

Arrange the
beds in your
garden running
north-south

with should look (as mentioned above) and smell more or less like soil.

Why compost?

Why compost? There are many reasons. At the most abstract level, composting takes non-toxic materials that would otherwise end up in landfills and returns them to the soil in a useful form. Food production should be a *closed loop*, meaning that food wastes (and perhaps human manure, as well) are returned to the soils used to produce the food to begin with. At present, most food production in the United States represents *open loops* – food comes from places, and food wastes end up in other places. Composting is a small step toward closing food loops.

Of more relevance to individual gardeners, compost itself improves garden soils in various ways (as discussed above). Well-managed “hot” composting can kill weeds and any seeds they might be carrying, so it’s a safe way to return the weeds you kill to your garden. Scientists have also recently begun to document a phenomenon noticed for some time by organic farmers, which is that application of compost to soils can actually help to prevent various plant diseases, particularly fungal ones. Why and how this works is still not very well understood.

For those who like physical work and are seeking “useful” excuses to be outside, building and managing a compost pile can also be just plain fun.

You should *not* feel like they need to compost, though if you do not you will still want to add purchased compost or some other **soil amendment** to your soil on a regular basis. You will also need to put your weeds and other garden waste *somewhere* – many people choose to do “pseudocomposting,” which involves just heaping these materials up out of the way somewhere. They will decay this way, but more slowly than if you compost them as described below. This form of composting does not necessarily kill weeds or weed seeds and the piles can in fact become homes for more weeds. Pseudocomposting with kitchen waste (eggshells, fruit peels, coffee grounds, etc.) can also attract raccoons, possums, and other undesirable pests. To help keep these pests away, you can cover your kitchen wastes with layers of newspaper, cardboard, or leaves.

Conditions needed for composting

There are four important conditions that must be met for composting to occur:

1) Proper pile size – As bacteria feed in a compost pile, they generate heat as a by-product (piles can get as hot as 82 C/180 F). The bacteria that do the best job of composting thrive on this heat, but they can only maintain the proper heat level if the pile they start working in is big enough. As a rule of thumb, a cubical pile 1 m (3 feet) on a side is the minimum size to start with. A pile larger than that is fine, as long as it gets enough air. It’s possible to compost on as large a scale as you want to -- some cities compost vegetable and yard waste, making piles called “windrows” that are hundreds of meters (yards) long, 2 meters (about 6.5 ft) high, and about 1-2 m (3-6.5 ft) wide.

2) Sufficient air movement – To do the work of digesting dead things, bacteria need air. To allow air movement throughout the pile, the piles you make shouldn’t be too big (see notes on size above). If you use a bin or container of some sort to hold your compost, it should have a lot of holes on all sides to allow air movement. To get air to all parts of the compost pile, gardeners who manage their compost carefully also tend to “turn” a compost pile two or three times at intervals from 4-14 days. This involves digging up the pile with a spade or spading fork (see **tools**) and moving it to a spot right next door to the old location. If your compost pile does not have enough air moving into it, the oxygen-dependent “aerobic” bacteria that you want will be unable to live and reproduce, and unde-

sirable “anaerobic” bacteria will take over. The anaerobic bacteria can survive without oxygen, and while they will keep breaking down the materials in your compost pile, they do it very slowly compared to the aerobic bacteria. They also make your compost pile smell bad.

3) Sufficient water availability – Like all living thing, the bacteria that do the work of composting need water to live and reproduce. Watering your compost pile too much encourages anaerobic bacteria (see above under “air movement”), but you should water it thoroughly if you dig into it and it appears dry 15-30 cm (6-12 in) into the pile. To water it, poke deep holes with a stick or the handle of a garden tool, and put the water into these.

4) A proper carbon-to-nitrogen ratio – Living things are mostly water, but if you take away the water, most of what remains is carbon, which is used for all sorts of purposes (in plants, for example, carbon makes up most of the weight of cellulose, the material that plants use to build their stems). Another critical element is nitrogen, which all living things use to make proteins. Nitrogen is needed in much smaller amounts than carbon, but nitrogen is also rarer in nature. As a general rule, the bacteria that do the work of composting need 30 units (kilograms, pounds, whatever) of carbon for every 1 unit of nitrogen that’s available to them. This so-called “carbon to nitrogen ratio” (or C:N ratio) of 30 to 1 (also written 30:1) is what the gardener tries to provide when selecting materials to put in a compost pile. While you might think that this would require fancy chemical analysis of your yard or kitchen waste, most gardeners do this only very approximately and the process of composting works out just fine.

Choosing ingredients for the compost pile

To reach the 30:1 carbon to nitrogen ratio mentioned above, gardeners tend to mix so-called “browns” (dry, dead materials like dry leaves, straw, or newspaper) with “greens” (wet, recently living things like freshly cut green grass, banana peels, apple cores, coffee grounds, etc.). The browns are high in carbon – straw, for example, has a C:N ratio of about 100:1. The greens are also mostly carbon, but they contain more nitrogen than the browns, and act as the nitrogen source for composting. Coffee grounds, for example, have a C:N ratio of something like 20:1. You may realize without doing any formal math that you need to use greater amounts of green materials than brown materials to weight the C:N ratio closer toward 30:1.

The table below provides carbon to nitrogen ratios for a few commonly used materials. There are many formulas you can use to figure out how much to use of each of these materials to reach the 30:1 target, but a simple way to think about it is as follows. If you have two units (wheelbarrows, carts, garbage cans, bags, whatever) full of manure or coffee grounds that are each 20:1, and one unit of leaves that is 60:1, you can add the carbon amounts of the three units together ($20 + 20 + 60 = 100$) and divide by 3 to get 33. The resulting compost should have a C:N ratio of about 33:1. Don’t worry too much about the numbers – what’s most important is to understand the idea of browns and greens and to put a little more green than brown into each pile.

Note that the table is in no way a comprehensive list of compostable materials. Almost anything that has at some point been alive can be composted, though you do need to think about possible contamination with toxic materials. Human hair, for example, is a rich nitrogen source, and farmers used to collect it from barbers and compost it. Now, however, human hair is often treated with chemicals that you wouldn’t want to put in your pile. Meat and dairy products can be used in composting, but you should only add them to your pile if you are going to manage your pile carefully so that it gets hot. If you don’t manage it, a pile with meat and dairy in it will smell bad and attract vermin. Do not put feces from dogs or other carnivorous animals in a compost pile, as these materials can carry disease. You can compost with wood chips or sawdust as your brown materials, but the

carbon content of wood products is so high (with C:N ratios as high as 600:1) that you must have large amounts of good green materials to ensure that your wood products break down completely.

Some materials for possible use in composting	
<i>"Browns" (Carbon sources)</i>	<i>Carbon to Nitrogen Ratio (C:N)</i>
Wood chips or sawdust	300-600:1
Newspaper	50-200:1
Pine needles	60-110:1
Straw	70-100:1
Straw (from wheat or oats)	80-100:1
Corn stalks	60:1
Dry leaves	60:1
Peat moss	60:1
Horse manure (with straw mixed in)	60:1
Horse manure (pure)	25-35:1 (on the edge between green and brown)
<i>"Greens" (Nitrogen sources)</i>	<i>Carbon to Nitrogen Ratio (C:N)</i>
Fruit or vegetable waste (cores, peels, etc.)	10-35:1 (on the edge between green and brown)
Cow manure (pure)	20:1
Coffee grounds	20:1
Sea weed and lake weed	20:1
Grass clippings (green and wet)	20:1
Mixed table scraps	15:1
Alfalfa hay (dried)	12:1

Building a compost pile

The building of a pile has several steps:

- 1) Gather the needed amounts of green and brown composting materials with the 30:1 carbon to nitrogen ratio in mind. If necessary, cut or chop your materials into small pieces. Keep your greens and browns separate at this point. Remember that you want to build a pile that is at least 1 m (3 feet) on a side.
- 2) On the location where you plan to compost, place two layers of sticks at right angles to each other. The sticks will increase air movement into the pile.
- 3) Start building your pile using alternating thin layers of green and brown materials. As you add each layer, try to mix it with the last layer using a spade or spading fork (see **tools**).

- 4) Every 30 cm (12 in) or so, water the new layers thoroughly.
- 5) Let the pile sit for a 1-2 weeks. It should get warm or even hot to the touch, and should start to shrink. What happens next depends on how much work you want to do. If you want to use your compost soon, proceed to step 6. If not, just let it sit – bacteria will continue to feed for as long as you let the pile sit, though the process of composting will slow down very much after a few weeks.
- 6) If you want to “finish” your compost quickly, you should “turn” the pile after its first 1-2 weeks. Many gardeners turn their piles by using a spade or spading fork (see **tools**) to move the pile a piece at a time into a new location right next to the old one. In the process, they mix the pile up and let air into the center of the pile. If the pile has dried out, water it in stages as you turn it.
- 7) If you have turned your pile, it will probably get hot again and should continue to shrink. After another 1-2 weeks, you can turn the pile again as described above.
- 8) After the second turning, wait 1-2 more weeks, and your compost should be “finished.” Finished compost should look more or less like soil, with few or no recognizable pieces of the materials you started with. If your compost doesn’t seem finished, even after two turnings, you may have started with too little green material (a common problem), let the pile dry out too much, or created too large or too small a pile.

Gardeners who compost a lot and like to keep things tidy sometimes have three bins right next to each other. A pile is started in bin 1, turned into bin 2 after a week or so, turned into bin 3 after another week, and then spread in the garden after one more week. All three bins can be filled at once with compost in various stages of formation.

For suggestions on what to do with your compost, see **soil amendments**.

Fertilizer

Note: if you read this section, you should also read the **soil amendments** section, as fertilizers and soil amendments are often confused and it is good to know about both.

An introduction to elements essential for plant growth

Like people and all other organisms, plants need many different nutrients to grow. Nutrients needed in large amounts are sometimes called “macronutrients,” while nutrients needed in smaller amounts are called “micronutrients.” The following table lists macro and micronutrients needed by plants, the percentage of an average plant that is made up of each nutrient, and the relative number of atoms of each nutrient needed for healthy growth. Note that even the macronutrients account for only a small percentage of the weight of a *dried* plant – almost all the rest of its weight is made of the element carbon (C). If you were to analyze a living plant (that is, one that had not been dried out), you would find that most of its weight was composed of water.

It is worth noting that many of these nutrients are not actually used by plants in the pure, elemental form shown in the table above. Nitrogen (N), for example, is most abundant on our world in the form of a gas, which consists of two N atoms bonded to each other make the molecule dinitrogen, or N₂. This gas makes up 78 percent of the atmosphere, but plants can’t use it. They rely instead on sev-

eral other forms of nitrogen, but mostly nitrate (NO_3^-) and ammonium (NH_4^+). These molecules are created by a number of biological and nonbiological processes that occur in the atmosphere, in the soil, and in the roots of special plants called legumes. Humans can (and do) also create large volumes of the plant-available forms of nitrogen using industrial processes. These processes require large amounts of fossil fuels, and the nitrogen fertilizers that result from them are *not* used in organic food production. Nitrogen-containing fertilizers used in organic production are made instead from animal wastes (manure), animal parts (bones, blood, feathers, etc.), or nutrient-dense plant products (ground-up seeds or fruits).

Macro and micronutrients needed by plants and their relative abundance in plants (Data taken from <i>Typical concentrations sufficient for plant growth</i> . After E. Epstein. 1965. "Mineral metabolism" pp. 438-466. in: <i>Plant Biochemistry</i> , J. Bonner and J.E. Varner, eds., Academic Press, London.)		
Macronutrient (chemical symbol)	Percentage of dried plant tissue that is composed of this nutrient	Relative number of atoms needed for healthy plant growth
Nitrogen (N)	1.5	1,000,000
Potassium (K)	1.0	250,000
Calcium (Ca)	0.5	125,000
Magnesium (Mg)	0.2	80,000
Phosphorus (P)	0.2	60,000
Sulfur (S)	0.1	30,000
(The line between macro and micronutrients is somewhat arbitrarily drawn here)		
Micronutrient (chemical symbol)	Percentage of dried plant tissue that is composed of this nutrient	Relative number of atoms needed for healthy plant growth
Chlorine (Cl)	Plants contain so little of these nutrients by weight that the percentages are essentially 0.	3,000
Iron (Fe)		2,000
Boron (B)		2,000
Manganese (Mn)		1,000
Zinc (Zn)		300
Copper (Cu)		100
Molybdenum (Mo)		1
Nickel (Ni)		1

Like nitrogen, other plant macro and micronutrients exist in forms that are available to plants and forms that are not available to plants. They can be made into fertilizers using methods that are considered either acceptable or unacceptable for organic production.

Why use organic fertilizers?

It's fair to ask why organic farmers, gardeners, and consumers should care about how plants get their nutrients. After all, nitrogen is nitrogen, yes? Well, yes and no. To a plant, a molecule of ammonium (NH_4^+) is indeed a molecule of molecule of ammonium, no matter where it comes from. But

that molecule of ammonium can get to the plant in ways that have either good or not-so-good consequences elsewhere. One concern about production of conventional (non-organic) fertilizers has to do with reliance on fossil fuels (coal, oil, and natural gas). As mentioned above, making plant-available forms of nitrogen in conventional industrial ways requires large amounts of fossil fuels. Fossil fuels are increasingly scarce, which is one problem, but scientists who study global warming feel that we need to cut use of fossil fuels even before we run out of them because the carbon dioxide and other gases that result from burning fossil fuels are changing global climate. Organic fertilizers can be produced with less fossil fuel input (though this is not always the case).

Another reason to use organic fertilizers instead of conventional, fossil fuel-based fertilizers has to do with how they release nutrients into the soil. When farmers apply conventional fertilizers to their fields, the nitrogen they contain is all immediately available to plants. Unfortunately, plants can't use it all (or even most of it) right away, and the unused portion tends to leave the field, either evaporating or getting washed away. When nitrogen gets into the air and into ground and surface water, it disrupts various natural systems. Organic fertilizers come in large particles that break up slowly and release their nitrogen over a much longer period of time. While this can sometimes mean that plants don't get as much nitrogen all at once as they might like, it does mean that at least some nitrogen is available to support plant growth over a long time period, and less nitrogen is free to evaporate or wash away. The same is true for other macro and micronutrients.

Buying organic fertilizers

Broadly speaking, there are two types of organic fertilizers – those that provide macronutrients, and those that provide micronutrients. Because organic fertilizers are made from complex living things, even the macronutrient fertilizers contain some micronutrients. However, the two are sometimes sold separately.

Like conventional fertilizers, organic macronutrient fertilizers are usually labeled prominently with three numbers. You might see a bag of composted turkey manure, for example, labeled 4-6-4 or 5-2-4. The three numbers represent available percentages of nitrogen (N), phosphorus (P), and potassium (K), in that order (N-P-K). If you put 100 units (kg, lb, whatever) of a manure-based 4-6-4 fertilizer on your crops, 4 units out of 100 would be nitrogen in a form available for plant growth, 6 units would be phosphorus in a form available for plant growth, and 4 units would be potassium in a form available for plant growth. The remaining 86 units would be various forms of carbon, together with small amounts of other nutrients.

Most common fertilizers contain nitrogen, phosphorus, and potassium as described above, but if you look at the table of necessary plant nutrients, you'll notice that plants also need significant amounts of calcium, magnesium, and sulfur. You might think these nutrients would be added to every fertilizer as well, but they aren't. In a nutshell, the explanation of this is that calcium, magnesium, and sulfur are more readily available in soils than are nitrogen, phosphorus, and potassium. This is partly a function of the fact that they are more stable in soil than the others. When a plant dies, much of the nitrogen it contains leaves the soil fairly quickly by one route or another, but most of the calcium it contains stays in the soil to be taken up later by other plants. You can certainly buy organic fertilizers that contain calcium, magnesium, and sulfur, and many gardeners would do well in particular to apply calcium to their soils (you can't have too much of it, and it is critical for crops like tomatoes, cucumbers, and melons), but most of the time you will buy fertilizers based on their N-P-K ratings. Nitrogen particularly encourages growth of leaves, while phosphorus and potassium particularly encourage root growth.

So. Which organic fertilizer to buy, and how much to buy? Beginning organic gardeners would do

well to start off the season with one 18-22 kg (40-50 lb) bag of general, all-purpose organic fertilizer. What you buy will depend on what products are available in garden stores in your area. N-P-K ratings vary widely, but in general you should look for something fairly balanced ($N = P = K$), like the 4-6-4 fertilizer mentioned above. If you see fertilizers with numbers that add up to more than 15, or where one of the numbers is more than 8, they are probably NOT organic and should be avoided (there are organic exceptions to this rule – fertilizers made from bat guano can be 0-13-0).

If you are a farmer or know a farmer who has livestock (cows, pigs, chickens, turkeys, etc.), you may be able to use the manure of your animals as fertilizer, but you'll need to be careful – fresh, raw manure (especially from chickens and turkeys) is too concentrated to apply directly to crops. It must either be composted somehow (see **compost**) or mixed well with soil a week or two before you plant your crops. The nutrient content of animal manure varies a lot.

When you buy fertilizer, you may also wish to buy **soil amendments**, which are not fertilizers but improve your soil's ability to make use of any fertilizer you do buy.

Applying organic fertilizers

If you have purchased an organic fertilizer that is fairly balanced (see above), you can apply it in one or more of three ways:

1) When **preparing a bed for planting**, scatter fertilizer over the surface of a bed before you dig into the soil. The fertilizer will end up incorporated randomly in the soil, and plant roots will find it and use it. For some plants (lettuce and other salad greens, radishes, and carrots, to name a few) this is enough fertilizer to ensure a good crop. How much fertilizer you scatter around depends on how strong it is – read the package for suggested application rates. If you cannot find a suggested rate for bed preparation in a vegetable garden, try applying it at rate of about 2.3 kg per 10 square meters (5 lb per 100 square feet). A garden bed 1 m wide and just over 9 m long (40 in wide and 30 ft long) would take that amount of fertilizer. If you only fertilize one way, this would be the way to do it.

2) Some plants, especially those that are transplanted and that produce large fruits (tomatoes, eggplants, and melons, for example) benefit from more fertilizer than the scattering method above provides. While it's still good to fertilize the planting bed as described, you should also add some fertilizer to each planting hole before the plant goes in, working it into the soil so it's not all in one place. This provides a more concentrated source of nutrients for these plants to grow with. The **crop pages** for these crops discuss how much fertilizer to use; also see **transplanting** for pictures of what this might look like.

3) Some plants (onions, broccoli, cauliflower, cabbages, and kale, to name a few) also benefit from scattered fertilizer, but are too small when they are young to make use of fertilizer applied as described in method 2, above. Instead, wait until these plants are about halfway toward maturity, then fertilize them again at the same rate you used in preparing the bed. You can't scatter the fertilizer



This man is applying fertilizer in the form of manure to a bed before planting in it.

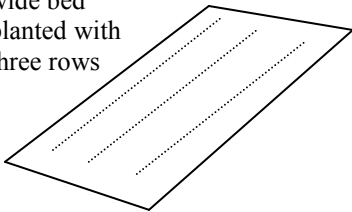
Floating row covers

Floating row covers are useful for extending the length of your growing season (see **season extension techniques** for a discussion of this idea). Even during the middle of the growing season, the extra heat they provide and the moisture they retain can speed up the growth of your crops. They are also helpful in keeping certain pests off your crops.

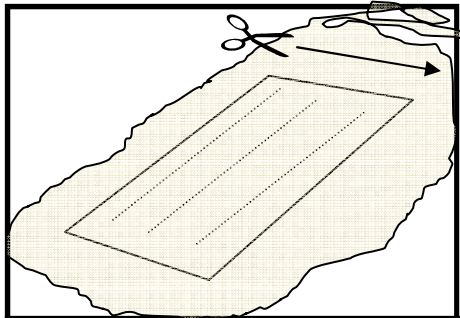
There are many different kinds and brands of floating row covers. They come in sheets of sizes ranging in width from about 3 to 30 m (10-100 ft) and in length from 8-300 m (25-1000 ft). Some covers are made of clear plastic, and these are intended to be used once and then thrown away or recycled (if possible). Most, however, are made of a something that looks like a thin but strong white cloth (it's actually a material called spunbonded polyester). Some brands are thicker than others. The thicker the fabric, the more heat and moisture it traps, and the longer it will last in your garden (most row covers can be used for two to four years if stored carefully inside when not in use; at some point they have too many holes to be effective). Buy the heaviest row cover you can find and afford. A few common brands are Reemay, Agrifabric, and Harvestgard. Most large garden stores and online garden supply companies sell floating row covers.

To use floating row covers follow the instructions below. If you are growing plants from seed, start at step 1. If you are growing plants from transplants, start at step 9.

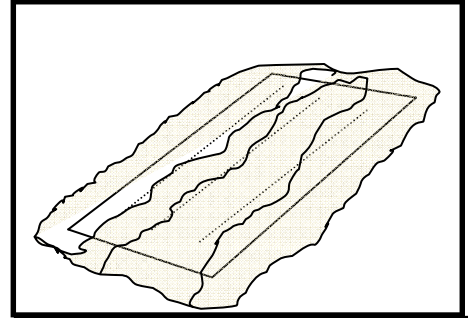
A 1 m (40 in)
wide bed
planted with
three rows



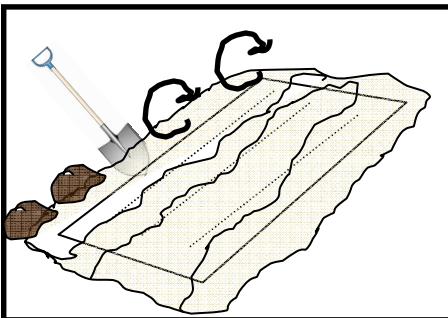
1. Buy a floating row cover. Plant seeds as appropriate for a given crop. If you are using **beds**, make sure that your beds are at least 60 cm (24 in) *narrower* than your floating row cover. Beds can be any length desired as long as they are shorter than the length of your row cover.



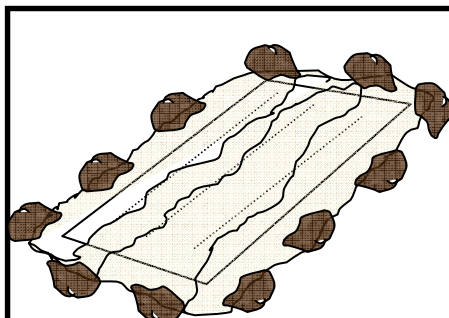
2. Unfold your row cover and spread it over the length of the bed which is to be covered. Cut it with scissors or a knife so that it is about 60 cm (24) in longer than the bed — precision is not required.



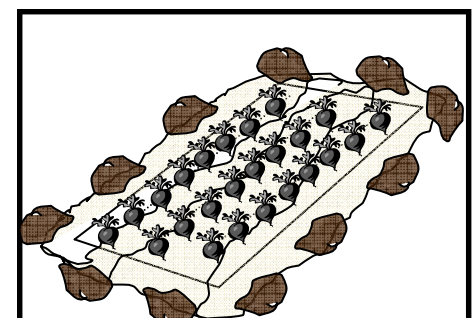
3. Bring extra material onto the bed, leaving only 10-20 cm sticking out beyond the sides and ends of the beds. **DO NOT** spread the row cover flat across the bed!



4. Use a spade to dig soil out from under the edges of the row cover, putting each scoop of soil back in the same small hole you took it out of but *on top* of the row cover. Repeat this around all four corners of the row cover at about 30 cm (12 in) intervals, making sure not to get soil on top of your rows of seeds. Also make sure to leave the loose material in the middle of the bed.

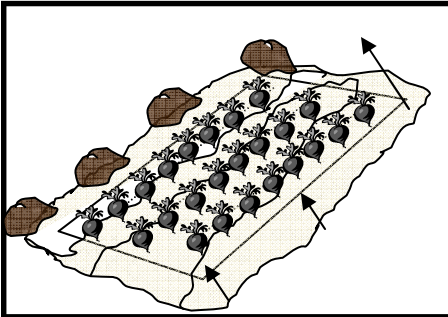


5. If all you care about is warming up the soil for your crop (to grow basil, for example), you are done when your bed looks like this. If you want to keep pests out, however, you should go around and perform the same scooping action until there is a continuous band of soil sealing the row cover to the ground.

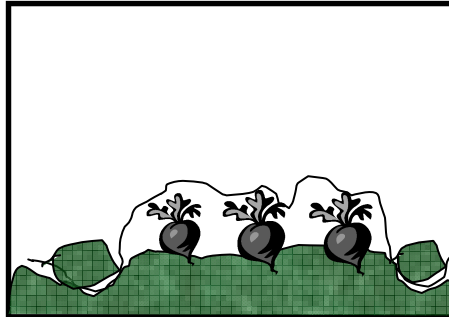


6. As your plants grow, you can leave the row cover in place most of the time. Watering can be done without removing the row cover, though gardeners with clayey soils should make sure that the row cover doesn't stick to the soil as it dries.

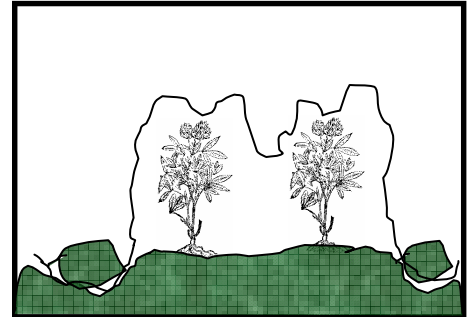
Floating row covers (continued)



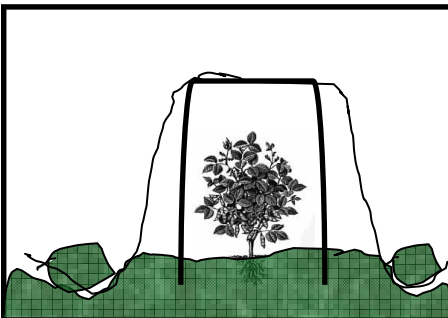
7. Unfortunately, weeds also do well in the conditions under a row cover. To weed under the row cover, lift the soil off three of the edges of the row cover with your hands and peel the sheet carefully back over the fourth side without disturbing the soil on that side. When you are done weeding, move the row cover back over the bed and use a spade to move the soil back over the three free sides. Make sure to leave the extra material in the middle as before. Weed again later as needed.



8. As your plants get bigger, they will push up the row cover — this is why it's important to leave the extra material on top of the bed. You can leave the row cover on until the plants are literally pushing it off, at which point you should remove it, shake it out, let it dry, and store it (or use it somewhere else). If the plants do not push the row cover off, you generally do not have to remove it except to harvest. There are a few crops, however — strawberries, melons, summer and winter squash, and cucumbers—that **MUST** be uncovered when they are about to flower. These crops are pollinated by insects that cannot visit the flowers when the row cover is on.



9. (for transplants only) Plant your transplants (see **transplanting** for help; for tomatoes and peppers, see step 10). Cover the bed with floating row cover as described in steps 1-5, making sure to leave plenty of extra material over the bed so that the plants have room to grow. Water and weed as described in steps 6-8, removing the row cover only if the plants are so big that they are about to push it off. With the exception of strawberries, melons, summer and winter squash, and cucumbers, you may choose to leave certain crops covered for their whole lifespan.



10. (for tomatoes and peppers only) Plant your peppers or tomatoes (see **transplanting**). Place wood or wire hoops over the plants at intervals along the bed. To do this, you can buy a spool of heavy-duty wire and cut sections off it, open up wire coathangers, or cut flexible branches off small trees. Cover the hoops with floating row cover as described in steps 1-5. Arrange the row cover so it fits well but not tightly over the hoops. The hoops keep the row cover from touching the tips of the plants stems, which are very sensitive. Remove the row cover when the plants have filled the available space.

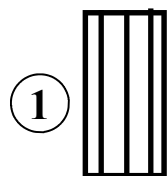
Garden Plans

Sample plans for gardens. The plans here are not actually plans for whole gardens. Instead, they are sample plans for individual beds (see **beds** for more details about how to use a bed system). Each bed can be treated more or less like its own independent garden. If you use beds that are approximately 1 m (40 in) wide (and as long as you choose), each of these miniature gardens can be planted at any time with either one row, two rows, or three rows of plants, depending on the size of the plants.

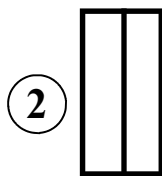
In the course of the season, each bed may be planted with:

- A) only one crop that takes up the bed for the entire season; see examples 1 and 2
- B) two successive crops; see examples 3, 4, 5
- C) three successive crops; see examples 6, 7, 8

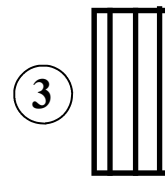
For beds with two or three crops, as soon as one type of plant is harvested, you can put in the next (different) crop. Note that a given bed may have different numbers of rows at different points in the growing season. The plans shown below are only a few of thousands of possible plans for a single bed for one year. Once you have a number of possible beds planned out that include all of the crops you want to grow, you can arrange them to fill in your available garden space (you can make some beds longer than others if you prefer some crops over others). Remember that it's important to practice **crop rotation** — put each crop in a different place than it (or any related crop) was the previous year.



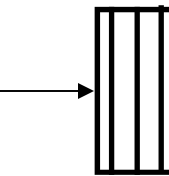
1
Crop: Parsnips
Rows per 1m (40 in) bed: 3
Date Planted: April
Date Harvested: After frost



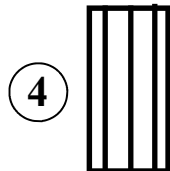
2
Crop: Brussels sprouts
Rows per 1m (40 in) bed: 1
Date Planted: April
Date Harvested: After frost



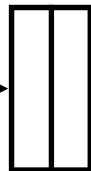
3
Crop: Potatoes
Rows per 1m (40 in) bed: 3
Date Planted: April
Date Harvested: August to October



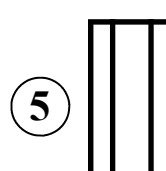
Crop: Garlic
Rows per 1m (40 in) bed: 1
Date Planted: Late October
Date Harvested: The following July



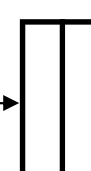
4
Crop: Beets or carrots
Rows per 1m (40 in) bed: 3
Date Planted: April
Date Harvested: June



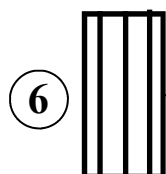
Crop: Eggplant or winter squash (if you plant winter squash, you will need to leave extra space around the bed because the plants get very big)
Rows per 1m (40 in) bed: 1
Date Planted: June
Date Harvested: Late August until frost



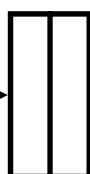
5
Crop: Cabbage or broccoli
Rows per 1m (40 in) bed: 2 (plant just one row for larger plants)
Date Planted: April
Date Harvested: Late June



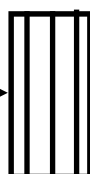
Crop: Late tomatoes
Rows per 1m (40 in) bed: 1
Date Planted: Early July
Date Harvested: September until frost



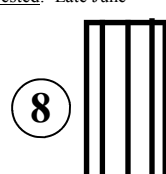
6
Crop: Peas
Rows per 1m (40 in) bed: 3
Date Planted: April
Date Harvested: June



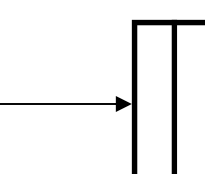
Crop: Cucumbers
Rows per 1m (40 in) bed: 2
Date Planted: June
Date Harvested: August to September



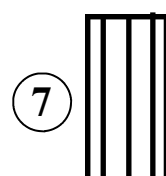
Crop: Greens
Rows per 1m (40 in) bed: 3
Date Planted: September
Date Harvested: Late September until frost



8
Crop: Greens or radishes
Rows per 1m (40 in) bed: 3
Date Planted: April
Date Harvested: May



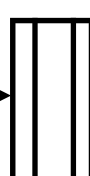
Crop: Early tomatoes (or peppers or eggplant)
Rows per 1m (40 in) bed: 1
Date Planted: Early June
Date Harvested: August-September



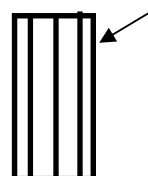
7
Crop: Greens
Rows per 1m (40 in) bed: 3
Date Planted: April
Date Harvested: Late May



Crop: Summer squash
Rows per 1m (40 in) bed: 1
Date Planted: Early June
Date Harvested: September



Crop: Broccoli or cauliflower
Rows per 1m (40 in) bed: 2
Date Planted: September
Date Harvested: November



Crop: Beets, spinach, or chard
Rows per 1m (40 in) bed: 3
Date Planted: September
Date Harvested: October-November

Hybrids vs. open-pollinated plants

Most garden plants are either *open-pollinated*, which means that they are the result of mating between two plants that look very much like they do, or *hybrid*, which means they are the result of mating between two plants that are different in one or more characteristics (for example, mating between a tomato plant that bears small fruit but is resistant to disease and a tomato plant that bears large fruit but is not resistant to disease might give rise to a tomato plant that bears large fruit and is resistant to disease). Mating two different plants together like this is called *hybridization*.

Hybridization can be very beneficial from a gardening point of view, because the hybrid often combines good traits from each parent. Hybrids occur naturally, but gardeners and farmers and scientists have created many more of them, and most garden centers and seed companies sell hybrid plants or seeds. Hybrids are not without their negative aspects. One problem with hybrids is that the hybrid plant is a mixed-up combination of two different sets of genetic material. If it tries to mate with another plant, even another plant of the same hybrid type, it may not be able to have any offspring (“children”) at all, or it will have offspring but they will look very different from their parents, and will usually fail to show the desired characteristic(s) of the parents. For example, if the large-fruited, disease-resistant tomato plant mentioned above were allowed to mate with another similar plant, the offspring might have small fruits *and* lack disease resistance – the benefits of creating the hybrid to begin with would have disappeared in producing the next generation. This means that you cannot save the seeds of hybrid plants and grow them the next year – you must buy them from a store or seed company every year. The stores and seed companies get them from farmers or scientists who repeat the original mating *every year* to produce seeds with the desired good trait(s). If you are growing an open-pollinated variety, you can at least theoretically keep your own seeds from year to year, though it’s actually a somewhat complex business (see **resources for more information** for sources of information on seed saving).

Besides preventing you from saving your own seed from year to year, one other problem with hybrids is that their proliferation has displaced many older, open-pollinated varieties that were themselves beautiful, flavorful, adapted to local climates, and (in many cases) also drought or disease or pest-resistant. Fortunately, many of these varieties are undergoing an increase in popularity, and are more widely available than they were ten or twenty years ago. These older varieties (some of which have been grown for hundreds of years) are often called *heirloom* varieties. Heirlooms are worth trying – some gardeners will swear, for example, that heirloom crops such as the Brandywine tomato are better tasting than any hybrid varieties – but they are not magical, since some of them are vulnerable to diseases, yield poorly under unfavorable weather conditions, or yield fruits that are not very uniform. There’s a reason people go to the trouble to create hybrid varieties.

Mulch

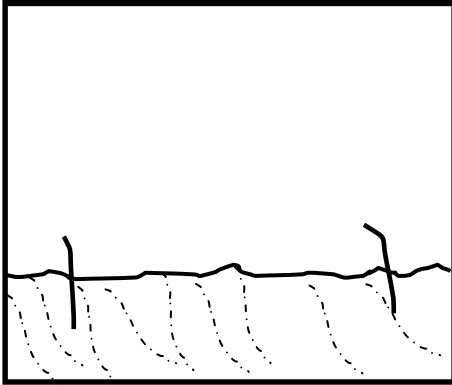
Mulch is any material that you spread over the soil to protect the soil from erosion, conserve moisture, and keep weeds from growing. Materials used for mulching can be: 1) natural, such as leaves and straw, 2) processed natural materials, such as newspaper and cardboard, or 3) manufactured materials such as plastic and landscape fabric (a material also made of plastic, but much more durable than ordinary plastic).

For organic gardeners in particular, the suppression of weeds is perhaps the most obvious short-term benefit of mulch, but moisture conservation and erosion prevention are significant whether you notice them or not. Mulch can also increase earthworm activity and protect other beneficial organisms that live on and in the soil. In addition, old mulch that is breaking down and no longer effective as a weed barrier can often be incorporated into the soil, thereby improving the soil’s organic matter content (see **soil** for a discussion of why this is beneficial).

Mulch is typically used in one of two ways. You can either 1) prepare a bed (see **preparing a bed for planting**), put mulch on it, and transplant plants through the mulch (see **transplanting**), or 2) prepare a bed, plant seeds into it, wait for the seedlings to get big enough that they won’t be buried by the mulch, and then mulch around them carefully. Many crops that are grown from seed in the garden never get mulched because it’s just too much trouble to put mulch around them without burying them. Use your hands or a hoe (see **tools**) to

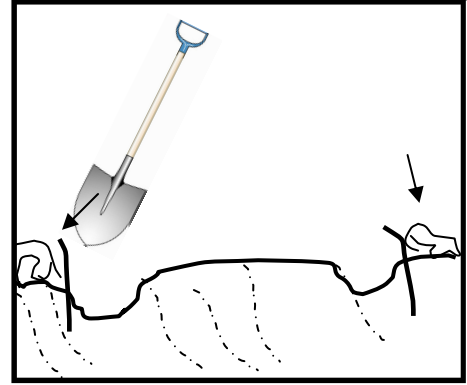
Laying and removing plastic mulch

Laying plastic mulch - 1



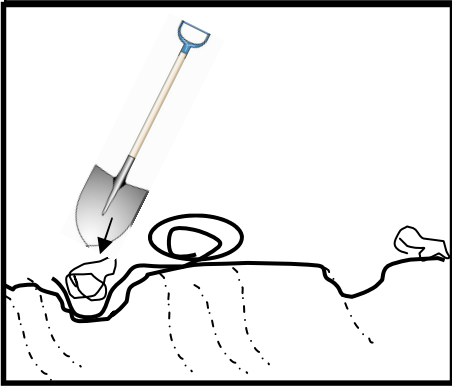
Prepare the soil (see *preparing a new garden plot*). Then, use sticks to mark out an area the length and width of the piece of plastic mulch (or landscape fabric) that you will be laying. Square or rectangular areas no wider than a single piece of plastic are easiest, but as you gain experience you may choose to lay curved beds.

Laying plastic mulch - 2



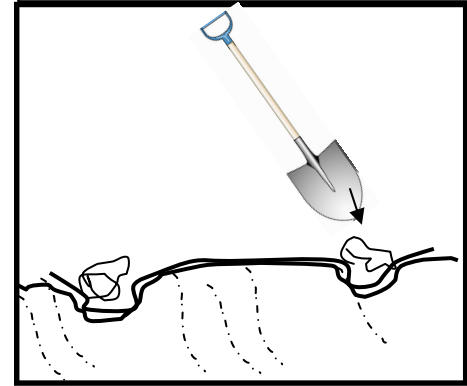
Use a spade to dig two narrow, shallow trenches the length of the piece, just inside the marking sticks. Put the soil you dig out just outside the area marked off by the sticks.

Laying plastic mulch - 3



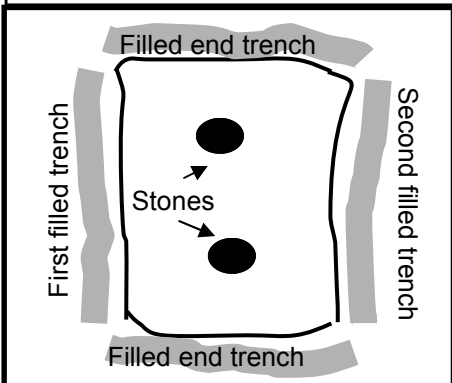
Remove the sticks. Unroll the plastic mulch partially and set one side in one of the two trenches. Use the soil that you removed from that side to fill in the trench on top of the plastic.

Laying plastic mulch - 4



Unroll the plastic mulch the rest of the way and set the other end in the other trench. Keeping the surface of the plastic as taught as you possibly can (by stepping on the plastic in the empty trench, for example), fill in the second trench.

Laying plastic mulch - 5



Your square or rectangular plastic sheet still has two loose ends. Dig enough soil out from under each loose end of the plastic to make a little trench as before. Stretch the plastic into each trench and bury it. You can put stones on top as weights if the surface is not taught.

Removing plastic mulch

Plastic mulch is usually easy to remove. At the end of the season, remove all plant materials, stakes or cages, and stones from on top of the plastic. Dig up one corner and try to pull the rest out by tugging on that corner. You may need to use a spade to dig out the parts of the plastic that are buried in the trenches.

If you have used heavy duty plastic, you may be able to dry it off, fold it up, and store it for reuse. If not, throw it away. This is one reason to use plastic sparingly!

weed around these crops instead of mulching them.

Materials to use for mulch

When you put mulch on your soil, you are deliberately putting on something intended to *discourage* plant growth. Mulches do this by blocking light (which penetrates the soil and encourages weeds to grow) and by physically preventing weeds from coming out of the ground. You want them to do this for as long as possible, or at least as long as you have a crop in the ground that you want to protect from weeds. As a result, a good mulch material should be:

1) *capable of blocking light and weeds* (so it does a good job of blocking downward movement of light and upward movement of growing weeds)

2) *durability* (so it can continue doing its job for several months or more, even when exposed to heat, light, and moisture; one aspect of durability has to do with how many nutrients there are in the material – materials that are low in nutrients tend to make good mulches because they do not encourage weeds by releasing nutrients and are not themselves eaten quickly by microorganisms).

More obviously, a good mulch material should also be readily available, affordable, easy to use, and easy to dispose.

A partial list of possible mulches and their benefits and drawbacks

1) Plastic mulch

What it is, key features: Big sheets of plastic. Plastic mulch has a number of benefits that other mulches do not -- in particular, the heat it traps can speed plant growth throughout the growing season, and especially during the cool weather at the beginning and end of the garden season (see **season extension techniques** for a discussion of this). It is also very, very effective at keeping down weeds. Unfortunately, you have to buy it, you cannot incorporate it into the soil (so it offers no long-term benefit to soil quality), and you have to throw it away, after which it will spend forever taking up space in a landfill.

Weed/light blocking capability: Excellent (buy plastic you cannot see through at all).

Durability: Will last a whole growing season.

Availability: Special agricultural plastic is available at many garden stores or through mail/internet companies in rolls or folded sheets. If you cannot find this, you can buy large sheets of plastic at any hardware store, though this plastic can be unnecessarily heavy.

Cost: Moderately expensive – buying a big roll or sheet can be cost-effective, because you can use small pieces of it over time.

Ease of use and disposal: Not too complicated, but not as simple as most other mulches. See **laying and removing plastic mulch** for tips on how to use this material. Should NOT be incorporated into the soil at the end of the growing season, but must be pulled up and thrown away.

2) Landscape Fabric

What it is, key features: Large sheets made up of plastic strips woven together. Unlike plastic mulch, landscape fabric lets air and water through to the soil while also providing the benefit of warming the soil. Because it lasts for multiple years, it can be very helpful in growing perennial herbs, fruits, and vegetables, but it is too expensive for most growers to use on a large scale.

Weed/light blocking capability: Excellent.

Durability: Will last multiple years if cared for properly.

Availability: Landscape fabric is available at many garden stores and through mail/internet retailers in rolls or folded sheets.

Cost: Quite expensive.

Ease of use and disposal: Not too complicated, but not as simple as most other mulches. See **laying and removing plastic mulch** and **season extension techniques** for tips on using this material. Can be used for multiple years, either left in one place in the garden or moved around. When it begins to fall apart, the fabric should NOT be incorporated into the soil, but must be pulled up and thrown away.

3) Newspaper

What it is, key features: It's newspaper, either shredded or in large sheets (large sheets make for better mulch). Avoid colorful, shiny paper. Newspaper ink used to contain lead, but this is no longer the case in the United States. Do *avoid* colorful, shiny newspaper, as this can contain harmful compounds.

Weed/light blocking capability: Good, especially if paired with another mulch (see "ease of use" below)

Durability: Good.

Availability: Easily available – collect it yourself or go to a nearby recycling facility.

Cost: Little or none.

Ease of use and disposal: Newspaper is very easy to use. After preparing a bed for planting, lay newspaper down on the bed 6-8 sheets deep, watering it to fit it to the soil. You can put a little bit of soil on top here and there to hold the newspaper down, or you can put on a layer of another mulch like leaves or straw (the combination of newspaper and straw or leaves can be almost effective as plastic, and is also biodegradable). Cut holes through the newspaper to put in plants. Newspaper can be incorporated into the soil at the end of the growing season.

4) Cardboard

What it is, key features: Brown, thick, corrugated cardboard, used in shipping and packing boxes. Avoid colorful, thin cardboard used for cereal boxes and other food packaging. Cardboard is very good at blocking weeds and is more durable than most other biodegradable mulches. If you have problem weeds like Canada thistles (see **weeds**) and you do not want to use plastic mulch to keep them under control, cardboard may help you. Apply several offset layers of cardboard so no soil is exposed.

Weed/light blocking capability: Excellent.

Durability: Very good.

Availability: Readily available. Collect it yourself from boxes you use, or visit a recycling facility nearby. Many businesses will also be happy to have you take away some of their cardboard.

Cost: Little or none.

Ease of use and disposal: Cardboard is pretty easy to use. Wet the cardboard (it takes a while to absorb water), prepare a bed for planting, and arrange the cardboard over the bed, using small amounts of soil to hold the cardboard down. When the cardboard is new, it can be hard to make it fit to the shape of your beds – keep wetting it and it will flatten out eventually. Over time, the cardboard will get soft and ragged and can be incorporated into the soil at the end of the growing season.

5) Leaves

What it is, key features: Dried leaves collected in the fall, either whole or shredded. Leaves are one of the most widely available mulches, and when applied thickly (about 15 cm/6 in deep – more if you have them), they will keep down weeds for much of the growing season. Water the leaves after applying them to keep them from blowing away.

Weed/light blocking capability: Good.

Durability: Good.

Availability: Good – either collect your own (if you have a yard), or collect them from homeowners who put them in bags. Many cities and towns also have facilities where you can pick up leaves for free.

Cost: Free.

Ease of use and disposal: Leaves are easy to move around and spread on beds, at least when they are dry. Wet leaves can be very heavy. Leaves can be incorporated into the soil at the end of the growing season.

6) Straw

What it is, key features: Cut, dried stems of wheat, oats, or other grains. One of the reasons to use straw in some situations is that it is not quite so dense as most other mulches, even when wet. As a result, it can be used to protect overwintering crops like garlic, which are able to grow up through the mulch in the spring. If you tried to use leaves for the same purpose, they would mat down such that you had to move them away from the garlic plants to let the plants grow out of the soil. The fact that straw is less dense than leaves or cardboard also means that some weeds can come up through it, but many fewer than if you did not mulch at all. When you apply straw, break it up from the tight sheets that it tends to form. Apply straw as thickly as you can – at least 12 cm (5 in) of loose straw if possible. Water the straw after applying it to keep it from blowing away. Straw can be incorporated into the soil at the end of the growing season. DO NOT confuse straw with hay when buying mulch. Both hay and straw are dry when you get them, but when hay was cut it

was wet and green. As a result, it is nutrient-rich, and it will tend to rot (and smell bad) instead of serving as a good mulch.

Weed/light blocking capability: Low to medium (sometimes this is a good thing -- see note above)

Durability: Medium – tends to pack down and can blow away in strong winds. May need to add more straw through the season if it is your only mulch.

Availability: Unless you are a farmer, straw must be purchased at a farm, garden store, or hardware center.

Cost: A bale of straw about 90 cm x 46 cm x 36 cm (36 in x 18 in x 14 in) can cost anywhere from \$3 to \$8. If suppliers are asking more than that, you might want to try another kind of mulch.

Ease of use and disposal: Straw can be incorporated into the soil at the end of the growing season.

7) Grass clippings

What it is, key features: Dried, cut grass. Any grass you use should be completely dry and brown. DO NOT use green, freshly cut grass. Like hay (discussed with straw, above), grass is usually cut when it is green, wet, and rich in nutrients. Wet grass, and dry grass that is still green, is better used to make **compost** or another **soil amendment** than mulch. If you are thinking about using grass clippings for mulch, make sure that the lawns they come from have not been treated with toxic chemicals. Unfortunately, many homeowners use pesticides and herbicides on their lawns that last on grass clippings for a long time.

Weed/light blocking capability: Good.

Durability: Not great – grass tends to break down fairly quickly because the stems are thin and there are enough nutrients for soil organisms to eat the grass. You may need to add mulch multiple times through the season to keep weeds down.

Availability: Depends – must be dry and chemical free. If you can produce your own, good. If not, be careful about where you get them. Some cities and towns collect these and give them out for free.

Cost: Usually free.

Ease of use and disposal: Very simple to use – one of the easiest mulches to spread around plants. Breaks down quickly, and can be incorporated into the soil at the end of the growing season.

There are many, many other materials you could use for mulching, including cocoa bean hulls (a by-product of chocolate production), corn cobs, and pine needles.

Materials NOT to use as mulch

There are also some materials you should *not* use as mulch, or at least not in certain places. While they do keep down weeds, woodchips, sawdust, and bark chips all contain a protein called *lignin*, which lasts for hundreds of years in the soil and sucks up nutrients that would otherwise be available to your plants. Generally, these materials should not be used as mulch in any bed where you are growing annual vegetables, herbs, flowers, or fruits. If you have permanent paths or plantings of trees around your garden, these woody materials can be used for mulch in these locations. Other materials like manure (from cows, horses, pigs, etc.) are much too nutrient-rich for mulch and are better used as **fertilizer** or **soil amendments**.

Pests

As in so many areas of life, the best pest control in organic gardening is prevention. As much as possible within the space of your garden, rotate (move) your crops around the garden so that no crop is planted in the same place for at least three years. Not only should you keep the same plant from going in the same place, but keep other related plants out, too. This will help save your plants from both diseases and pests that build up in the soil around the roots of a particular kind of plant. See **planning what to grow** for more discussion of rotations and their benefits. In addition, it's good to grow as many different crops as you feel comfortable taking care of. Besides giving you some harvest even if one of your crops is completely destroyed by pests, this diversity is itself a form of pest control – pests move quickly through large plantings of the same crop, but more slowly through small plantings of diverse crops.

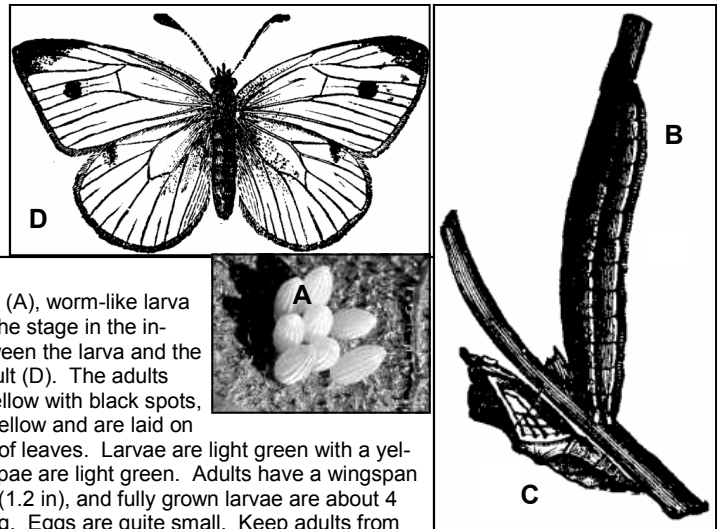
Use of varieties with genetic resistance to pests and diseases is also a time-honored way to prevent pest problems. When you buy seeds or transplants (see **getting seeds and transplants**), look at the seed packets and transplant labels for claims about disease and pest resistance. Contrary to what you might think, dis-

ease and pest resistance are in most cases *not* the result of genetic engineering, but of plant breeding methods that have been practiced for hundreds of years.

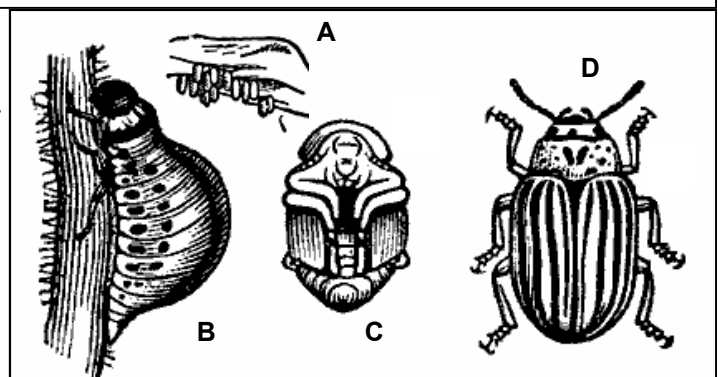
For insect pests, two other forms of prevention are the use of **floating row covers** and the use of transplants (see **getting seeds and plants** and **transplanting**). Floating row covers keep pests off your crops through a combination of a physical barrier (the row cover) and the creation of conditions under the cover that are unfavorable for insect growth and reproduction. Use of transplants does not actually keep pests off your crops, but by leaving plants in your home or a greenhouse until they are large enough to defend themselves at least a little bit, you increase the chance that any pest problems you do have will not kill your plants. Most plants have few defenses when they are small, but as they grow older, their stems get thicker and less tasty for insects, and they develop the ability to release bitter or otherwise unpleasant substances in response to insect feeding. Their resistance to disease also increases.

If you have used the various preventative tactics mentioned above and you still have insect pest problems, there are some compounds that are used as organic pesticides. Keep in mind that these compounds are not like some of the conventional insecticides you might have used in the past – if they are o.k. for use in organic production, they are less toxic to your health, or at least break down more quickly in the environment than standard pesticides. Most of these compounds only kill insects when the insects are very small (larvae, or worm-like creatures, rather than adults). Also, most of these compounds are only effective for a day or two after you apply them, after which point they are destroyed by sunlight, rain, or just exposure to the air.

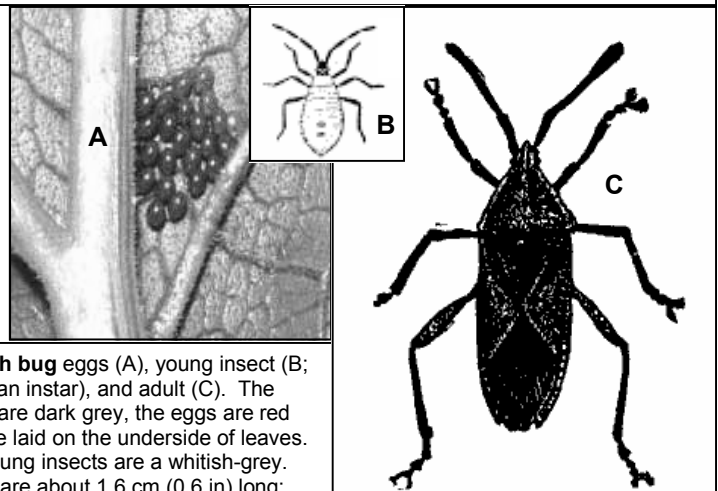
A thorough discussion of organically approved pest controls is beyond the scope of this manual. However, three of the most commonly used compounds are *azadirachtin*, which is derived from the seeds of an Indian tree called Neem, pyrethrin, which is derived from chrysanthemums (a flower) and *Bt toxin*, which is derived from a soil-dwelling bacterium called *Bacillus thuringiensis*. Azadirachtin is marketed in compounds with names like Neemix, Green Light Neem, and Agroneem. Pyrethrin is marketed



Cabbage butterfly eggs (A), worm-like larva (B), pupa (C; the stage in the insect's life between the larva and the adult), and adult (D). The adults are white or yellow with black spots, the eggs are yellow and are laid on the underside of leaves. Larvae are light green with a yellow stripe. Pupae are light green. Adults have a wingspan of about 3 cm (1.2 in), and fully grown larvae are about 4 cm (1.5 in) long. Eggs are quite small. Keep adults from laying eggs with **floating row covers**; can spray with Bt toxin to kill young larvae, or pick eggs off your plants (if you're very careful and attentive) before they hatch into larvae. The larvae will eat the leaves not only of cabbages but of kale, broccoli, cauliflower, collard greens, and other related plants.



Colorado potato beetle eggs (A), worm-like larva (B), pupa (C; the stage in the insect's life between the larva and the adult), and adult (D). The adults are whitish yellow with black stripes and orange heads, the eggs are orange-yellow and are laid on the underside of leaves. Larvae and pupae are orange and black. Adults are about 1 cm (0.4 in) long, and larvae are variable in size. Eggs are quite small. Plant resistant varieties of potatoes and keep adults from laying eggs with **floating row covers**; can spray with Bt toxin to kill young larvae, or pick eggs off your plants before they hatch (if you can find them). Colorado potato beetles will eat the leaves of eggplants, potatoes, and tomatoes.



Squash bug eggs (A), young insect (B; called an instar), and adult (C). The adults are dark grey, the eggs are red and are laid on the underside of leaves. The young insects are a whitish-grey. Adults are about 1.6 cm (0.6 in) long; young bugs vary in size from tiny to almost adult sized. Squash bugs are hard to control — one of the only really effective ways to control them organically is to pick the eggs off the undersides of plants before they hatch. Young squash bugs will eat almost any vining crop — squash, pumpkins, cucumbers, zucchini, etc. They don't necessarily eat much, but they often kill plants by spreading disease.

under various names, of which Pyganic is one of the most widely sold. Bt toxin is marketed under many different names – when you buy it, make sure to get a variety that is supposed to be effective for the kind of pests you have (some varieties affect Colorado potato beetles, for example, while others do not). Azadirachtin and Bt toxin are not harmful to people at all, but pyrethrins definitely can be – all should be used with care. All three compounds work by poisoning insects. There are other insecticidal (insect-killing) compounds that are based on oils and soaps, but these compounds work (at least in some cases) by covering the holes through which insects breathe, which chokes them.

See **resources for more information** for directions to more information about pest control (Peaceful Valley Farm Supply is one business in particular whose web site and catalog provide many products for organic pest control together with information about how and when to use them). In general, before you launch an elaborate program to deal with any kind of pest or disease, you should talk to an experienced gardener and/or a local agricultural extensionist (again, see **resources for more information**) to make sure that you have both identified your pest or disease accurately and come up with treatment methods that are safe, organic, and potentially useful.

Preparing a bed for planting

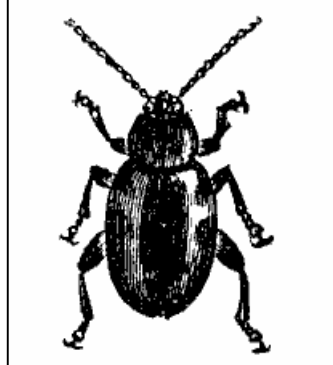
Why do any special preparation?

Seeds and transplants are much more likely to survive and produce for you if you do some work to prepare the soil in which they will grow. For both seeds and transplants, your goals in preparing a bed are pretty much the same: 1) take preventative action to reduce competition between weeds and desired plants, and 2) increase the organic matter content and nutrient content of your soil. For seeds, you have an additional goal – break the soil lumps nearest the surface into very small pieces to make what's called a *seed bed*.

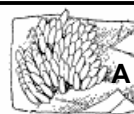
Why make a fine seed bed? When a seed is placed into a bed of very finely divided soil, the soil will touch the seed at many points on the seed's surface. This "seed-soil contact" allows the seed to absorb water from the soil quickly. This is important, because the average seed must absorb twice its own weight in water to be able to germinate (start growing). If the soil is in bigger lumps and seed-soil contact is not so good, a seed cannot absorb much water and will often fail to germinate (or start growing but then die for lack of water). If the soil is in very large pieces, then seeds may also tend to fall down between them and get buried too deeply for their seedlings to grow out of the soil. Remember that each seed is a little package of fuel – the seed only contains enough fuel to grow the plant a certain distance out of the ground before it reaches sunlight and starts to make new fuel.

There are as many ways to prepare a plot for planting as there are gardeners; the method presented below is one simple, reasonably reliable method that requires relatively few tools and less physical work than some other methods (some serious gardeners swear by a method called "double digging," but this is very labor-

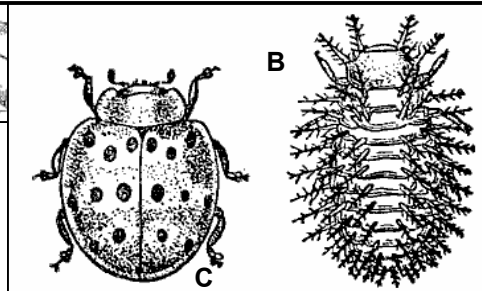
Flea beetle adult. The adults are shiny black and very small (1.5-2 mm, or 1/12 to 1/16 of an in). Flea beetles can be hard to see because the adults jump off the plants as you approach and hide in the ground. If your plants have many small holes in the leaves, however, flea beetles may be to blame. Flea beetles particularly like eggplants and cabbage-family plants (broccoli, cauliflower, kale, collard greens, etc.), but they will eat almost anything. Keep plants covered with **floating row covers** to protect them from flea beetles. The beetles are hard to kill with organic insecticides because of the way they hide in the soil. You won't see other life stages of this insect because they live in the soil.



Cucumber beetle adult. The adults are greenish yellow with black spots or stripes. Like flea beetles (above), cucumber beetles can be hard to see because the adults jump off the plants as you approach and hide in the ground. If your squash, pumpkins, cucumbers, or zucchini are being eaten to death, however, cucumber beetles may be involved. Keep plants covered when young with **floating row covers** to protect them from these beetles. Older plants can be uncovered because they usually outgrow the beetles (and must be uncovered so bees and other insects can visit them to pollinate them). Like flea beetles, cucumber beetles are hard to kill with organic insecticides because of the way they hide in the soil. Adults are 6-12 mm (0.25-0.5 in) long.



Mexican bean beetle eggs (A), larva (B), and adult (C). The adults are



yellow to orange-brown and about 6-7 mm (0.2-0.3 in) long. The spiny larvae range from very small to about the same size as the adults, and are whitish, yellow, or orange. Bean beetle larvae can eat your beans to death. Because bean beetles go through multiple generations in the course of the summer and the populations get bigger and bigger from one generation to the next, the best way to deal with them is to plant beans only early in the season (late May or early June). Some types of beans (like soybeans and yardlong beans) and some varieties of common green beans are less popular with or resistant to bean beetles. You can also try covering your beans with **floating row covers** to keep the beetles from laying eggs, and spray with Bt toxin to kill the larvae.

intensive).

Timing of preparation

If you want to plant in a spot where no one has gardened recently (the spot has been unused for a year or more), see **preparing a new garden plot** and follow the steps described there; this would typically happen in the fall (if you have a dense mat of grass sod to deal with) or the spring (if your soil is reasonably exposed and easy to work in). If your soil is hard or tends to dry out easily, you may wish to go through the steps of **preparing a new garden plot** each year (see **soil** for some discussion of these issues).

If you are done with the basics of preparing a new plot, or if you (or someone else) used the garden plot the previous year, then follow the step 1-4 below about a week before you want to plant. Besides giving the soil some time to settle (removing trapped pockets of air that can cause your seeds or plants to dry out), stirring up the soil a week in advance will encourage weeds to start growing that you will kill when you complete step 5 on the day of planting. Note that if the area is *very* weedy, with well-established grasses or other perennial plants, you may want to follow steps 3 and 4 *several* times in the 4-6 weeks before your desired planting date – this may eliminate the problem weeds, or at least set them back so they compete less with your crop(s).

You are most likely to need to go through all five of these steps in the spring and early summer. Later in the year, if you have just harvested a crop (such as early-season tomatoes) and you want to put another crop (such as lettuce) in the same place, you may be able to skip steps 1 through 3 or even 1 through 4.

Steps in bed preparation

1) Working at a time when it has not rained for several days (so the soil is not too wet), use sticks to mark off the outline of the area that you plan to plant. From this point forward, you will want to avoid stepping in the area as much as possible – walking in it compacts the soil, which is bad for the roots of your plants. Because you will want to be able to weed and harvest the whole bed without stepping in it, this may determine how large an area you mark off (see **beds** for discussion of one commonly used scheme for arranging a garden).

2) Spread an organic **fertilizer** over the top of the planting area. The amount you spread will be determined by the kind of plant you wish to grow – again, see **fertilizer** for some recommendations. If you want to add a **soil amendment** to the planting area, you can spread it either below or on top of the fertilizer.

3) The next step is to break the soil up into clumps, with the secondary goal of working the fertilizer into the soil. If your soil is very light or very rich in organic matter (see **soil**), you might be able to do this with a sharp hoe, but for most people this will require a spade (see **tools**). Beginning in one corner of your planting area, dig up the whole area systematically, turning each lump of soil over onto its side, or about 90 degrees. Though the blade of your spade may be as much as a 30 cm (12 in) long, you generally do not need to dig that deeply – 10-15 cm (4-6 in) should be enough. As you dig, take the time to remove stones, sticks, and the roots of any plants that are growing in your planting area. If the roots are dense and fibrous, this can be a lot of work – knock the clumps of roots against your spade to knock the soil off, and remove the roots from your garden (do NOT put them in your **compost**). If you find that there are many roots in your garden (for example, the roots of quackgrass or Canada thistle – see the **weed guide**), you may want to dig as deeply as your spade can go, removing all of the roots you find. In general, this step in bed preparation is one of the most physically demanding tasks in gardening. Some gardeners complete this step using a rototiller (a gasoline-powered tool that grinds up the soil), and there's nothing terribly bad about this, but rototilling can damage your soil over time and may spread problem weeds.

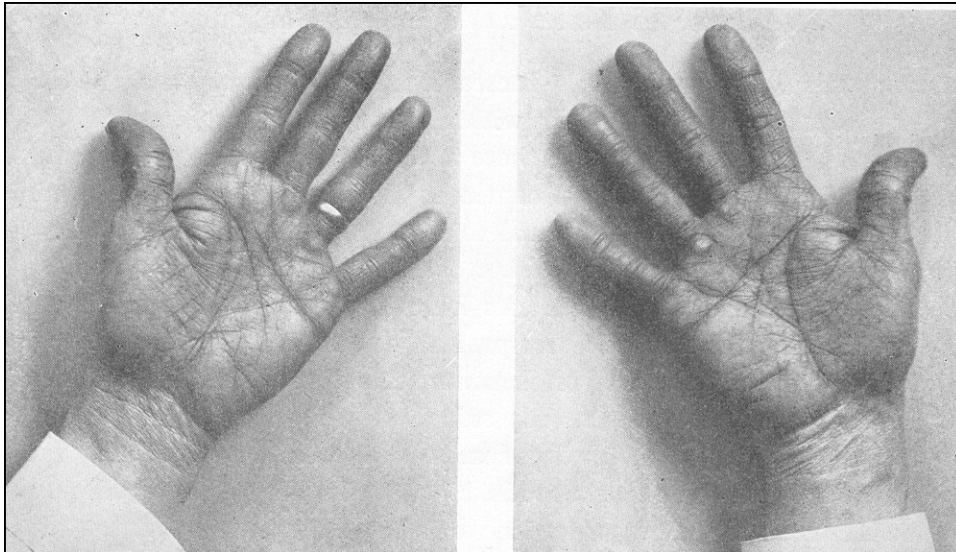
4) Once you have dug the bed into large clumps, take a hoe (see **tools**) and use it to begin breaking the large clumps into smaller clumps. If you do not have a hoe, you can do this with your spade (it's just a little more difficult). As you work, keep removing stones, sticks, and roots. Your goal here is to break the soil into clumps that are no more than about 5 cm (2 in) across.

5) Note -- this step should wait until immediately before you plant; it kills weeds that have been encouraged to grow by the earlier steps of bed preparation. If you do it earlier, then weeds will start to grow which will come

up before (or along with) your plants. This is bad. In this step, use a garden rake (see **tools**) to break the medium-sized clumps into small pieces, sometimes called *crumbs*. You can use a combination of back-and-forth movements and chopping movements to do this, and this work may dig up still more sticks, stones, and roots, which you should remove. How small your target crumbs are depends on what you want to plant. If you are going to transplant plants, the crumbs do not need to be very small at all – 1-2 cm (0.4-0.8 cm) across is enough. If you are going to plant small seeds like lettuce, however, the crumbs nearest the surface should be like fine bread crumbs, less than 3-5 mm (0.1-0.2 in) across. Preparing a fine planting bed like this takes time and some practice – do not be discouraged if your first seedbeds seem lumpy or uneven.



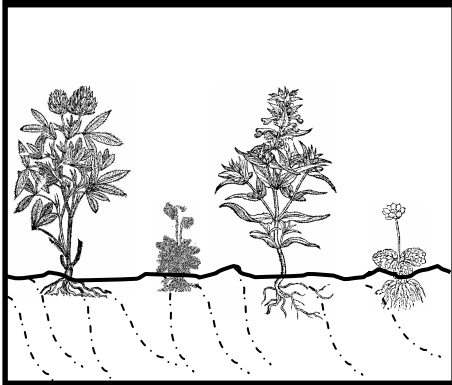
A garden rake is a very helpful tool in the final step of bed preparation. Here, a gardener uses a rake to break the soil into small pieces and level it just before planting.



Preparing beds for planting is some of the hardest physical work of gardening, and much of it comes in the spring when your hands may be soft from disuse over the winter. Wearing leather or cotton work gloves can help prevent blisters and dryness.

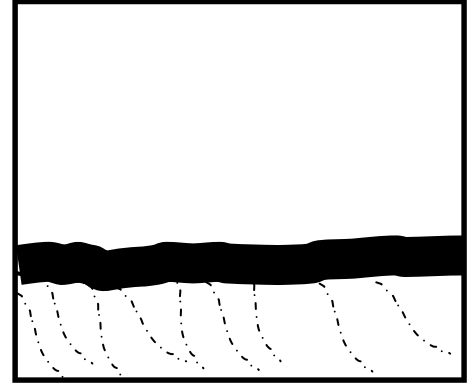
Preparing a new garden plot

Preparing a new garden plot - 1



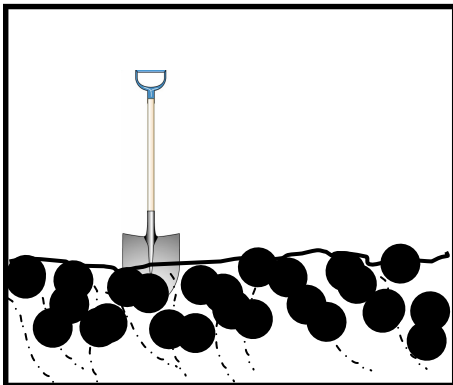
Unless it's already marked out for you (in a community garden, for example), use sticks to mark out the area in which you plan to garden. Try to avoid shade. Pick up any sticks, garden tools, or other messes and move them off the plot. If there are any strong stakes or tomato cages (see the crop page for tomatoes), keep them for your own use. If possible, talk to an experienced gardener to see if there are perennial plants that you might want to keep (for example, rhubarb, asparagus, strawberries, herbs, or fruit trees). If there's nothing you want to keep, remove all vegetation, using a spade or trowel as needed (see **tools**). **DO NOT JUST PULL THE TOPS OFF THE PLANTS!** Time spent now digging out roots and bulbs will be time you save weeding later. If there is a solid mat of sod (grass and grass roots), you will want to rototill the area and/or dig it with a spade, pulling up clumps of grass, knocking as much of the soil off their roots as you can, and taking the grass out of the plot. Ideally, you would do this in the fall to give the sod a chance to break down over the winter. If there are mounds or holes in your garden, move soil around with a spade to make the plot as level as possible.

Preparing a new garden plot - 2



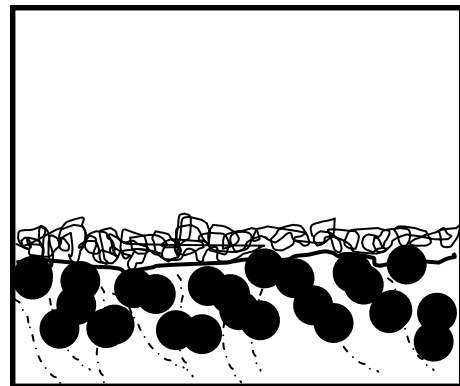
If you have **compost**, composted manure, or another **soil amendment**, spread as much of it as you can (up to 8 cm, or 3 in). Work around any plants that you may have decided to keep. If you are not a new gardener, this can be done every year, either in the fall or as early in the spring as you can work the soil (late March or early April, for example). If you don't have access to any soil amendments, skip to step 4.

Preparing a new garden plot - 3



Use a spade or rototiller to dig the soil amendment into the top 15 cm (6 in) or so of soil. Do this by turning each spadeful of soil over in place and using the spade to break up the clumps (a hoe can also be useful for this).

Preparing a new garden plot - 4



If you have it, spread **mulch** on top of the soil. You can put as much as 15 cm (6 in) of leaves (whole or shredded) or straw down. The leaves or straw will suppress weed growth and will also eventually rot, improving your soil. If you do not have leaves or straw, you can use newspaper (put down up to six layers) or old cardboard boxes. These will also do a good job of keeping the weeds down and will eventually rot. Once you have spread your mulch, your garden can sit and wait until you are ready to use any given piece of it.

Season extension techniques

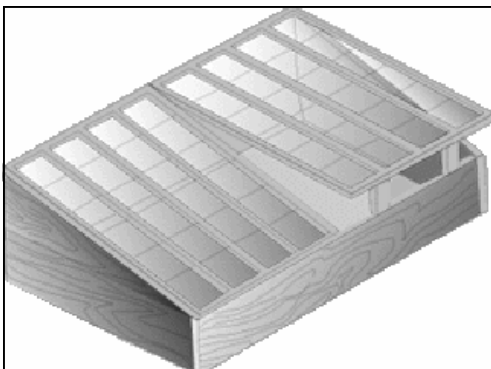
Why try to extend the season?

In the upper Midwest, the gardening season is not very long. Some crops that are fun to grow (watermelons, for example) need a long, warm growing season that is hard to provide without using some kind of special method. Other crops like spinach can be grown easily enough, but use of a season extension technique allows you to harvest the crop early in the spring and/or well into the winter. Finally, some season extension techniques (particularly the use of “floating row covers”) also serve as important pest controls for organic gardeners.

What are some common season extension techniques?

There are many ways to get more crops out of your garden in a given year. Some of the most appropriate for gardeners:

- 1) Selection of appropriate varieties—Every vegetable (and fruit and flower) is available in multiple varieties. Some of these varieties are more cold-tolerant than others and will start to grow earlier in the spring (or survive later into the fall) than others. Some varieties also mature more quickly than others, and can therefore be planted and harvested in a narrower window of time (whenever in the season you plant them). See **choosing plant varieties** for more information.
- 2) Use of transplants—Many common garden plants (tomatoes, eggplant, peppers, and cucumbers, for example) will not germinate (start to grow) in cool spring soils. If you start growing plants inside your house or apartment in cold weather, however, or buy young plants from a professional, you can put those plants in the same soil and they will grow. If you want to grow your plants inside, you may need to start as early as February or March. See **starting plants inside** for more details. You can also buy plants from garden stores.
- 3) Locating your garden appropriately—Many gardeners do not have a choice about where to garden. If you do have a choice, however, avoid low ground. Cold air sinks into low spaces, and the temperature difference between the top of a hill (even a very small hill) and the neighboring valley can be multiple degrees.
- 4) Use of cold frames—Cold frames are boxes with glass lids that act as miniature greenhouses to trap the sun’s heat. Even a very basic cold frame can be used at the beginning or end of the gardening season to add weeks of extra growing time. Cold frames need not be fancy — any on old window set on top of a wood frame works fine (see picture below).
- 5) Use of plastic mulch—Plastic mulch is a layer of plastic that you put over the soil and weight down at its edges. The plastic warms the soil underneath it, greatly helping plants that need higher temperatures to grow (this is true not only early and late in the season, but even in the middle, when Midwestern temperatures are a little low for some really heat-loving crops like eggplant and watermelons). Plastic mulch also retains moisture, reducing the need to water your garden, keeps down weeds, reducing the work of weeding, and can reduce problems with some pests and diseases. See **laying and removing plastic mulch** for tips on how to get started with this technique. Unfortunately, plastic mulch can only be used once and then must be thrown away. There is a material called landscape fabric that serves the same purpose and can be reused multiple times, but it is significantly more expensive than regular black plastic. With landscape fabric, you also need a scissors or a sharp knife to cut holes for your plants.
- 6) Use of floating row covers—Floating row covers are pieces of plastic or (more often) strong, fabric-like material that are placed over crops and anchored around their edges with soil, rocks, or something else. Floating row covers serve as miniature greenhouses, trapping heat and moisture while also keeping pests out. Row covers are light enough that they sit lightly (or “floats”) over the crops so that in most cases nothing needs to be put in between the crop and the row cover. A few crops (tomatoes, peppers, and summer squash) have sensitive tops and you should use wire hoops to keep the row cover from touching the plants. Floating row covers can be used together with **plastic mulch** to help plants grow even faster in cool weather. Most of the time, row covers are used for both their heat-retaining benefits and their power to keep out pests. Sometimes, as with young brassicas (broccoli, cauliflower, and their relatives), the pest-related benefits alone justify the use of floating row covers. If young brassicas are not kept covered, small insects called flea beetles will eat them to death. Once the plants get larger, the row cover can be removed and the plants will survive flea beetle damage. See **use of floating row covers** for more information on how to use these tools.



A cold frame made out of a wooden frame and two old windows. One of the windows is propped up with boards to let extra heat out (on an unusually hot spring day, for example). This cold frame has angled sides (the downward side would be angled toward the south), but this is not necessary. A cold frame can be simple to make — don’t think that it has to be expensive, fancy, or well put together to work!

Soil

You probably can't choose where to garden, and whatever soil you have in our gardens is the soil you have to work with. Having said that, you can a) work to understand the soil you have, and b) make some attempts to improve (or maintain) its suitability for gardening.

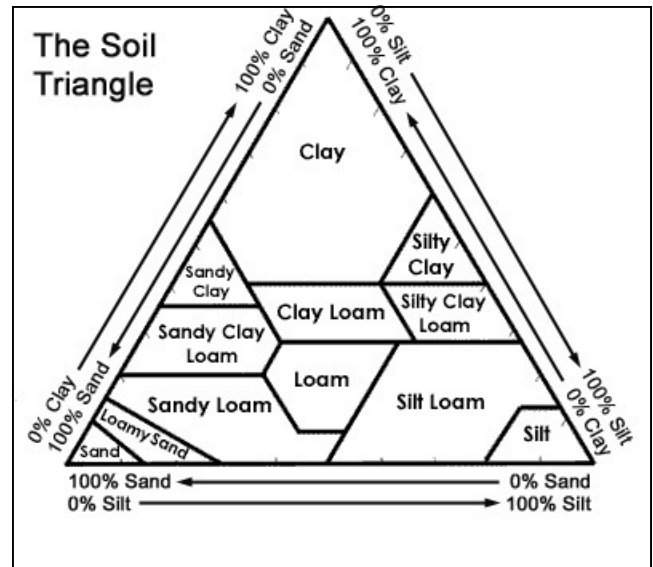
What is soil?

If you're not familiar with soil, it may all look sort of blackish-grey and crumbly. Soils are quite variable, however – soils a few hundred meters or yards apart can have different properties and support the growth of different crops. Any soil is a complex, constantly changing mix, made up of several components: *minerals*, *organic matter*, and *living organisms*.

Minerals

If you pick up a handful of soil, between 90 and 99% of what you're holding was originally rock. Over millions of years, water and wind and freezing and thawing wear rocks into small or very small pieces. Soil scientists group these pieces into three categories by size. *Sand* particles are the largest, ranging in size from 2.1 millimeters (1/12 in) down to 0.05 millimeters (1/500 in) in diameter. *Silt* particles are next smallest, ranging in size from 0.05 millimeters (1/500 inch) down to 0.002 millimeters (less than 1/12,500 in). *Clay* particles are even smaller – so small that individual particles cannot be distinguished even under a fairly powerful microscope.

Theoretically, a soil could be all sand, all silt, or all clay, but most soils are made of at least some of each of these three particles. The soil triangle (see picture at right) is a tool used by soil scientists to classify soils. You may not be able to tell exactly where your soil fits on the triangle, but the soil itself can tell you some-



The soil triangle is used by scientists who study soil to describe a given soil in terms of how much sand, silt, and clay it contains. To use the triangle, you need to know what your soil is composed of. To figure this out approximately:

- 1) Take a jar with a tight-fitting lid and fill it half full of your soil. Pack the soil loosely.
- 2) Add water carefully to the jar until the soil is completely soaked with water, but there is no water standing above the top of the soil. Tap the jar to settle soil.
- 3) Use a permanent marker to mark the level of the soil on the side of the jar.
- 4) Fill the jar with water to the top, put the lid on, and shake the jar for several minutes.
- 5) Put the jar on a table and let it sit for 40 seconds.
- 6) Some material will have settled out — this is the sand. Mark the level of the sand on the side of the jar.
- 7) Let the jar sit undisturbed for 6 hours. More material will have settled out — this is the silt. Mark the level of the top of the silt on the side of the jar.
- 8) Use a ruler to measure the distance between the bottom of the jar and the starting soil line (in inches or millimeters — doesn't matter). This number represents the total volume of soil you started with. Call this number S_{total} .
- 9) Measure the difference between the bottom of the jar and the sand. This number represents the relative volume of sand in your soil. Call this number S_{sand} .
- 10) Measure the difference between the sand line and the silt line. This number represents the relative volume of silt in your soil. Call this number S_{silt} .

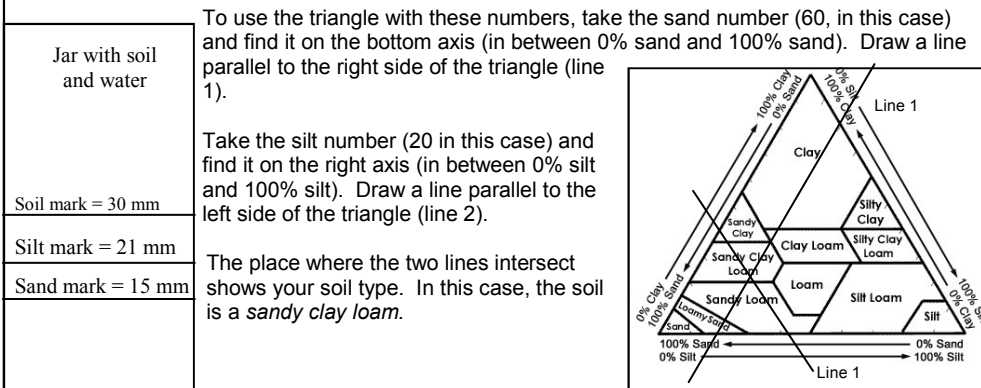
The triangle shows you percentages by *weight*, not volume, and with your jar of soil and water, you have measured percentages by *volume*. So, you need some conversion factors to convert the volume of each soil element to weight.

$$\begin{aligned}\% \text{ sand in your soil} &= (S_{sand}/S_{total}) * 119 \\ \% \text{ silt in your soil} &= (S_{silt}/S_{total}) * 87 \\ \% \text{ clay in your soil} &= 100 - (\% \text{ sand} + \% \text{ silt})\end{aligned}$$

For example, if you mixed your soil with water and marked it as described above, you might end up with a jar marked as shown below.

$$S_{total} = 30, S_{sand} = 15, \text{ and } S_{silt} = 6$$

$$\begin{aligned}\% \text{ sand in this soil} &= (15/30) * 119 = 59.5, \text{ or } 60 \\ \% \text{ silt in this soil} &= (6/30) * 87 = 17.4, \text{ or about } 20 \\ \% \text{ clay} &= 100 - (59.5 + 17.4) = 23.1, \text{ or about } 20\end{aligned}$$



thing. Just feeling it is a good start -- sand feels coarse and rough between your fingers, silt feels gritty, and clay feels sticky (at least when wet). You can also learn what's in your soil by watching it over time. If, when your soil is dry, for example, it develops large cracks, it probably has a high clay content. If you can walk on it without getting your shoes dirty even when it is wet, it probably has a high sand content.

Sand, silt, and clay come from hard, dead rocks, so you might think that these soil components would do little more than serve as a physical medium for plants to put their roots into. In fact, however, they play very important roles in assisting plant growth. Rocks are made of some of the same essential elements that our bodies are, and the soil mineral particles that come from them gradually release these elements such that plants can take them up. Clay (and to a lesser extent silt) also plays important roles with respect to water availability and the usefulness of any **fertilizer** that you might apply. Clay particles are very small and very numerous, and therefore have an enormous total surface area which also happens to be electrically charged. Important plant nutrients that we apply in fertilizers are also electrically charged, and the nutrients interact with the charged clay and stick to it such that they stay around until plant roots need them. Because clay particles are small and numerous, there are also many small spaces between them where water can be held very firmly -- this too can be taken up by plants as needed. Soils that lack clay must be watered and fertilized often because the soil can't balance, or "buffer," the availability of nutrients like it could if there were clay present.

Because different plants have different needs, there's no particular mixture of sand, silt, and clay that's ideal for all vegetables. In theory, you could change the properties of your soil by adding large amounts of one or the other sizes of minerals. While people do occasionally do this (by adding sand, for example, to help soils drain better), the more common way to improve soil for gardening is to try to increase the soil's organic matter content (see below).

Organic matter

Organic matter is a fancy term for broken-up formerly living things. When animals and plants die, they are gradually broken up into smaller pieces. Some of these pieces are eaten or carried away by creatures large and small, but some of them end up getting incorporated into the topmost layer of soil. Though organic matter almost never makes up more than 10% of soil, and may make up as little as 1 or 2%, it has a disproportionately large impact on a soil's potential to support plant growth. Like the mineral portion of the soil, organic matter gradually releases the elements it contains for plant growth. If you think about where the organic matter comes from, however, it makes sense that it would be even more important than the mineral part -- dead living things might logically be assumed to contain most or all of the elements needed to grow live living things, while the mineral part of the soil only holds some of these elements. Organic matter is also even better than clay at holding water and any additional nutrients you might apply in the form of fertilizer. Plants can then pick these up from the organic matter and use them to grow.

Organic matter makes soils less dense, easier to move around with tools, easier for plants' roots to grow through. It tends to make soil look dark, and it tends to be concentrated near the soil surface. If you have a soil that seems to be low in organic matter, that's something you can do something about. Even if your soil seems rich in organic matter, you can always add more (good gardeners do). You might think you could just add any dead things that you have on hand (woodchips, leaves, whatever), but unfortunately it's not that simple -- not all dead things are created equal. Wood and dry fall leaves are not very nutritious at all compared to stuff that's wet, green, or otherwise closer to being alive (freshly cut green grass, freshly pulled weeds, manure, coffee grounds, banana peels, etc.). Neither the really dry, bland stuff nor the wet, green juicy stuff is something you want to add to your soil -- the best thing to do is make a blend, and the best way to blend them is to compost them. See the **compost** page for more details on how to create useful organic matter for your soil.

If you don't want to bother composting, or you need to improve your soil in a hurry, you can go to a garden center or hardware store and buy bags of organic matter (composted manure or any other **soil amendment**) that you can add to your soil right away. If you buy something that's already composted, there's really no limit other than the size of your pocketbook and the strength of your back to how often or how much organic matter you can safely add to your soil. See **preparing a new garden plot** for instructions on how to incorporate organic matter into your soil (you can use these instructions even if you are already gardening).

Living organisms



While soil itself is not alive, any soil that is good for growing vegetables contains enormous numbers of living organisms. Most of these creatures are far too small for you to see. Bacteria are the most abundant of these – 28 g (1 oz) of soil can contain more than 30 billion of them! Fungi (related to mushrooms) are almost as abundant, followed by other less familiar forms of microscopic life. These tiny creatures break down dead things, making the nutrients they contain available for plant growth.

Less numerous but also very important are the creatures we can see – earthworms, insects, small mammals (mice, moles, voles), and others. These creatures also help recycle nutrients, and they also make tunnels that help air and water move through the soil.

Whether they're plants you want or ones you don't (like weeds), plants themselves are important to the soil. Plants called *legumes* (a group that includes beans and peas) collect nitrogen from the air and make it available in the soil for other organisms to use. All plants put roots through the soil, and when these die and decay, the resulting channels help with air and water movement. Plants with very deep roots can help bring nutrients up from very deep in the ground that are otherwise unavailable.



A quick note on soil health and soil erosion

As discussed above, soil is *not* just a place for your plants to stick their roots. While gardening inevitably involves some disturbance of the soil, you cannot dig it up, turn it over, or move it from one place to another and expect it to be the same as it was before. There are a few informal rules to be followed for long-term soil health (and good yields of vegetables, fruits, herbs, and flowers):

- 1) When you harvest produce from your garden, you are removing nutrients. These *must* get returned somehow. Some combination of **fertilizer**, **soil amendments**, and/or **mulch** is *essential*.
- 2) Soil with nothing growing on it is vulnerable to *erosion*, which is the removal by blowing wind and flowing water of the mineral and organic particles needed to support plant growth. Because it is concentrated near the soil surface, organic matter is especially vulnerable to erosion. Soil erosion often happens a little bit at a time, without anyone noticing, though heavy rains may leave channels in the soil that tell you soil has been removed and carried away. In nature, bare, exposed soil is rare and soil erosion rates are low. If there is a natural disaster like a mudslide or volcanic eruption that leaves the soil uncovered, there may be a lot of erosion for a short time, but plants quickly take advantage of the open space to grow. In these circumstances, erosion is usually brought under control fairly quickly without any human intervention. In gardens, however, we not only uncover and disturb soil repeatedly, but we try to prevent plants (weeds) from covering it up again. This can lead to substantial erosion, which in the long run can make your garden much less productive. Soil is hard to replace once it's gone – in an undisturbed forest or grassland, it can take 500 to 1,000 years to produce 2.5 cm (1 in) of soil. For this reason, gardeners have a responsibility to keep soil covered as much of the time as possible – if not with plants, then with **mulch** of some sort. Mulching is particularly important over the winter, when winds are strong and there are no living plants, and in the spring, when plants are small and it rains frequently.

Soil Amendments

Note: This section will make more sense if you read the **fertilizers** and **soil** sections first.

Soil amendments are not fertilizers

As discussed in the **fertilizers** section, plants need a number of different nutrients to survive. These nutrients can be purchased and applied to soil in concentrated forms called fertilizers. Fertilizers are rated according to how much they contain of three critical plant nutrients -- nitrogen (N), phosphorus (P), and potassium (K). Most fertilizers have labels that give you concentrations of N, P, and K as three numbers, like 4-6-4 or 6-2-0. In the same place where they sell fertilizers, many garden stores also sell other products that are not really fertilizers but might seem like it at first glance. These products, which this guide calls *soil amendments*, con-

tain some of the same nutrients that fertilizers do, but in much, much smaller amounts. Soil amendments that have N-P-K labels may have numbers like 0-0.5-0, for example. Because they contain so few core plant nutrients, these products are *not* an effective way to provide most garden plants with nutrients.

What soil amendments are, and why you should use them

Soil amendments are made from a wide variety of materials, and they can be purchased in garden stores or made at home (if you have the materials, space, and time to make them). Manure from cows or horses is often used, as are various household and kitchen wastes (vegetable peels and cores, grass clippings, etc.). To make a soil amendment, these materials are processed somehow, usually by being made into **compost**. Though this process can actually result in the loss of some nutrients, it makes the materials into a stable form of organic matter that is highly beneficial for your soil (see **soil** for a discussion of organic matter and why it's important).

You might wonder why gardeners don't just add materials like manure, kitchen waste, and yard waste directly to their soil. There are several reasons for this. Fresh manure is neither very pleasant to handle nor very stable in the soil (it and the nutrients it contains can wash away, evaporate, etc.). Manure can also carry disease-causing organisms that are killed by the process of composting. Other materials are harmless enough from health and environmental perspectives, but if you add them to your soil unprocessed, the result can actually be the *removal* of nutrients from your soil, at least in the short term. This occurs because the materials you add to the soil don't just sit there – various creatures start to eat them immediately, and if the food you give them does not contain all of the nutrients they need to grow and reproduce, they will scavenge (collect) the nutrients out of the soil around them.

How much soil amendment to apply

Unlike fertilizers, which can be overapplied, there is no upper limit to how much soil amendment you can safely put in the soil – the amount you put in depends on how much time, money, and energy you want to spend buying, making, and applying the stuff. It's safe to say that you should add at least a small amount of some sort of soil amendment to part of your garden every year, and to the whole garden if you can. Gardeners who make their own **compost** (or who are willing to buy a lot of it) sometimes add as much as 5 cm (2 in) of compost across their whole gardens each year.

How to apply soil amendments

Soil amendments can be spread on a garden at any time of year, though it can make the most sense to do this at either the beginning of the year (when you are **preparing a bed for planting**) or at the end of the year (when you are preparing the garden for winter – see **the garden through the season**). Dump your soil amendment on the ground in a pile, and use a spade, spading fork, or garden rake (see **tools**) to spread it around to the desired thickness. Then, use a spade or spading fork to work it into the ground. It doesn't have to go in deeply – a depth 20 cm (8 in) or less is enough; just get it off the surface (it will break down faster and be less useful on the surface).

Mulch can count as a soil amendment

Organic gardening is much easier if you use leaves, straw, newspaper, or some other kind of **mulch** to help control weeds. With the exception of plastic and landscape fabric, most materials used as mulch can be dug into the ground as described above once they are done performing their job. Like compost and other soil amendments that you might make or purchase, these mulch materials contain organic material and can benefit your soil. They tend to contain very few nutrients, however (the fact that nothing wants to eat them this is partly why they make effective mulches). Because mulches are nutrient-poor, if you incorporate large amounts of mulch and want to plant in the same place right away, you'll want to add extra fertilizer to feed the organisms that are eating the mulch. If you don't, they'll take the fertilizer you intended for your plants and use it to complete their meals.

Starting plants inside

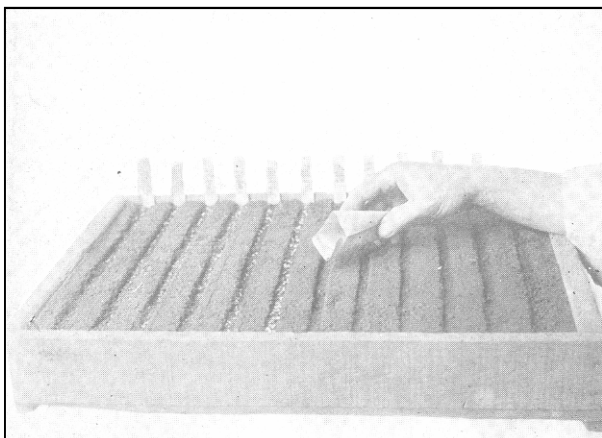
As shown in the ***quick reference guide for vegetable planting***, some plants can be grown in your garden from seed. Other plants are more often started inside, either because they cannot handle the cold conditions of the early growing season or because they need such a long season to grow that they need to start growing while there is still snow on the ground (or both). If you start plants inside, you raise them to a certain size and then transplant them out into your garden (see ***trans-planting***).

Starting plants inside is not particularly recommended for beginning gardeners. There are several reasons for this:

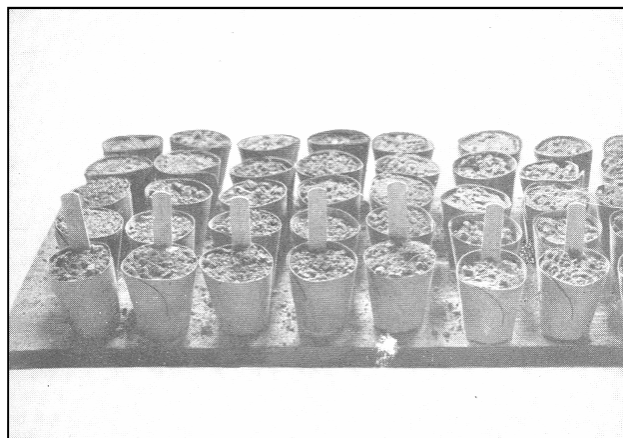
- 1) Space -- Starting more than a few plants takes space inside a house or apartment that many beginning gardeners do not have. You can't start plants just anywhere – you have to start them in a place that's warm, with good light, where you are comfortable spilling water and/or soil.
- 2) Light – In the late winter, when many gardeners are starting plants inside, days are short and the light that reaches into your house or apartment is weak. If they grow at all, plants grown under these conditions tend to become very tall and thin (a look sometimes called “leggy”) as they search for light. Leggy plants do poorly when transplanted into the garden. As a result, gardeners who are serious about starting plants inside buy grow lights and place these very close to their plants to provide extra light.
- 3) Cost and time – Besides the cost of the seeds you wish to plant, starting plants inside requires pots, potting soil, and often lights (see above) and the cost of the electricity they use. Starting plants also requires some time – in addition to planting, you must also water, turn lights on and off, etc.

Starting plants inside can be very fun and rewarding, but most beginning gardeners will want to buy plants at a farmers' market or garden store (see ***getting seeds and transplants***).

For those who do wish to start plants inside, most garden stores now kits (sometimes called “seed-starting kits”) that contain everything you need to get started with indoor growing, including instructions. To find instructions on starting plants inside *without* buying a kit, refer to one of the all-purpose gardening resources mentioned in ***sources for more information***.



The first step in starting seeds inside is to sow seeds thickly in a flat (shallow tray) full of potting soil. The tray shown here is made of wood, but modern trays are usually plastic. Seeds can be planted in furrows pressed into the soil, as shown here, or scattered over the soil surface and covered with a thin layer of additional soil. Water, light, and warmth are critical for germination and growth of your seedlings.



Before seedlings become crowded in a flat like the one shown at left, they should be transplanted carefully to individual pots (either paper or plastic) or into another plastic tray that is divided into little boxes. Some plants, especially vining crops like cucumbers, winter squash, and melons, should be started in small pots or cells from the beginning.

Thinning

If, like most gardeners, you want to make sure to have good, full rows of plants, you will probably want to thin at least some of your vegetables, flowers, and herbs. What does thinning involve? You prepare for thinning by planting seeds more densely (meaning closer together) than you actually want your plants to grow. After the plants emerge from the soil, let them grow for a little while (a week or two, for most crops), then pull up some of the plants such that the remaining plants (the biggest, healthiest looking ones) are approximately the distance apart recommended in the ***quick reference guide to vegetable planting*** (the guide also tells you which plants should be thinned).

Why thin? While you may think you don't want to waste seeds, seeds are generally inexpensive. It's much better to plant seeds thickly and need to thin the resulting plants than to plant seeds far apart and find that too few of them have germinated to give you the crop you want. Seeds also must literally push their way out of the soil. If you plant them close together, they help each other with this sometimes very difficult task.

In some cases, the plants that you pull out while you're thinning can be ***transplanted*** elsewhere if desired. Broccoli, cabbage, kale, and their relatives fit in this category, as do a variety of other plants. In other cases, the plants you pull out should just be added to the ***compost*** pile. Beets, carrots, parsnips, cucumbers, melons, and squash are among the plants that ***cannot*** be pulled out and planted elsewhere.

If you plant seeds densely, it is very important to make sure that you do thin the plants out. If you don't, the plants will be too close together and will compete with each other for light, water, and nutrients. They will stay small and will not produce much of what you want (leaf, fruit, root, etc.).

A variation on thinning is the planting of plants in a small, dense ***seedbed***. If, for example, you want to create warm growing conditions for basil seedlings, you can plant 50 or 100 seeds very close together (say, in a square 60 cm/24 in on a side), then cover them with a cold frame (see ***season extension techniques***) or a ***floating row cover***. When the plants are about 10 cm (4 in) tall, you can dig them ***all*** up and ***transplant*** them into rows so they are about 60 cm (24 in) apart. Once they're that big, they can live without the extra heat. Something similar is also commonly done for broccoli, cauliflower, cabbage, kale, collards, and related plants. For these plants, the purpose of the cover is not extra heat but protection from flea beetles (see ***pests***). The flea beetles can eat the very small seedlings to death, but not the larger transplants.



A gardener pulling unneeded plants from the row at left and piling them up on the right. If the plants were cabbages or some other crops (see text), the plants that have been pulled out could be replanted elsewhere. If they were beets or certain other crops (see text), they would be discarded.

An important gardening lesson:

A small number of plants planted the proper distance apart will almost always give you a larger and higher-quality harvest than a larger number of plants planted too close together.

Follow recommended plant spacings!

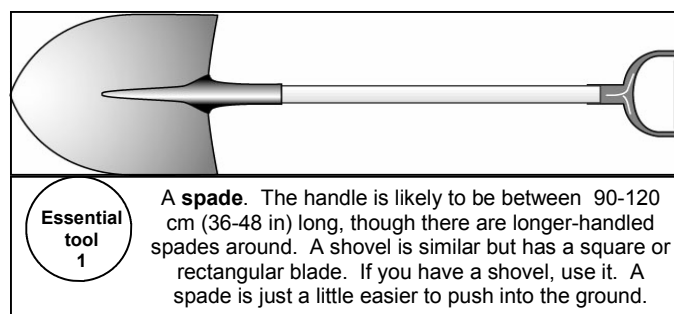
Tools

Most tools are badly manufactured. You can buy tools cheaply, but they may break quickly. You may still want to buy cheap tools if you are not sure how much you'll like gardening, if you are working in an area where your tools may be stolen, or if you want to buy many tools for children or other new gardeners in a community garden or educational setting. Spending more money to buy better tools is advisable if you have the money and a place to store your tools that is both safe from theft and protects from the elements – both the blades and handles of garden tools are damaged by exposure to sun and water. See ***the garden through the season*** for more discussion of storing tools.

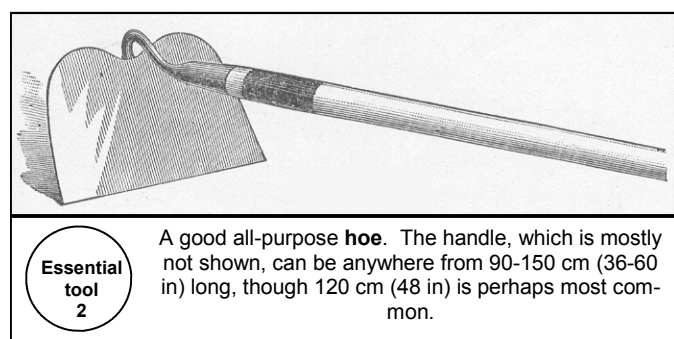
It can be hard to know what makes one tool better than another, but in general, good tools have handles that are wood (cherry or something other than pine) or fiberglass (which can look like plastic but is heavy). Handles that are plastic are almost always bad. The metal heads of tools should not just be fitted onto their handles, but should be attached with one or more screws or other hardware. Thicker metal parts are better than thinner metal parts. Tools that say things like “contractor grade” can be good, but shopping with an experienced gardener is your best bet.

The three essential tools – spade, hoe, and garden rake

If you could only have one tool for gardening, it should probably be a *spade*, which has a blade with curved edges like the one shown here. Do not buy a *shovel*, which has a blade with straight edges. Use your spade for ***preparing a bed for planting***, for moving soil around in your garden as needed, and for many other tasks.



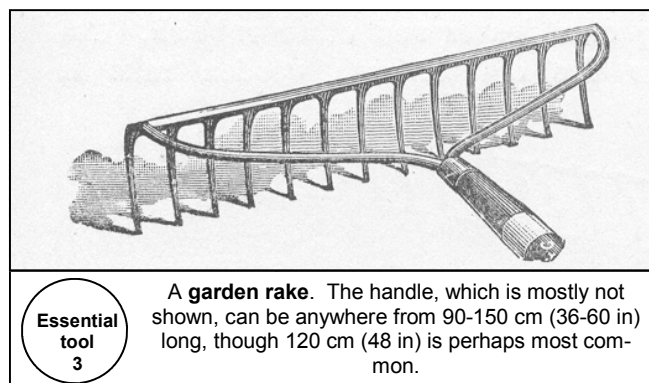
If you could only have two tools for gardening, they should be a spade and a *hoe*. There are hoes with heads of many different shapes for different kinds of purposes – a common, all-purpose shape is shown here. Hoes are good for weeding and for ***preparing a bed for planting***.



If you could only have three tools for gardening, they should be a spade, a hoe, and a *garden rake*. A garden rake is different from the kind of rake used for raking leaves. A garden rake has a stiff metal head with short tines, or fingers, while a leaf rake has a metal head with long, flexible tines. One sample garden rake is shown here. A garden rake is useful for ***preparing a bed for planting***, for moving ***mulch*** around, and for various other tasks.

Very useful tools

Your spade, hoe, and rake are the most important, but two other very useful tools to have are a *spading fork*, which looks like a giant dinner fork with thick tines, and a *trowel*, which is a small, hand-held digging tool. A spading fork is useful for moving leaves and other kinds of ***mulch***, for digging potatoes and other root

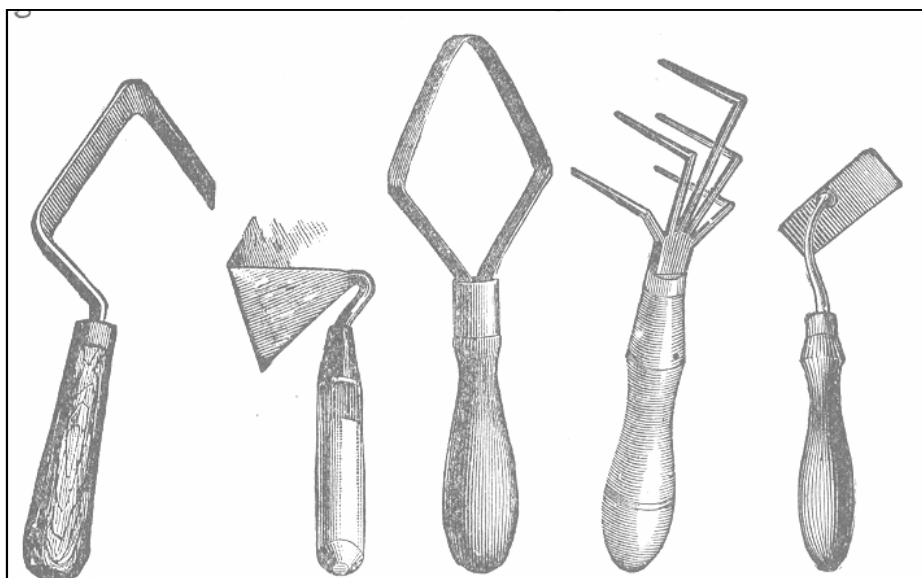
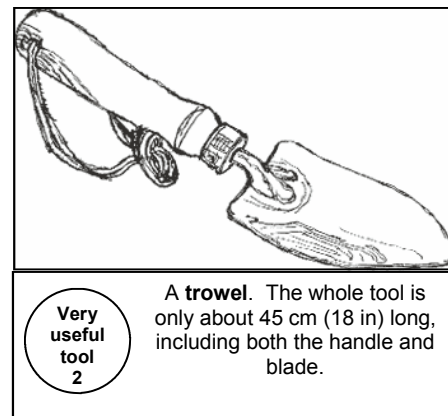
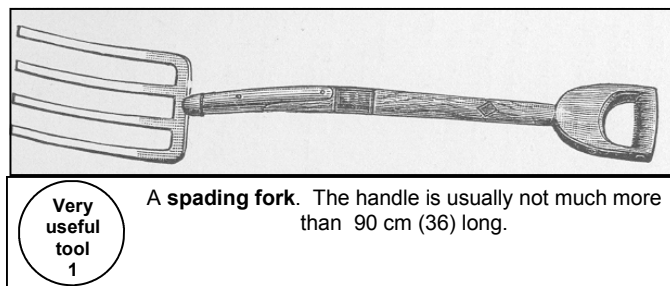


vegetables, and for some other tasks. A trowel is useful for **transplanting**, for digging out weeds, and for other tasks.

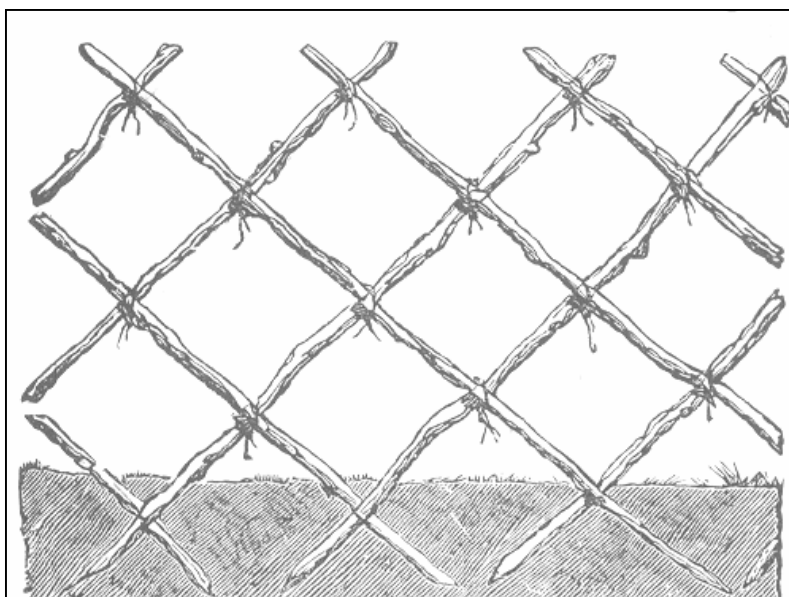
Nice tools

Other useful tools to have are:

- something to water with (see **watering**)
- a ball of string or twine for various purposes (avoid nylon twine, which will not break down in your garden)
- a knife or pair of scissors (for cutting twine and plant parts)
- a sturdy box (metal or plastic) with a tight-fitting lid for seeds
- a wheelbarrow or cart for moving **mulch**, soil, fertilizer, harvested plants, etc.
- a box or can for **fertilizer** storage (fertilizer usually comes in bags that almost immediately begin to leak)



This 140 year-old picture shows a set of small weeding tools (each about the size of the trowel shown above), most of which are still available in garden stores today. Each has its own special purpose, and they can be helpful, but if you have a trowel, your hands, and the desire to get weeds out of your garden, you don't need these.



You will find many purposes for string in the garden. Here branches have been stuck into the ground and tied together to form a trellis. A structure like this is important for peas and climbing beans and can be used for growing cucumbers vertically (they take up less space that way). Make sure to use a string made of cotton, sisal, or something else that will break down in the garden over time (nylon will not).

Transplanting

Before you transplant:

Some plants will grow anywhere, in any soil, but many transplants do best in soils that have been fertilized or otherwise prepared in special ways. Often, this preparation can be done immediately before transplanting, but sometimes it needs to happen a week or more in advance. For some crops (especially tomatoes, eggplant, and melons) your preparations may include laying **plastic mulch**. See the fact sheet(s) for the crop(s) you plan to transplant for advice on how to prepare the soil (and/or mulch) before transplanting.

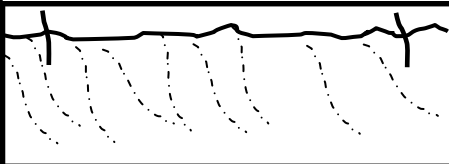
Types of transplants:

Transplants are of three general types:

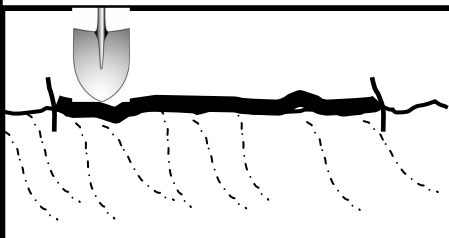
- 1) *Bare-root transplants* are transplants that consist of a green, living top with one or more leaves and a set of exposed roots (no soil). Strawberry plants and onion and leek “sets” are often sold this way. They need to be carefully protected from drying out before you put them in the garden.
- 2) *Potted transplants* are (surprise) transplants that are grown in pots of some sort (many commercial nurseries use shallow plastic trays, or flats). Tomatoes, peppers, eggplant, herbs, and many other plants are sold this way (or you can grow them at home). Potted transplants usually have stems, leaves, and roots growing in at least a little bit of soil. They must also be protected from drying out before transplanting.
- 3) *Bulbs* and *bulb-like plant parts* are not exactly transplants, but many are planted more like transplants than seeds. Garlic, potatoes, sweet potatoes, Jerusalem artichokes, rhubarb, asparagus, and many flowers are planted similarly. Most (but not all) bulbs can be stored for long periods.

Transplanting without plastic mulch

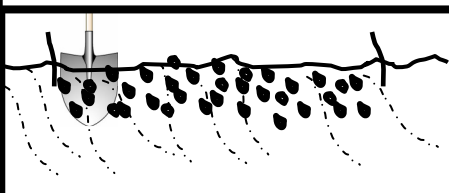
1. Determine how much space will be needed for your plant(s) *at their maximum size*. DO NOT underestimate this! Mark the area off with sticks.



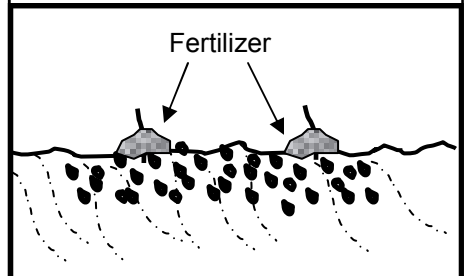
2. If the soils in your garden are dry, dense, and hard, or have not been treated well in the past, spread composted manure or some other **soil amendment** (NOT **fertilizer**) in the marked area. The more, the better. If you have already done this while preparing your garden, skip to step 4.



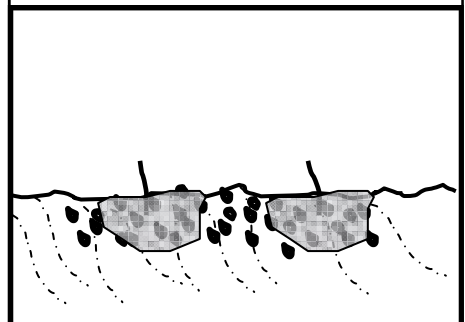
3. Use a spade or rototiller to dig the soil into the top 15 cm (6 in) or so of soil. Use your spade and/or a hoe or garden rake to break up large clumps and make a smooth bed.



4. Measure and mark the location(s) for your plants with sticks. Read the fact sheet for your crop to determine how much (if any) fertilizer is needed for each plant. If fertilizer is needed, put it in a pile at the base of the stick.



5. Remove the stick(s) and use your hand or a trowel to dig the fertilizer into the soil where your plant(s) will be. Keep the fertilizer in a small area (about 25 cm wide and 20 cm deep, or 10 inches wide and 8 inches deep). Replace the stakes, marking the center of each fertilized area.

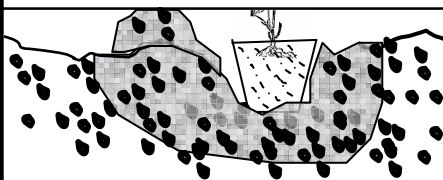


Transplanting (Continued)

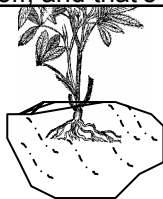
6. Bring your transplant(s) to the newly prepared area.

For potted transplants

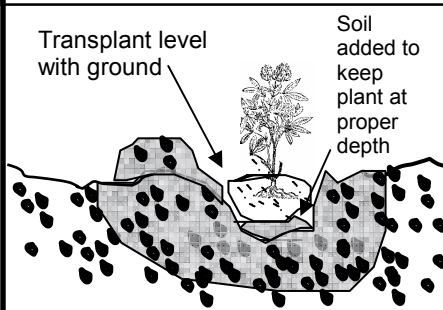
Dig a hole slightly bigger than the pot in the middle of the fertilized area. Use the pot (with the plant in it) to measure as needed.



Place one hand over the top of the pot with the stem of the plant between your fingers. Turn the pot over and shake it to release the plant and its roots from the pot. Your hand will catch the plant and root mass as it comes out. You can squeeze plastic pots to help plants come out. If the pot was full of roots and the roots are tightly bound together, squeeze the root ball several times to loosen the roots. Some soil may fall off, and that's o.k.



Place the plant and its root ball into the hole. Put some soil under the plant if needed such that the top of the soil from the pot matches the top of the surrounding ground. *Burying the plant deeper than this can kill the plant* (except in the case of tomatoes, eggplants, and peppers—see right).

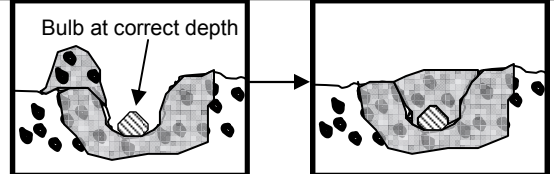


For bulbs

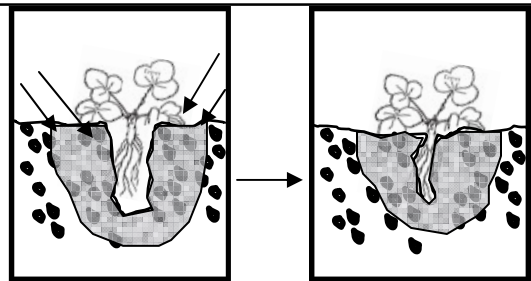
Look up information about planting depths and methods for the bulb(s) you want to plant. For many bulbs, you can dig a hole (or trench, if you are planting multiple bulbs) of an appropriate depth, place the bulb(s) firmly in the bottom of the hole or trench, and fill the trench in, pressing the soil down as you go to improve contact between the bulb and the soil. Some bulb-like plants (garlic, asparagus, rhubarb) have their own somewhat different planting methods.

For bare-root transplants

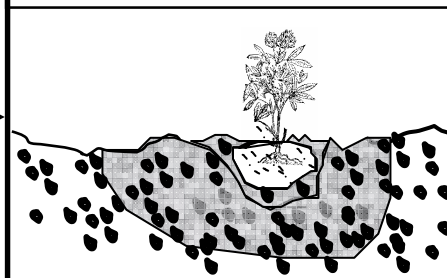
Note: If you are planting tomatoes, peppers, or eggplants, dig a hole that is 7-10 cm (3-5 in) deeper than the pot.



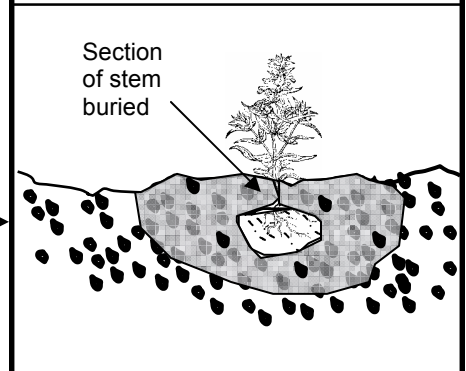
Use a stick or your finger to make a hole big enough for the roots of plant. Put the roots of the plant into the ground, filling in the hole a little bit first if needed so that if needed such that the leaves of the plant remain above ground level. Press the soil around the plant toward the plant so that the hole is filled in, then water thoroughly.



Use the soil you removed earlier to fill in around the plant. Use both hands to press the plant down firmly into its new home. This improves contact between the roots and the soil. Water the plant *thoroughly*. If the plant is tall and weak (or a tomato) you may want to stake it to help it stand up.

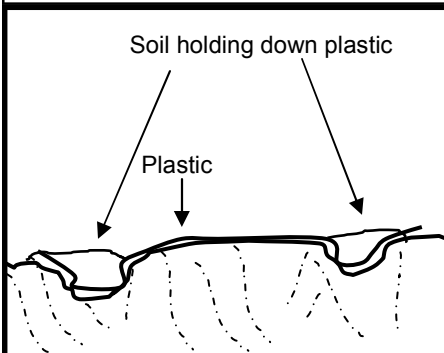


If you are planting tomatoes, peppers, or eggplants, you can make a deeper hole and fill the hole up so that part of the stem is underground and the top of the pot's soil is well underground. These plants will grow roots from their stems and will be healthier if you do this than if you plant them like other plants. Press in and water as described at left.

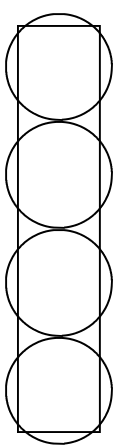


Transplanting (Continued)

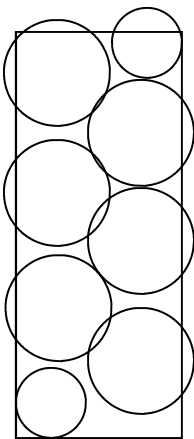
Transplanting *with* plastic mulch



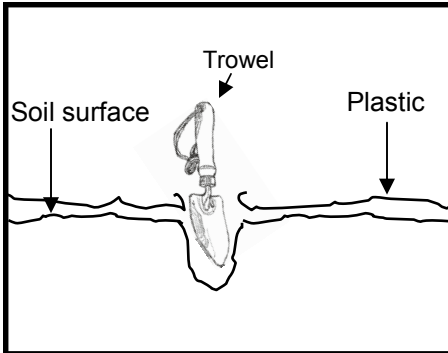
1. Figure out how much space you need and how you will lay your plants out, then lay plastic mulch to match (see **laying and removing plastic mulch**). Keep in mind that many plants planted in plastic (especially eggplants and tomatoes) can end up 1 m (3 ft) or more wide. Depending on the layout of your garden and the width of the plastic you have bought, you may want to lay your plastic and arrange your plants in various different ways (overhead views of two possibilities are shown below). Mark the planned location of each plant with a stick.



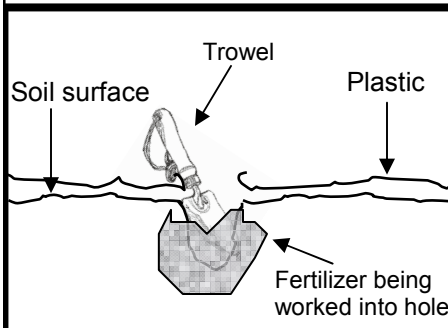
Narrow plastic with a single row of large plants.



Wider plastic with two staggered rows of plants, including plants of two different sizes.

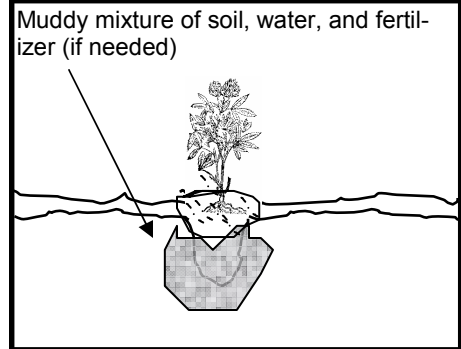


2. Use your fingers, a stick, or a trowel to make a hole through the plastic and into the soil underneath. Keep the hole in the plastic as small as you possibly can (the bigger it is, the more weeds will grow through it). If the pot of the plant you are going to plant is fairly big (bigger than 10 cm or 4 in across), you may want to remove some soil. If the pot is smaller, you will not need to remove any soil at all — you can just loosen it. For tomatoes, peppers, and eggplants (the plants most commonly planted into plastic), you should dig a hole 8-10 cm (3-4 in) deeper than the pot is tall.

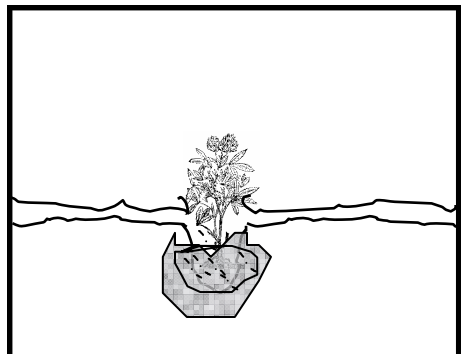


3. Read the fact sheet for your crop to determine how much (if any) fertilizer is needed for each plant. If fertilizer is needed, put it in the hole and use your fingers or a trowel to work it into the soil around the hole. Again, try to keep the hole in the plastic small.

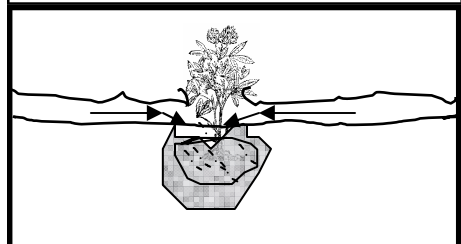
4. Put water into the hole until the soil around the hole is well soaked and muddy.



5. Remove your plant from its pot as described on the previous page. Set it in the hole. You may need to stretch the plastic to do this.

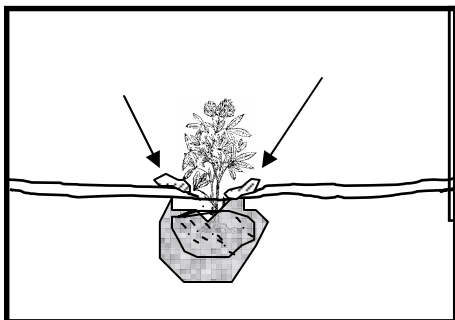


6. Use your hand to work the roots of the plant down and into the muddy soil mixture. For some plants (like sweet potatoes) you should make sure that the leaves and stem are above ground level and the roots are below ground. For other plants (like tomatoes, peppers, and eggplant), you should try to bury at least some of the stem of the plant underground (it will grow roots and make the plant stronger).



7. Sweep your hand under the plastic to move soil in and over the plants roots. Press it down firmly to give the plant good contact with the soil.

Transplanting (Continued)



8. Use soil (not from under the plastic), leaves, pine needles, or small stones to weight down the plastic so that it does not move up and over the plant's leaves (if it does, the plant will get too hot and die).

9. Water the plant(s) thoroughly. *After this watering, make sure to water the plants only if the soil underneath the plastic is truly dry (put your hand under the plastic as needed to check). The plastic holds water very well (this is partly what it's for!).*

Watering

Many beginning gardeners tend to overwater their gardens (as do some experienced gardeners). In general, watering is important in three situations: 1) when you have crops growing, the weather is warm, and it has not rained for 1-2 weeks, 2) when you have just transplanted a crop and it is not likely to rain within the next 24 hours, 3) when you have just seeded a crop and it is not likely to rain within the next week. In the first situation, it may make sense to water the whole garden. In the second and third situations, you may only need to water the newly planted plants or seeds.

If you're not sure whether or not to water, do this: pull back any **mulch**, and dig a hole about 10-12 cm (4-5 in) deep. Take some soil from the bottom of the hole and try to squeeze it into a ball. If it sticks together, you don't need to water (unless you have a bunch of young, small plants with short roots). If the soil does not stick in a ball, you may need to water. Sandy soil (see **soil**) will not ever form a ball, but if it sticks to your fingers, it's wet enough.

However you water, it's best to water *thoroughly* (meaning, wetting the soil to a depth of 12-15 cm/5-6 in). Getting water down that far encourages plants to grow deep, strong roots. Getting water that deep can take considerable time, and as a result, most gardeners tend to water too shallowly. There is no single recommendation for how long to water, but if your soil seems to be dry based on the test above, it may take as much as several hours to water your garden thoroughly (the method you use to water will determine the time it takes).

As tempting as it can be when you're standing in the garden with a hose in your hand, it's generally not a good idea to try to water your whole garden by hand – you just won't be willing to stand there long enough to do the job properly. If you just need to water a few seeds or transplants, and your soil is reasonably moist (from rain or another recent watering), you can get away with a quick hand watering.

Overwatering is as bad for plant roots as underwatering. Water your soil until it is moist to the desired depth, but not until the soil is muddy or has water standing on top. Unless you are using drip hoses (and your soil is *very* dry), watering all night long is a bad idea.

There are, in general, three ways to water your garden – by hand, with an overhead *sprinkler*, or with a *drip hose* or *soaker hose* at the surface of the ground.

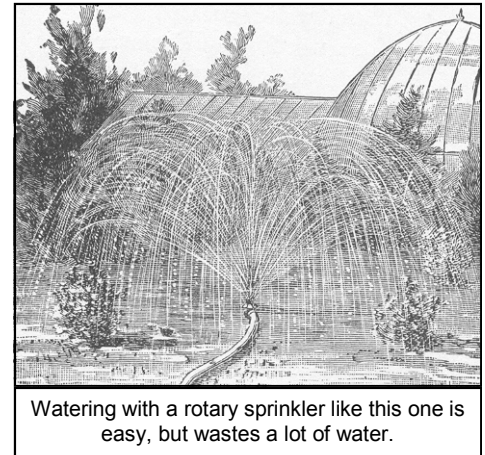
Hand watering

You can water small portions of your garden using a hose with some kind of watering attachment mounted on the end. There are many kinds of devices – some look a bit like guns and have a trig-

ger you pull to release the water, some look like long wands with fat knobs at the end from which the water comes out. Most of these tools are poorly made. If you can, buy one that is all metal (ideally brass). You could just use a hose with nothing on the end at all, but the flow of water that comes out of a hose can be very strong, and can easily dig up seeds that you've just planted. As mentioned above, trying to water your whole garden by hand is a recipe for underwatering.

Overhead watering with sprinklers

Overhead watering is just what it sounds like: some sort of device (usually a *sprinkler*) sprays water over the plants, and it falls down onto the ground. Overhead watering is simple, but inefficient, because a lot of the water sprayed into the air evaporates before it hits the ground. Besides the fact that it can damage the leaves of your plants, watering in the middle of the day in hot weather can cause as much as 80% loss of water to evaporation. Overhead watering should always be done in the morning (before 9 or 10 a.m.) or in the evening (after 5 or 6 p.m.).



Watering with a rotary sprinkler like this one is easy, but wastes a lot of water.

There are many kinds of sprinklers that vary in cost, efficiency, and durability, as well as in terms of the area of ground they can cover without being moved. “Fixed” sprinklers spray water out in the same pattern (usually a square or a circle) all the time. “Oscillating” sprinklers spray water vertically along a tube that moves back and forth and can be set to cover a circle or any part of a circle. “Rotary” sprinklers spray water sideways and can be set to cover a circle or any part of a circle.

Most sprinklers are badly designed and/or cheaply manufactured. In general, the best sprinklers are made with metal parts, while the worst ones are all plastic or are plastic with a few metal parts. Damm is one company that makes good, all-metal sprinklers.

Surface level watering with drip hoses or soaker hoses

Drip hoses and soaker hoses are much more efficient ways to water your garden than are sprinklers. Drip hoses are hoses that have small holes cut at regular intervals on one side of the hose, while soaker hoses have small holes cut at irregular intervals all around the hose. Whichever kind you use (drip hoses are better but not available at some garden stores), arrange the hose to cover the parts of your garden you want watered, and the hose will slowly but steadily release water into the soil. Drip and soaker hoses water more slowly than sprinklers, but they use much less water to do the same job. They are also superior because they don't wet plant leaves or stems, which can encourage various diseases. Unlike sprinklers, they can be used even in the middle of the day.

Buying hoses

Like hand watering tools and sprinklers, hoses are of varying quality (with most being junk). The best hoses are thick, heavy, and made of black rubber over a fiber core. Sears sells Craftsman brand hoses that are usually well made and carry a good warranty (so you can return them if they fail).

More watering tips

If possible, put your hoses and other watering tools away before winter in a place where they will not freeze. At the very least, put them in a covered place where they will not get snowed on or exposed to sun and wind. Use of **mulch** helps the soil retain water and can reduce the need for watering.

Weed guide

A few notes on identifying weeds

Weeds are an important part of the experience of gardening, especially if you are gardening organically. This section is intended to show you pictures of some of the most common garden weeds of the upper Midwest, as well as providing a small amount of information about how to control particular weeds organically. There are far more species of weeds found in US gardens and farm fields than can possibly be shown here. *Weeds of the Northeast*, by Richard Uva, Joseph Neal, and Joseph DiTomaso (Cornell University Press, 1997), which is one of the best available guides for weed identification in the US, lists 299 species. Some of these are also quite variable in appearance, such that a plant growing in full sun and good soil will look very different from a plant of the same species growing in the shade or in poor soil. Identifying weeds can be quite difficult.

On the bright side, most gardeners do not really need to worry too much about identifying weeds – if something is coming up from the ground that you didn't plant, it's a weed and you can kill it. Unfortunately, there are times when the situation is not quite that simple. You may have planted seeds or bulbs, for example, and not have any idea what the plants that are supposed to grow from them will look like. When the first plants start to grow where you planted the seeds or bulbs, you may not know if they're "your" plants or weeds. If you have planted a whole row of seeds or bulbs, however, you can usually just wait a while for enough plants to grow big enough that it's obvious which ones are the uninvited guests. There are also some weeds (quackgrass and Canada thistle, for example) that are very hard to kill, and it can be important to know that you have these if that's the case. Finally, some people just like to know more about weeds. Many weeds lead interesting lives of their own and have medicinal, culinary, or other useful purposes. Local university extension agents and experienced gardeners can be helpful resources to consult if you have a problem weed and cannot identify it or control it.

There is a longer discussion of how to manage weeds in the **weeds** section.

Grass weeds and non-grass (broadleaf) weeds

For the purposes of controlling weeds in gardens, weeds can be grouped into two broad categories: grasses and everything else. Most grasses look quite similar, at least when they are young, and gardeners don't usually grow grasses. This means that almost anything that grows in your garden that looks like a grass is a weed. There are a few exceptions to this simple rule -- sweet corn is actually a grass and can be confused when it is small with many common weeds, and leeks, onions, scallions, and garlic are not grasses but look somewhat like grasses when they are small.

Grasses have narrow, rounded stems with joints at intervals. Their leaves are fairly narrow, and where each leaf meets the stem it wraps around it like a sheath. Grasses tend to have fibrous root systems that hold soil firmly. They are easy to pull out when they are small and very hard to pull out when they are large.

Non-grass weeds (sometimes called "broadleaf" weeds because their leaves are wider than grass leaves) are much more diverse in appearance than grasses, and there's no quick way to describe them. Broadleaf weeds are more easily confused with common garden plants, and in fact some garden plants (sunflowers, dill, and mint, to give only a few examples) can themselves appear, weed-like, where you did not plant them. Some broadleaf weeds are easier to pull out than others.

Some common garden weeds

Weeds shown on the following pages:

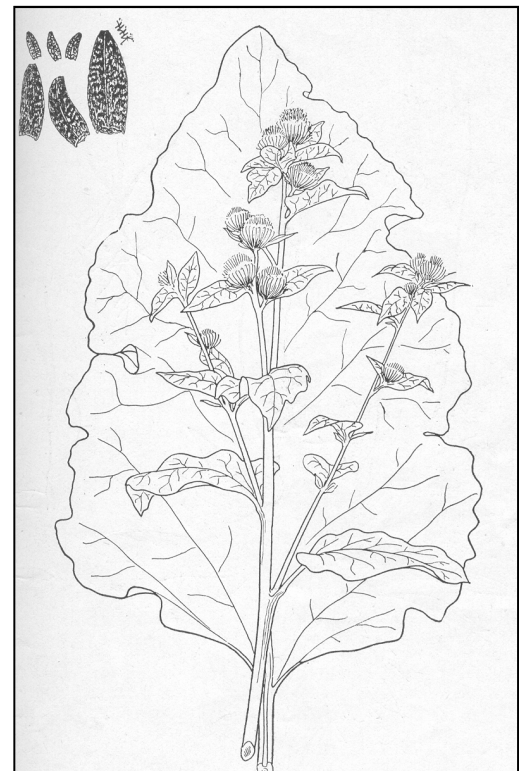
Amaranth (also called pigweed)
 Burdock
 Dandelion
 Foxtail
 Lamb's quarters (also called chickweed)
 Mustard
 Prickly lettuce (also called milk thistle or sow thistle)
 Purslane
 Ragweed
 Quackgrass
 Thistle, Canada
 Thistle, common (also called bull thistle or just "thistle")
 Velvetleaf

(A note about the pictures: Ideally, the pictures included here would show you what common weeds look like when they are small and easy to kill. Unfortunately, such pictures are hard to come by, especially if one wants clear, black-and-white drawings that are not copyrighted. Even if you had them in front of you, pictures of young weeds are not as helpful as you might think, since many young weeds look considerably alike. These are the best pictures that could be provided for now, and they do at least show you a little of what adult plants may look like (often with flowers and/or seeds). Do your best to take the weeds out *before* they produce seeds!)



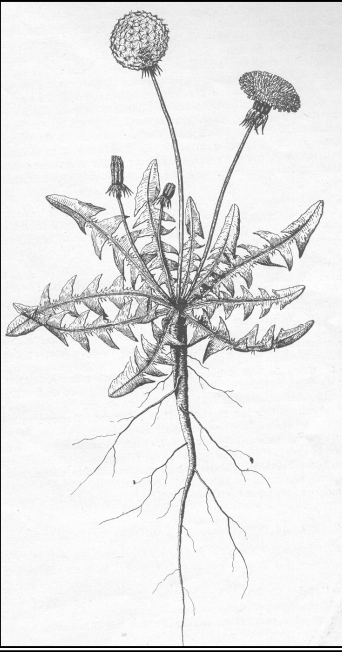
Amaranth, or Pigweed

Rough pigweed (left), red or spiny pigweed (right). The plants are dark green, and the flowers pinkish or red. The seeds are tiny and edible (the plant is an important grain crop in Africa). Plants can get taller than a tall person and become very hard to get out of the ground. Dig them out early!



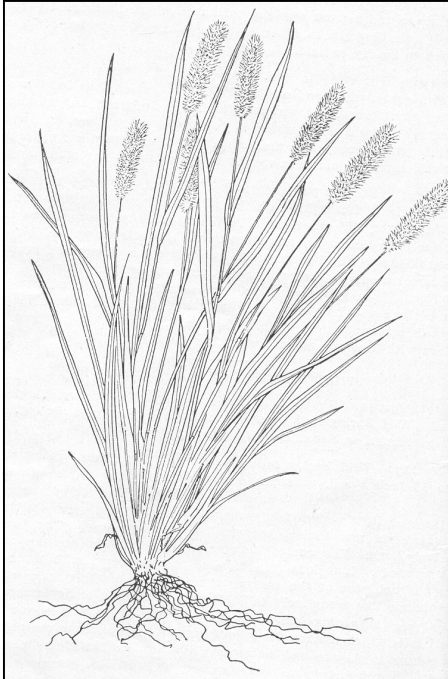
Burdock

The leaves become very large and can be confused with those of the desirable perennial vegetable rhubarb. The roots can be hard to dig out. The seed heads are spiny and stick to your clothes — keep the plants from seeding! Plants can reach waist height.



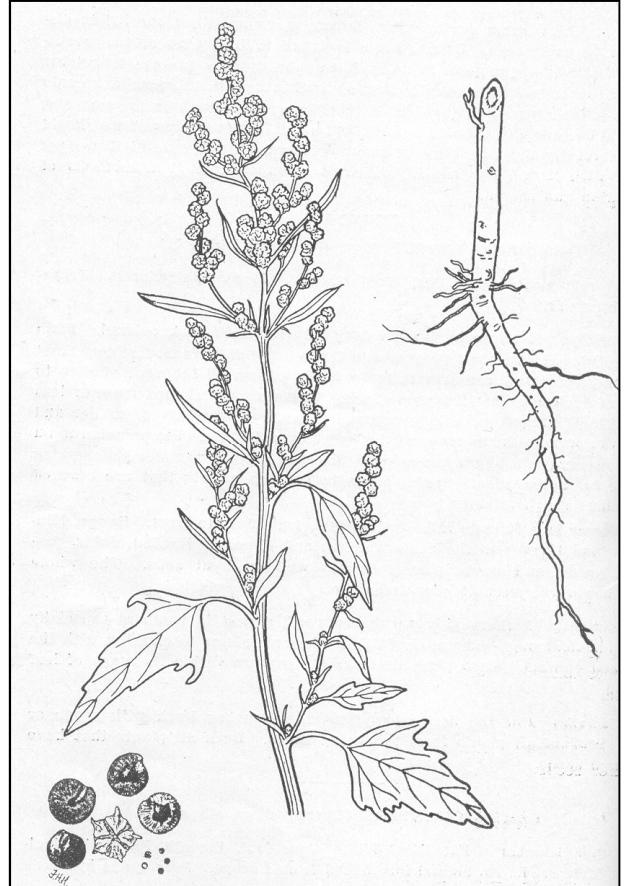
Dandelion

This common lawn and garden weed makes a wheel of flat leaves that are edible when young. The flowers are yellow and the seed heads are puffy and white. When you remove it, dig out the whole long root or it the plant will grow back.



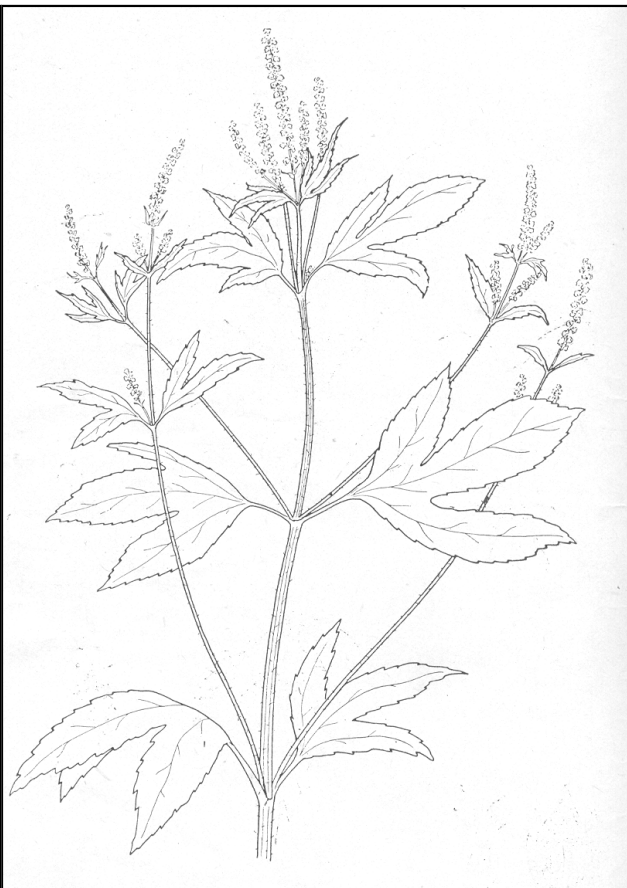
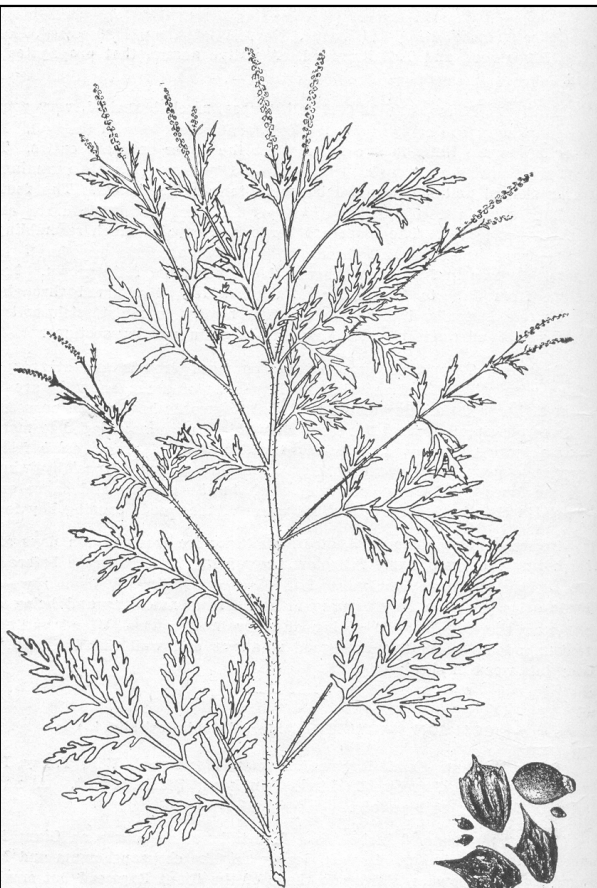
Foxtail

Unless you have quackgrass, this is probably the most common grass weed you will see. Leaves are pale green (and, in some species, reddish near the bottom). The plant produces huge numbers of seeds and large root masses — get them out while they are small!



Lamb's quarters, or chickweed

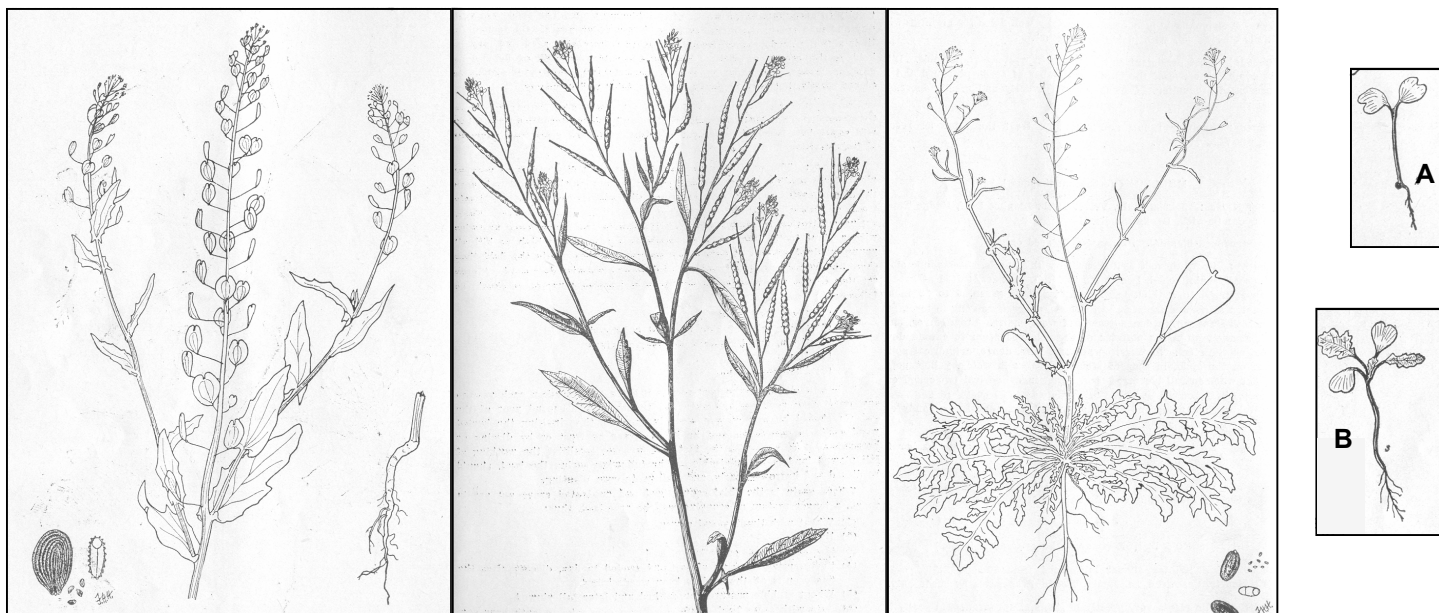
One of the most common non-grass weeds. Plants are grey-green and have very strong stems. In good soils, the plants can get as big as a grown man. Another species not shown here has leaves like these, but narrower.



Ragweed

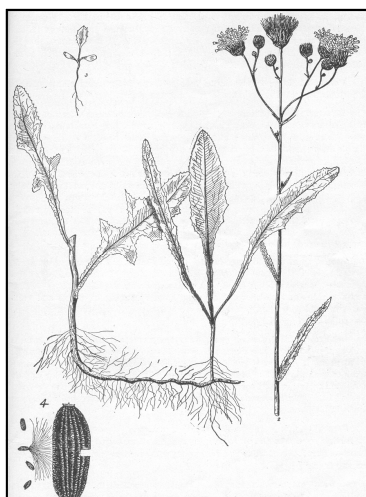
There are two common species of ragweed in the upper Midwest. Little ragweed (or "common" ragweed, shown at left) has finely divided leaves and doesn't get much taller than knee height. Giant ragweed, shown at right, can get as large as 3 m (10 ft)

tall or more. Neither plant is hard to pull up, but they're definitely ones you don't want to let flower — many people have severe allergies to ragweed pollen.



Mustard

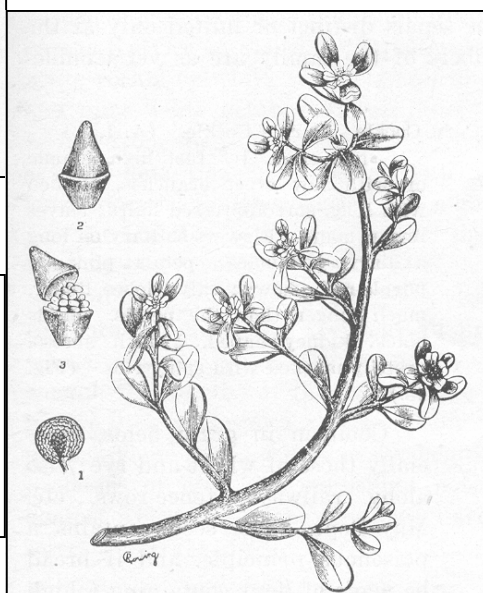
There are many species of mustards that show up as common weeds in gardens. These are several representative species. All mustards look very similar when they are young — new seedlings (A) have just two heart-shaped leaves; older seedlings (B) have their first two leaves and two other leaves that have more of the shape of the plant's mature leaves. Unfortunately, mustard seedlings look very much like the seedlings of broccoli, cabbage, kale, cauliflower, collard greens, and kohlrabi, to which they are closely related. Most mustards do not get taller than about knee height.



Prickly lettuce, milk thistle, or sow thistle

Looks superficially like lettuce or like dandelions, but grows more upright than dandelions and has fewer leaves when mature than any lettuce. Flowers are yellow. Not an aggressive weed, and usually easier to remove than dandelions.

Called a thistle, but spines are not painful to touch. If you break the stem, the plant bleeds a whitish "milk" (dandelions do this, too). Plants rarely get taller than knee height.



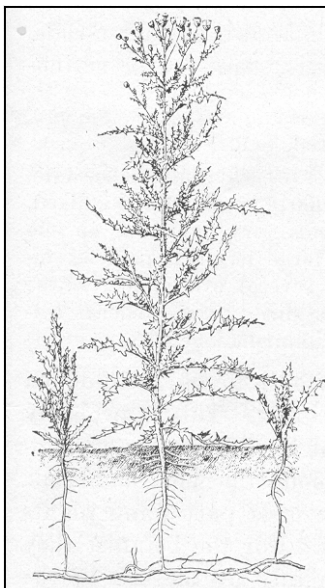
Purslane

This plant grows close to the ground, rarely more than about 15 cm (6 in) tall. It has thick, fleshy stems and leaves which are edible and can be quite good in salads if you wash all the soil off. You have to dig the roots out — pulling on the tops just breaks them off.



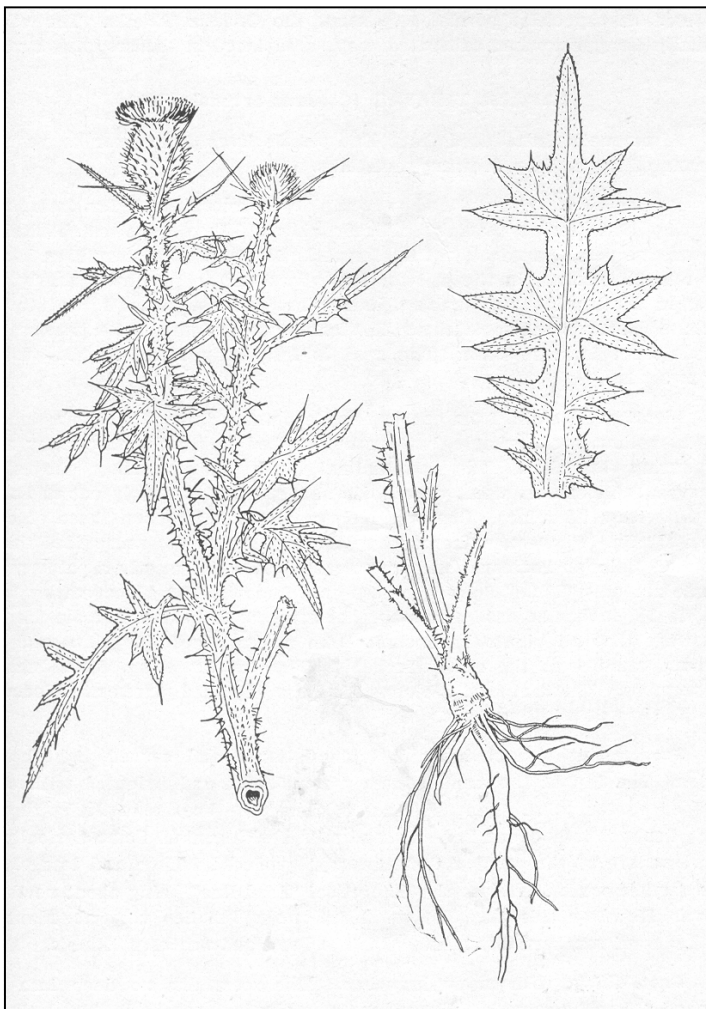
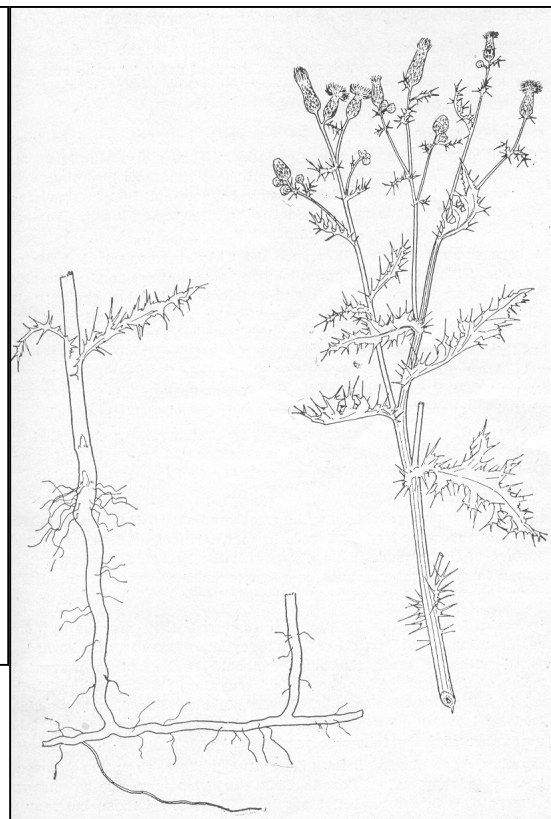
Quackgrass

A nasty perennial weed. The plant spreads by producing seed, but also by growing fat white horizontal roots, called rhizomes. Whenever you try to get rid of quackgrass, you must make sure to dig up these rhizomes and remove them from the soil. If you leave a piece of rhizome even a few cm (1-2 in) long, it can grow into a new plant. For this reason, it's almost impossible to remove quackgrass completely all at once. As with Canada thistles, this grass is killed by harassing it to death. Dig it up, remove all the rhizomes you can, let the soil sit for a while, dig it up and remove any live rhizomes, and repeat this cycle until you just have to plant something in the soil where the thistles were. At that point, **mulch** the soil to keep the thistles from coming up and pull them up again if they do..



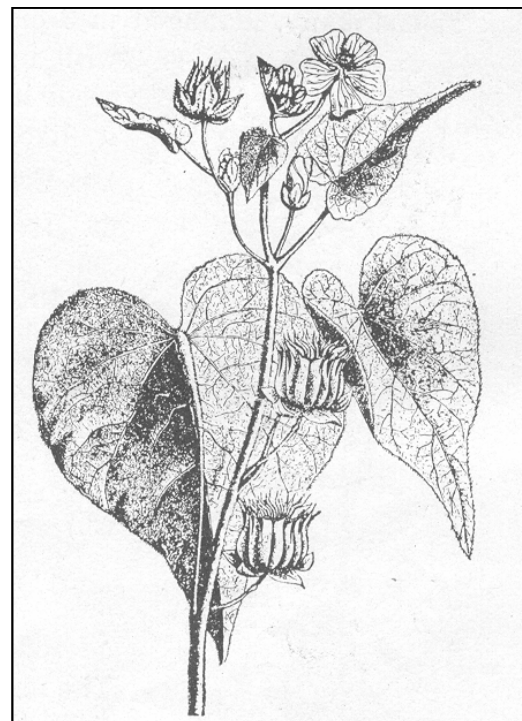
Canada thistle

This nasty perennial weed is not actually from Canada, but from central Asia. Like quackgrass and other perennial weeds, Canada thistle spreads not only by producing seed, but also by growing fat white horizontal roots, called rhizomes, from which new plants then grow up (see picture at left, with three plants in different stages of growth from the same rhizome). Whenever you try to get rid of Canada thistle, you must make sure to dig up these rhizomes and remove them from the soil. If you leave a piece of rhizome even a few cm (1-2 in) long, it can grow into a new plant. For this reason, it's almost impossible to remove Canada thistles completely all at once. As with quackgrass, these thistles are killed by harassing them to death. Dig them up, remove all the rhizomes you can, let the soil sit for a while, dig it up and remove any live rhizomes, and repeat this cycle until you just have to plant something in the soil where the thistles were. At that point, **mulch** the soil to keep the thistles from coming up and pull them up again if they do so anyway. The plant, which is painfully spiny, can reach waist height or even shoulder height and produces pinkish-purple flowers that release fluffy white seeds. DO NOT let the plants go to seed — use a knife or other tool to cut the flowers off. Even if you have not been able to get the roots out, keeping the plants from producing more seed is helpful.



Common thistle

Though this weed looks superficially like Canada thistle, it is an annual crop that is much easier to get rid of than Canada thistle. The plants can reach waist to shoulder height and have purple flowers. The leaves are wider and the flowers larger than those of Canada thistle. There are no fleshy rhizomes that you need to dig out of the soil, though you do need to make sure to dig out the whole deep root, as the original plant can grow back otherwise.



Velvetleaf

This is more of a problem on farms than in gardens, but it's worth pulling up. The leaves are large and pale green and the undersides are as soft as velvet. The plants can reach waist height. Unless the plants are very large, it's easy to pull them up when the soil is moist.

Quick Reference Guide for Vegetable Planting

Notes:

- 1) Dates provided are appropriate for an average season in southern Wisconsin and other areas in zone 4 of the United States Department of Agriculture's Zone Map (see page 2). In zone 4, average last frost date in the spring ranges from May 1 to May 30 and average first frost date in the fall ranges from September 1 to September 30. If you are located outside this zone, you should try to find locally appropriate dates (see "resources for more information"), but you can also try to adjust by allowing six days difference for every 160 km (100 mi) of latitude you are away from Madison, Wisconsin. North, plant later; south, plant earlier.
- 2) Note that planting dates in many cases refer to transplants and *not* seeds. Transplants must be started substantially earlier, either indoors or in a cold frame.
- 3) The **crop pages** (CP) provide more information for most crops listed here, including tips on planting, care (including fertilizer use), and harvesting.
- 4) Where a range of dates is given for planting, you may choose either to put in a single planting any time within the range of dates, or (for crops that you like a lot) put in multiple successive plantings. *Do not plant after the last date given — the plants may not mature before frost!* Dates indicate safe time for seeding *or* (for certain crops) transplanting; if not purchased from a store or farmers' market at planting date, transplants must be started indoors weeks earlier than these dates.
- 5) When a range of seeding depths is given, plant deeper if you have light (sandy) soils and more shallowly if you have heavy (clayey) soils (see **soil** for discussion of soil types; if you aren't sure what your soil is, plant your seeds more shallowly and make sure to water them as needed).
- 6) Where a range of plant spacings is given, putting your plants closer together will keep their leaves/bulbs smaller but will allow you to fit more different crops in a small garden without making the plants compete too much for resources.

Crop Note that some popular crops are grouped together (for example, spinach and lettuce are both listed under "greens," and watermelons are listed with other crops under "melons")	When to Plant See note 4 for important information about these dates	Depth to Plant s = seeds, tr = transplants (cm/in)	Distance Apart In Row s = seed initially at about this distance th = seed as noted, then thin to about this distance after plants begin to grow tr = transplant to this distance (cm/in)	Distance Apart Between Rows If you are planting only one or a few plants, leave this much space around the plant (s) (cm/in)	Days to Maturity (When the plant or fruit will be ready to eat) Variation in dates can result from both weather and varieties used
Artichoke, Jerusalem (also called "sunchokes")	any time in April or May	tr (bulb) 10 cm/4 in	tr (bulb) 30 cm/12 in	90 cm/36 in	Any time after first fall frost—can dig one plant at a time until the ground is too hard to dig; will survive just fine overwinter in the ground
Asparagus	April 15 to May 15 (earlier is better)	tr (root masses, or "crowns") in a trench 15 cm/6 in deep; cover with 5 cm/2 in of soil, then fill the trench in as the plants emerge from the ground	tr 30 cm/12 in	60 cm/24 in	(Begin in third year—see CP for a discussion of harvesting) April-June
Beans (Various)	May 10 to July 15 (can put in successive plantings — see notes)	s 2.5 cm/1 in	s 2.5 cm/1 in th 8-30 cm/3-12 in	45 cm-120 cm/ 18-48 in	55-90 days from seeding
Beets	April 15 to August 15 (can put in successive plantings at about 10-day intervals)	s 1 cm/0.5 in	s 2.5 cm/1 in th 8 cm/3 in	25 cm/10 in	50-70 days from seeding

Crop Note that some popular crops are grouped together (for example, spinach and lettuce are both listed under "greens," and watermelons are listed with other crops under "melons")	When to Plant See note 4 for important information about these dates	Depth to Plant s = seeds, tr = transplants (cm/in)	Distance Apart In Row s = seed initially at about this distance th = seed as noted, then thin to about this distance after plants begin to grow tr = transplant to this distance (cm/in)	Distance Apart Between Rows If you are planting only one or a few plants, leave this much space around the plant (s) (cm/in)	Days to Maturity (When the plant or fruit will be ready to eat) Variation in dates can result from both weather and varieties used
Broccoli	April 15 to August 1 (can put in successive plantings; early planting should be transplants)	tr - plant slightly deeper than they were originally or s 0.6-1.3 cm/0.25-0.5 in	s 2.5 cm/1 in th 45-60 cm/18-24 in or tr 45-60 cm/18-24 in	90 cm/36 in	60-70 days from transplanting
Brussels Sprouts	April 15 to May 15 (should be at least 16 weeks before first fall frost)	tr - plant slightly deeper than they were originally or s 0.6-1.3 cm/0.25-0.5 in	s 2.5 cm/1 in th 45-60 cm/18-24 in or tr 45-60 cm/18-24 in	90 cm/36 in	80-120 days from transplanting
Cabbage	April 15 (spring planting) or July 1 (fall planting)	tr - plant slightly deeper than they were originally or s 0.6-1.3 cm/0.25-0.5 in	s 2.5 cm/1 in th 45-60 cm/18-24 in or tr 45-60 cm/18-24 in	90 cm/36 in	65-70 days from transplanting
Cauliflower	mid April to mid May (spring planting) and/or early July (fall planting)	tr - plant slightly deeper than they were originally or s 0.6-1.3 cm/0.25-0.5 in	s 2.5 cm/1 in th 45-60 cm/18-24 in or tr 45-60 cm/18-24 in	90 cm/36 in	50-60 days from transplanting
Carrots	April 15 followed by plantings as desired at 3-4 week intervals until early June	sow on surface of soil and cover with a thin layer of sand or fine soil (0.5 cm/0.3 in)	s 1 cm/ 0.4 in th 4 cm/ 1.5 in	15 cm/6 in	70 days from seeding
Celery, celeriac, and lovage	May 20 to June 15	tr - match depth in pot to surface of garden	tr 15 cm/6 in	40 cm/15 in	110-150 days from transplanting
Chard, Swiss	April 15 to July 1 (can plant two successive plantings, but one can last all season)	s 1.3-2.5 cm/0.5-1 in	s 2.5 cm/1 in th 20 cm/8 in	30-60 cm/12-24 in	50-60 days from seeding
Collard greens	April 15 to July 1 (can plant one early planting and one late planting)	tr - plant slightly deeper than they were originally or s 0.6-1.3 cm/0.25-0.5 in	s 2.5 cm/1 in th 45-60 cm/18-24 in or tr 45-60 cm/18-24 in	90 cm/36 in	70-85 days from seeding
Corn, sweet	April 15 to June 15 (can plant successive plantings—see notes)	s 2.5 cm/1 in	s 2.5 cm/1 in th 8 cm/3 in	80 cm/30 in	65-95 days from seeding

Crop Note that some popular crops are grouped together (for example, spinach and lettuce are both listed under "greens," and watermelons are listed with other crops under "melons")	When to Plant See note 4 for important information about these dates	Depth to Plant s = seeds, tr = transplants (cm/in)	Distance Apart In Row s = seed initially at about this distance th = seed as noted, then thin to about this distance after plants begin to grow tr = transplant to this distance (cm/in)	Distance Apart Between Rows If you are planting only one or a few plants, leave this much space around the plant (s) (cm/in)	Days to Maturity (When the plant or fruit will be ready to eat) Variation in dates can result from both weather and varieties used
Cucumber	June 1 to July 1 (can plant successive plantings at 2-3 week intervals)	s 1.3 cm-2.5 cm/0.5 -1 in or tr - match depth in pot to surface of garden	plant 5-8 seeds in a little clump every 30 cm (12 in), then when plants have their first true leaves thin each clump to the 2 healthiest plants. If transplanting, plant 2 plants together at 30 cm (12 in) intervals	120 cm/48 in	55-72 days from seeding
Eggplant	June 1 to July 1	tr - plant slightly deeper than they were originally	tr 60 cm/24 in	60 cm/24 in	75-90 days from transplanting
Flowers	Planting information is quite variable. See the CP on flowers for more details.				
Fruit	Most fruits are not appropriate for small gardens, but a few (particularly strawberries) can be fun to try even in a small space. Planting information is quite variable. See the CP on fruit for more details.				
Garlic	late October/early Nov. (preferred) or April	tr (clove) - plant so that the pointed top of the clove is about 2.5 cm (1 in) under the soil surface	tr (cloves) 8 cm/3 in	15 cm/6 in	most varieties can be harvested in July (see CP for discussion)
Greens (includes spinach, lettuce, arugula, mizuna, bok choy, and many others)	Planting information is quite variable. See the CP on greens for more details.				
Herbs	Planting information is quite variable. See the CP on herbs for more details.				
Kale	mid April to mid May (one planting yields into November or December)	tr - plant slightly deeper than they were originally or s 0.6-1.3 cm/0.25-0.5 in	s 2.5 cm/1 in th 45-60 cm/18-24 in or tr 45-60 cm/18-24 in	90 cm/36 in	55-70 days from transplanting
Kohlrabi	April 15 to July 15 (can plant multiple successive plantings)	tr - plant slightly deeper than they were originally or s 0.6-1.3 cm/0.25-0.5 in	s 2.5 cm/1 in th 30 cm/12 in or tr 30 cm/12 in	60 cm/24 in	50-60 days from transplanting

Crop Note that some popular crops are grouped together (for example, spinach and lettuce are both listed under “greens,” and watermelons are listed with other crops under “melons”)	When to Plant See note 4 for important information about these dates	Depth to Plant s = seeds, tr = transplants (cm/in)	Distance Apart In Row s = seed initially at about this distance th = seed as noted, then thin to about this distance after plants begin to grow tr = transplant to this distance (cm/in)	Distance Apart Between Rows If you are planting only one or a few plants, leave this much space around the plant (s) (cm/in)	Days to Maturity (When the plant or fruit will be ready to eat) Variation in dates can result from both weather and varieties used
Leeks	transplant in late April to late May (start indoors 4-6 weeks earlier) Or, seed outside in early May and be patient...	tr - match depth in pot to surface of garden (can seed at 0.6-1.3 cm/0.25-0.5 in but generally transplanted)	tr 8 cm/3 in, then when leeks are the thickness of pencils, thin to 15 cm/6 in If seeding, plant seeds 1.3 cm/0.5 in apart and thin gradually once leeks are about 5 cm (2 in) tall	15 cm/6 in	80-100 days from transplanting (80 for small leeks; closer to 100 days for thicker leeks)
Melons (watermelon, muskmelon, and cantaloupe)	May 20 to July 1	tr - match depth in pot to surface of garden	Various, but most need 60-90 cm/24-36 in	Various, but most need 60-90 cm/24-36 in	75-90 days from transplanting
Okra	early June	s 2.5 cm/1 in	s 5 cm/2 in th 30 cm/12 in	90 cm/36 in	55-70 days from seeding
Onions	April 15 to May 10 (a few onion varieties are planted in the fall, sit over winter, and keep growing in spring)	s 0.5-2 cm/0.25-0.75 in or tr onion “sets,” putting the bottom of the set about 2.5 cm/1 in underground	s 5 cm/2 in th 13 cm/5 in	th 13 cm/5 in	80-110 days from seeding
Parsnips	April 15	sow on surface of soil and cover with a thin layer of sand or fine soil (0.5 cm/0.3 in)	s 1 cm/ 0.4 in th 4 cm/ 1.5 in	15 cm/6 in	95-120 days from seeding
Peas	April 15 (can also plant a fall crop in late July to September)	2.5 cm/1 in	s 5 cm/2 in	40 cm/15 in	55-70 days from seeding
Peppers	May 20 to July 1	tr - plant considerably deeper than they were originally (see CP for details)	tr 45 cm/18 in (for hot peppers) tr 60 cm/24 in (for sweet peppers)	tr 45 cm/18 in (for hot peppers) tr 60 cm/24 in (for sweet peppers)	60-75 days from transplanting
Potatoes, “Irish”	April 15 to July 10 (very cold tolerant)	tr (seed potatoes—see CP for a discussion of how to plant) 3-10 cm/1-3 in	tr (seed potatoes) 30 cm/12 in	30 cm/12 in	70-90 days
Potatoes, sweet	early June	tr (sprouts) 10 cm/4 in	tr (sprouts) 20 cm/8 in	80 cm/36 in	120-150 days after transplant

Crop Note that some popular crops are grouped together (for example, spinach and lettuce are both listed under “greens,” and watermelons are listed with other crops under “melons”)	When to Plant See note 4 for important information about these dates	Depth to Plant s = seeds, tr = transplants (cm/in)	Distance Apart In Row s = seed initially at about this distance th = seed as noted, then thin to about this distance after plants begin to grow tr = transplant to this distance (cm/in)	Distance Apart Between Rows If you are planting only one or a few plants, leave this much space around the plant (s) (cm/in)	Days to Maturity (When the plant or fruit will be ready to eat) Variation in dates can result from both weather and varieties used
Pumpkin	May 20 to July 1 (but plant as early as possible to avoid frost and maximize harvest)	s 2.5 cm/1 in or tr - match depth in pot to surface of garden	If planting seeds, plant 4 seeds in a little clump every 60 cm (24 in) then when plants have their first true leaves, remove all but the healthiest 2 plants. If transplanting, plant 2 or 3 plants together as described above.	180 cm/72 in	85-105 days from seeding, 60-80 days from transplanting
Radish	mid-April through August (can plant multiple successive plantings a week or two apart; plantings from late June through early August may become woody and/or fail to produce bulbs)	s 1.3 cm/0.5 in	s 1.3 cm/0.5 in th 2.5-5 cm/1-2 in (large varieties may need to be thinned to as much as 15 cm)	15 cm/6 in	various—depends on variety (some varieties need only 18 days from seeding, most take 21-27 days; some large storage varieties take 50 or more days)
Rhubarb	April 15 to May 15 (earlier is better)	tr (roots) so that the top of the root mass is 5 cm/2 in below the surface	90 cm/36 in	90 cm/36 in	(Begin in second year—see CP for a discussion of harvesting) April-June
Squash, summer (includes zucchini, yellow squash, patty-pans, and others)	May 20 to July 1 (some gardeners plant two plantings at opposite ends of this time window, one of which matures midsummer and one of which matures in the late summer and early fall)	2.5 cm/1 in or tr - match depth in pot to surface of garden	If planting rows, plant 4 seeds in a little clump every 60 cm (24 in) then when plants have their first true leaves, remove all but the healthiest 2 plants. If transplanting, plant 2 plants together as described above.	120 cm/48 in	45-85 days (depends on type, variety and weather)
Squash, winter	May 20 to July 1 (but plant as early as possible to avoid frost and maximize harvest)	2.5 cm/1 in or tr - match depth in pot to surface of garden	If planting rows, plant 4 seeds in a little clump every 60 cm (24 in) then when plants have their first true leaves, remove all but the healthiest 2 plants. If transplanting, plant 2 plants together as described above.	180 cm/72 in	90-120 days from seeding, 70-100 days from transplanting

Crop Note that some popular crops are grouped together (for example, spinach and lettuce are both listed under “greens,” and watermelons are listed with other crops under “melons”)	When to Plant See note 4 for important information about these dates	Depth to Plant s = seeds, tr = transplants (cm/in)	Distance Apart In Row s = seed initially at about this distance th = seed as noted, then thin to about this distance after plants begin to grow tr = transplant to this distance (cm/in)	Distance Apart Between Rows If you are planting only one or a few plants, leave this much space around the plant (s) (cm/in)	Days to Maturity (When the plant or fruit will be ready to eat) Variation in dates can result from both weather and varieties used
Tomato	May 20 to July 1 (can plant one planting at the beginning of this window and a second planting near the end; see the CP)	tr - plant deeper in garden than in pot (see CP)	60-120 cm/24-48 in (some varieties get much larger than others—see the CP for details)	60-120 cm/24-48 in (some varieties get much larger than others—see the CP for details)	65-80 days
Turnip (includes rutabaga)	April 15 (and successive plantings as desired at 10 day intervals to August 15; large fall-harvested rutabagas need 100 days before frost, and turnips need 70-80 days)	s shallowly (not more than 1.3 cm/0.5 in) and keep moist	s 3 cm/1 in th 8 cm/3 in	30 cm/12 in	70-100 days (for the bulbs of large, fall-harvested varieties); 45 days for bulbs of small varieties; 20-30 days for leaves (“turnip greens”)

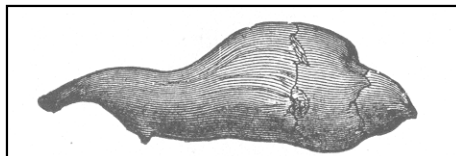
Crop Pages

How to use the crop pages

Very basic planting information (plant spacings, planting dates, etc.) for every crop listed here is available in the ***quick reference guide for vegetable planting***. Additional useful information is provided in these crop pages. Read the quick reference guide first, and then come back here to learn

Artichoke, Jerusalem

Be aware that the above-ground parts of the plants get *enormous*—make sure they have room to grow (you may wish to tie the stems into a bundle and attach them to a stake to keep them from shading the rest of your garden). Remove flowers as they appear to get larger tubers. Tubers do not store well indoors - leave in ground until ready to eat. If storing inside, store for as short a time as possible in slightly moist paper towels in a perforated plastic bag in the refrigerator. Roots may be eaten raw or baked or roasted and eaten like potatoes. Jerusalem artichokes contain a form of starch which does not affect your blood sugar, and the tubers are therefore sometimes called the “diabetic’s potato.” Leave some tubers in the ground as you harvest and you won’t need to plant again for the next year



Jerusalem artichoke root, shown at left, is the edible part of this plant, which has flowers like sunflowers. Do not confuse Jerusalem artichokes with artichokes (also called globe artichokes; see picture at right). Globe artichokes are more closely related to thistles, and the edible part of those plants is the unopened flower head. Globe artichokes can be grown in the upper Midwest, but it’s not a project for beginning gardeners.



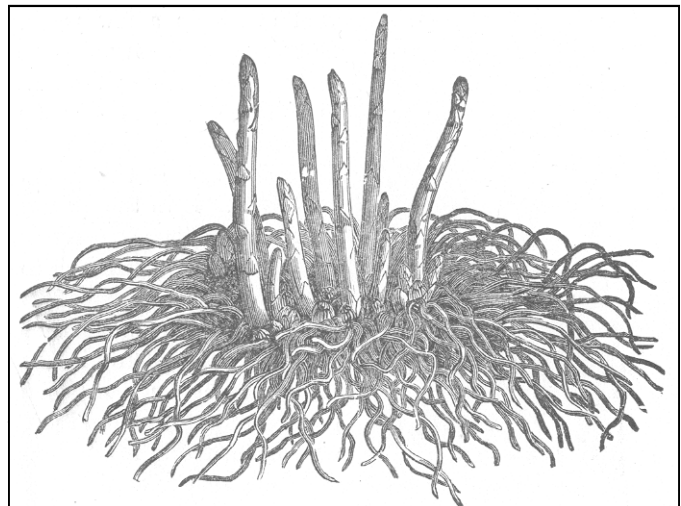
(it's hard to get them all out anyway).

Asparagus

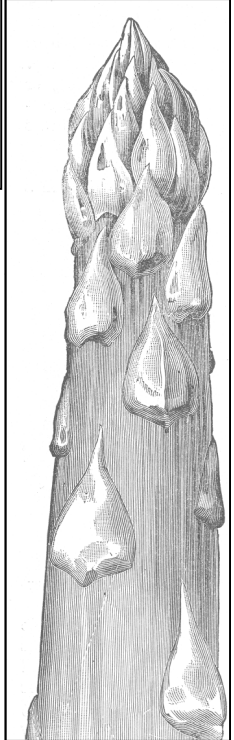
A perennial whose young stems are usually eaten steamed (but sometimes raw). Should not be harvested until the third year after planting, but then can yield for twenty years. Harvest stems, or “spears” when they are no taller than 20 cm (8 in). Do not harvest for more than one month the first year you harvest. In later years, you can harvest for 8 weeks, but do not remove all of the spears that come up during that time (let about a quarter of them grow). Sometimes grown from seed, but more often from one-year-old root masses, or “crowns,” rather than from seed. Growers who start asparagus from seed must wait an additional year to harvest their plants. Crowns are available from many garden stores and internet-based supply companies. Make sure to buy a so-called “all-male” variety, as female plants use a lot of energy to produce seeds that you don’t want.

To plant these crowns, dig a trench 30-45 cm (12-18 in) across and 15 cm (6 in) deep. Spread the crowns out neatly in the trench with the roots down and buds up (see picture). Cover the crowns with two inches of soil and water them thoroughly. It may take several weeks for the plants to send up their first spears. As the spears get larger, gradually fill in the remainder of the trench.

Asparagus should be fertilized every year to maintain productivity – use any solid or liquid organic **fertilizer** and apply in April (years 1-3 of your planting) or July (years 4 and up) at the rate suggested on the package. Some growers also put up to 5 cm (2 in) of soil or **compost** each year on top of their asparagus, as the crowns tend to rise toward the surface. Because it is a long-lived perennial, asparagus plantings can tend to accumulate weeds. Make sure to weed your asparagus planting thoroughly, and **mulch** it heavily with straw after you fertilize it in the spring (the spears can come up through the straw, but many weeds cannot; if you have leaves but not straw, wait to mulch until June or July, since the spears have a hard time coming up through wet, packed-down leaves). Each fall after frost, cut off the dead asparagus stems a few cm (1-2 in) above ground and put them in the **compost**.



An asparagus crown (above), beginning to produce shoots. Planting of crowns is the most common way to start asparagus. A close-up of an asparagus spear ready for harvest is shown at right. Asparagus should always be harvested before the spears begin to open up and unfurl their leaves.



Beans

There are many, many different varieties of beans that you can try in a garden. Like peas, all plants called beans are “legumes,” plants whose roots provide a home to bacteria that are able to take nitrogen out of the air and make it available to the plant. This reduces the amount of fertilizer that you need to grow beans (or peas) successfully. Most kinds of beans need warm weather to grow, and you should not put in your first planting until late May (you can then plant beans about every two weeks into September if you want to have a long, continuous harvest). Beans are always grown from seeds rather than transplants.

Most kinds of beans are easy to grow, except that in some gardens, a pest called the Mexican bean beetle (see **pests**) can be a serious problem, especially on plantings late in the season. Adult Mexican bean beetles lay eggs on your beans, the eggs hatch, and the young yellowish-orange spiny larvae eat your bean plants to death. There are a few organic tools for dealing with bean bee-

flies – you can plant beans only early in the summer, when the beetles are not very numerous, you can plant varieties that are supposed to be resistant to the beetles (look on seed packages for claims about resistance), you can cover your bean plantings with **floating row covers** to keep the beetles off them, or you can use a spray containing **BT** to try to kill the young larvae.

Because of the problem of bean beetles (and some diseases), remove your bean plants from the ground as soon as they are done producing, and do not plant beans of any kind in the same place for at least a couple of years if possible.

Within the group of plants we call “beans,” there are plants that are quite different from each other. Some of the most popular of these are:

1) green beans – These beans are the most commonly grown in the United States. Green beans are of two types – either *bush* beans (also known as *snap* beans), which grow into small bushes, or *pole* beans, which need to be supported with some kind of pole or trellis (a wood or metal structure that you build right over the plants). Bush beans are less work, but it can be fun to watch pole beans climb up whatever structure you provide for them. Both types produce similar fruit, which you should pick when the pods are long (about 10-15 cm or 4-6 in) but before the beans inside have gotten very large (they get tough and chewy if the beans are too big). Harvest the plants regularly to keep them producing. Eat the beans (pods and seeds together) either raw or cooked (steaming them lightly is common).



A picture of green beans from an old seed catalog (your beans are not likely to be *quite* this productive). This is a bush-type variety.

2) yardlong beans (also called asparagus beans, snake beans, and Chinese long beans) – Originally from China, yardlong beans are a climbing bean whose pods get very, very long (35-80 cm or 15-30 in). In warm weather, the beans grow very fast. Harvest them while they are slender and eat cooked or raw (pods and seeds together). Some varieties of yardlong beans seem to be more resistant to Mexican bean beetles than are green beans. Harvest the plants regularly to keep them producing.

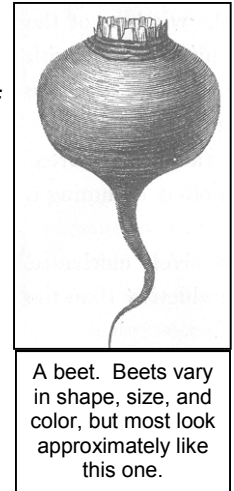
3) edamame (also known as edible soybeans) – Edamame is a Japanese name used for varieties of soybeans that are eaten fresh or lightly steamed. Pick the pods when they are fat but still green, harvesting all of the pods on the plant at once. Though the plants are sometimes not very productive, the seeds are delicious either fresh or boiled in their pods for about 10 minutes. The pods themselves are not edible.

4) other beans – There are other less common (but still delicious) kinds of beans to try. Azuki or adzuki beans are red beans that can be eaten like green beans (pod and beans together) when young. Broad beans produce giant, delicious seeds that are wonderful eaten fresh. Winged beans have four wing-like ridges around the pod; the pods and seeds are edible. Mung beans are small green beans that are usually grown for dried beans, which are then sprouted and used in salads and cooked dishes. Black beans are also usually grown for dried beans. You may also see cluster beans, hyacinth beans, and lima beans, all of which can be eaten fresh or cooked.

Beets

Can be planted any time through the season, though summer plantings may not make large roots. Water regularly. It is important to **thin** plants, as the beets will not produce good bulbs if the plants are too close together. Plants you pull out while thinning can be eaten as greens in a salad. You can harvest beet roots when small (2.5 cm/1 in across) and eat them fresh, or wait until later and harvest larger roots for cooking. Beets are also excellent pickled – pack a jar with thinly sliced beets

and some garlic, salt, pepper, and herbs like oregano and thyme; add white vinegar or cider vinegar to fill $\frac{3}{4}$ of the remaining space in the jar and water to fill the last $\frac{1}{4}$. Let the pickled beets sit in your refrigerator for one or two days before taking some of the slices out to eat. Beets stored like this will keep for many weeks.



A beet. Beets vary in shape, size, and color, but most look approximately like this one.

Broccoli

Broccoli can be grown from seed in the garden, but seedlings must be protected with **floating row covers** (small plants can be eaten to death by tiny black flea beetles if not protected – see **pests** for a picture). You can avoid the need to buy large amounts of floating row cover by starting a small, covered “nursery” seed bed (say, 60 cm or 24 in on a side) where you plant broccoli seeds very densely. When the plants are at least 15 cm (6 in) tall and have at least four leaves, they are much more likely to be able to survive damage from flea beetles. At that point, you can uncover them, moisten the soil of your nursery bed, gently pull the plants up, and **transplant** them elsewhere in your garden at the appropriate spacing using about 50 g (2 oz) of organic **fertilizer** per plant (broccoli needs this fertilizer to produce good heads!). The plants are small, but DO NOT put them too close together when you transplant them! They will get big!

Besides the flea beetles, the only common pest of broccoli is the cabbage butterfly (see **pests**). These small yellow or white butterflies lay their eggs on broccoli plants and the green worm-like larvae that hatch out can damage your plants quite a bit. You can try to kill these larvae with a **BT** spray, but you can also just pick them off the plants with your fingers.

Broccoli is not really a summer crop – if you put in plants that you expect to mature in July or August, they may produce only small heads (or no heads at all). Growers who really like broccoli plant a spring planting and a fall planting. For the spring planting, you can start plants inside, in a cold frame, or under floating row covers in the late winter (see **season extension techniques**). These plants can then be transplanted outside in April or early May, and they will mature before the hottest part of the summer. For the fall planting, the plants can be started outside at the end of July or the beginning of August – they will mature as the weather gets cold, and will survive multiple frosts. Growers who don’t like broccoli quite so much may only put in a spring crop or a fall crop.

The part of the broccoli plant that we eat is actually the flowers. After the plant gets big, it will produce a small, dense head of pale green flowers at its center. This head will grow gradually, and at some point it will start to turn dark green. If you don’t cut it off soon after this, the flowers will spread out and begin to open (at which point they’re not so good to eat). Harvest the head by cutting it off with about 10 cm (4 in) of stalk, leaving the rest of the plant undamaged. Over the next few weeks, the plant will grow small broccoli heads, or “side shoots” from the sides of the stalk, and these can be harvested using the same process. This can be repeated several times. Broccoli heads should be refrigerated as soon as possible after harvest. They will keep for 1-2 weeks loosely wrapped in a plastic bag. Broccoli can be eaten fresh or cooked.

Brussels sprouts

See the broccoli crop page for information on how to start Brussels sprouts plants. Broccoli and Brussels sprouts are grown almost identically, except that Brussels sprouts grow more slowly and there is usually just one planting that takes the whole season to reach maturity. The plants also have the same pests.

The sprouts mature late in the season and can be harvested as soon as they reach a size you like

(some people like them small, some like them bigger). Plants are very cold tolerant and flavor is best after at least one frost. Harvest the sprouts by cutting them off the stalk where they meet it. They will keep reasonably well for a couple of weeks in your refrigerator (wrap them loosely in a plastic bag together with a dry paper towel). If you have a cold place to store it, you can cut a whole stalk of sprouts off its roots, remove the leaves, and bring it home to sit for a while until you want to cook your sprouts. Brussels sprouts are almost always eaten cooked, either baked or steamed.

Cabbage

See the broccoli crop page for information on how to start cabbage plants. Broccoli and cabbage are grown almost identically, and the plants have the same pests.

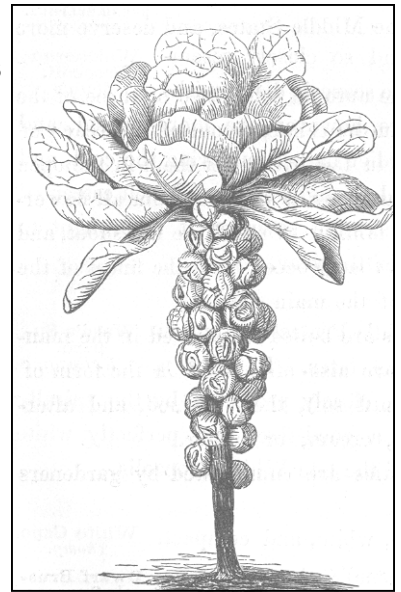
Like broccoli, cabbage can be grown as either a spring crop or a fall crop, but often does not do well in the middle of the summer. Fall cabbage is the most tasty, especially after one or two frosts. You can harvest cabbages any time after they begin to produce heads. A head is a dense, tightly wrapped bunch of leaves at the center of the plant. Be careful – the plant will *look* like it has a head before it actually does – you can squeeze the leaves in the middle to determine if there is a head in there or not. Harvest cabbages by cutting through the stem right below the head. Remove any dirty, damaged outside leaves. Cabbages will store reasonably well in your refrigerator for at least a couple of weeks (do NOT wrap them in plastic!). If you have a lot of them, you can also dig a hole at least 60 cm (24 in) deep in your garden, line it with straw, and put the cabbages in it (covering them first with straw and then soil) until you want to dig them out and eat them. They will store all winter long this way.



A cabbage. Most cabbage varieties are classified as either green cabbages (which make large heads with pale green leaves), red cabbages (which make smaller, denser heads with purple-red leaves), or savoy cabbages (which make loose heads of textured green leaves). This is a Savoy.

flowers begin to open significantly. Unlike broccoli, cauliflower does not produce good side shoots, so you should pull the plant up and **compost** it as soon as you harvest the head. Cauliflower heads should be refrigerated as soon as possible after harvest. They will keep for 1-2 weeks loosely wrapped in a plastic bag. Cauliflower can be eaten fresh or cooked.

A mature head of cauliflower viewed from above. Cauliflower and broccoli should both be picked like this (that is, when the flowers that make up the head have not yet begun to spread out and open).

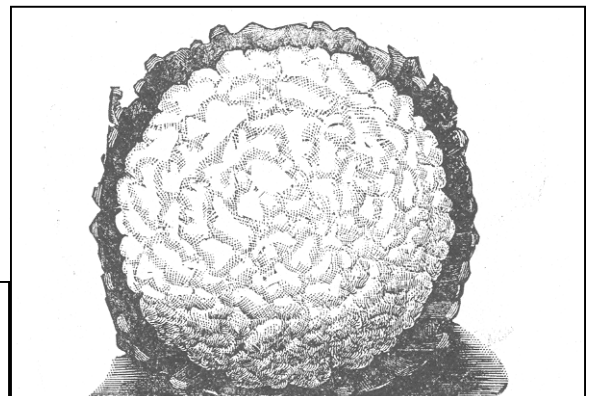


A stalk of Brussels sprouts. The sprouts (which are the part we eat) are the round balls on the lower of the stem.

Cauliflower

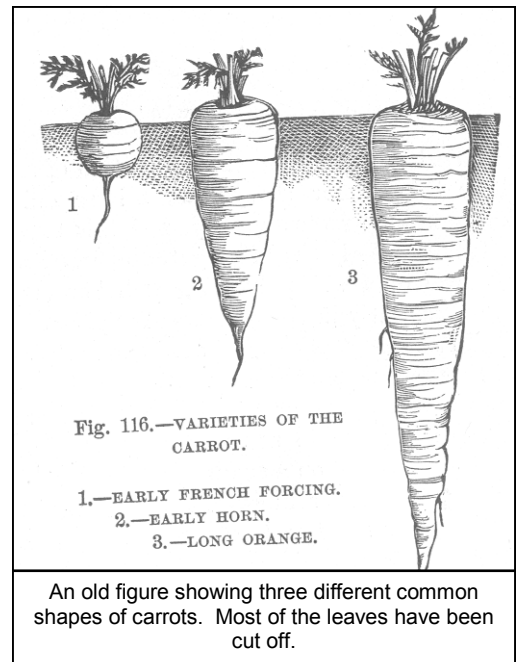
See the broccoli crop page for information on how to start cauliflower plants. Broccoli and cauliflower are grown almost identically, except that most growers only plant cauliflower for fall harvest (the plants don't do well at all in hot weather). The plants also have the same pests.

Cauliflower produces an edible head of flowers much like broccoli, except that the cauliflower head is a yellowish-white. As with broccoli, harvest the head before the



Carrots

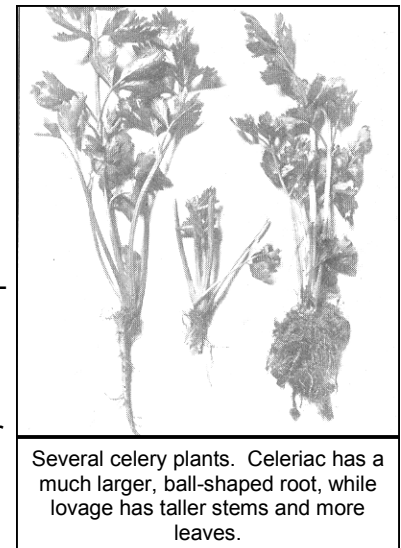
Carrots are tough once they start growing, but can be hard to start. One common mistake is to bury their seeds too deeply – they should be planted very shallowly. Another mistake is to let them dry out – you should keep the soil and seeds moist by watering every 2-3 days (if there is no rain) and possibly by using a light cover of straw to keep in moisture. Carrots are slow to germinate (the seeds can take 10 days or more to open up), so be patient. Carrots can be grown all season, but are not really a summer crop—carrots grown in the summer will be shorter, wider, and woodier than spring and fall carrots. Carrots can survive some frost and will taste best after they have experienced some cold weather in the fall. Always water carrots thoroughly—branching of carrot roots is caused by roots searching for water. Harvest carrots when they reach a size you like – do not wait for the tops to die. You can “store” carrots in the ground for long periods unless it’s very hot out (when they will start to get woody and bitter).



Carrots are sometimes eaten underground by small wormlike creatures called nematodes (see **pests**). If your carrots have small holes in them, you may want to try surrounding your carrot planting with regularly spaced marigold plants. The marigolds make pretty flowers and their roots keep nematodes away. As your carrots get big, they may start to stick out of the ground, and the parts that stick out may get eaten by mice or other animals. To prevent this, you can use a tool to move soil up and over the exposed parts of the carrots.

Celery and celeriac and lovage

Celery, celeriac, and lovage are three closely related plants that are grown similarly. Celery is grown for its stems, celeriac for its large, rounded, strong-flavored root (good in soups), and lovage is an herb grown for its leaves and stems (which are also good in soups and other foods). All three plants can be grown from seed in the garden, but they grow slowly and are more likely to be successful if seedlings are grown indoors to a height of about 12 cm (5 in) and then transplanted (see **starting plants inside**). All must be watered regularly and harvested before frost. To harvest celery, pull the whole plant up and cut off the roots and leaves – the stalks can be stored in the refrigerator in a loose plastic bag for 1-2 weeks. To harvest celeriac, pull the whole plant off and cut off the stalks and leaves – the root can be stored in a refrigerator or other cool place for up to several months (do not wrap in plastic). To harvest lovage, you can cut off leaves and small stems throughout the season and use them either fresh or dried (see the “herbs” crop page).



Chard, Swiss

Chard is basically the same plant as beets, but is bred to produce large leaves and no bulb. Both the stems and leaves of chard can be eaten, usually steamed or otherwise cooked rather than eaten fresh, though small leaves can be added to salads. If you put in a planting of chard in April or May and leave the plants until they are 15-20 cm (6-8 in) tall, you can harvest a single planting all season

long by taking only one or two leaves from each plant during any given harvest. Cut the plants down to the ground in late August to force new growth for the fall. Chard is frost tolerant and if protected with a **floating row cover** will yield into November or even December.

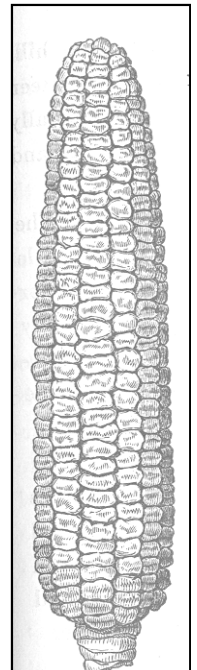
Collard greens

See the broccoli crop page for information on how to start collards. Broccoli and collards are grown almost identically, except that one planting of collards put in the garden in April can continue to yield leaves until after frost. The plants have the same pests.

Collard plants get very large. You can begin to harvest leaves once the plants are at least 25 cm (10 in) tall, removing 2-3 of the middle-sized leaves from each plant approximately once a week and continuing this all season (the largest leaves will help the plant grow, and the smallest leaves are too small to be useful). The plants will survive multiple frosts, and the leaves taste best after at least one frost. Some growers do not like large collard leaves (which can become bitter in hot weather), and prefer to harvest whole plants while they are still small (less than 25 cm/10 in tall). Collard leaves are usually steamed or otherwise cooked.

Corn, sweet

Most people like sweet corn, but sweet corn is NOT recommended for small gardens because the plants get very large and because they are *wind pollinated*. The fact that corn is wind pollinated means that you must always plant at least two rows of plants, and preferably more, to ensure that there is enough pollen floating around to produce full ears of corn. Corn can usually be purchased relatively cheaply, and you may be better off using your precious garden space to grow vegetables that are more expensive or harder to find. If you do decide to grow sweet corn, wait until late May or early June to plant, **fertilize** heavily, and harvest at the “milk” stage when kernels are full-sized but not yet mature and dry— this is about 20 days after the appearance of golden-brown “silk” at the top of the ear. Late-season plantings are vulnerable to various pests including corn earworm. Remove, chop up, and compost corn stalks after harvest. Gardeners who are serious about growing corn will want to look in one of the **sources for more information** – it’s a complex crop!



An ear of sweet corn (this one has been allowed to dry — most gardeners eat theirs fresh).

Cucumber

Cucumbers require warm weather to grow well, but with a modest amount of care and attention they can produce a lot of fruit. They are closely related to vine crops like watermelons and winter squash, but cucumber vines are smaller than some others, and cucumbers are more tolerant than most vine crops of being “trained” (made to grow) vertically onto trellises (wood or metal structures that you build right over the plants). As a result, they can be appropriate for small gardens when other vine crops are not.

Plant cucumbers as described in the “quick reference guide for vegetable planting.” Whether seedling or transplanting, you must wait until all danger of frost has passed. If you want early cucumbers, you can use transplants that you have grown inside or purchased from a garden store. If you’re willing to wait a while longer, plant seeds. Either way, you will want to consider use of **plastic mulch**, a good amount of organic **fertilizer** (60 ml or ¼ cup per plant), and a **floating row cover**. You do not have to use plastic mulch to grow wonderful cucumbers, but use of plastic mulch speeds up growth of your cucumbers a lot, conserves moisture, and greatly reduces the need for weeding. Use of fertilizer increases yield of these plants, which need a lot of nutrients. Work the fertilizer into the soil

right around where you are going to plant the seeds or transplants. Whether or not you use plastic mulch, a floating row cover may be necessary, as cucumber beetles (see **pests**) can eat your young cucumbers to death unless you protect them. You can try to grow cucumbers without row covers, and you may be lucky, but many gardeners lose their cucumbers to the beetles. The row cover also speeds up the growth of the plants. If you use a floating row cover, put it over the plants immediately after planting, making sure to leave slack cover over the plants so that they have room to grow. Uncover the plants once you can see flowers beginning to open – the flowers need to be exposed so that insects can pollinate them, and the cucumber beetles can't do much harm to the plants once they're big enough to flower. Once you uncover the plants, give them some kind of trellis (a wood or metal structure that you build right over the plants) to grow on, and move the vines toward it as they get longer – they should climb up it. You can use tomato cages as trellises if you have them (see the tomato crop page for details).

Every cucumber variety represents one of two different types. Make sure you know which of these types you are planting! The two main types are:

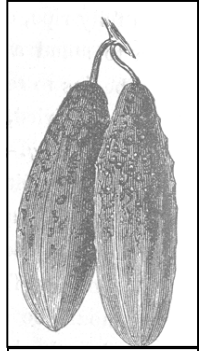
1) Pickling cucumbers -- Pickling varieties are bred to produce many small fruits that are dense and crispy. Harvest these cucumbers when they are 5-10 cm (2-4 in) long. There are many ways to pickle cucumbers, but a quick way is to make "refrigerator pickles" – cut a number of pickling cucumbers into four long, thin quarters and pack them into a jar with some garlic, salt, pepper, and herbs like oregano and thyme; add white vinegar or cider vinegar to fill $\frac{3}{4}$ of the remaining space in the jar and water to fill the last $\frac{1}{4}$. Let the pickles sit in your refrigerator for one or two days before taking some out to eat. Cucumbers stored like this will keep for several weeks.

2) Slicing cucumbers – Slicing varieties are bred to produce fewer, larger fruits, and are usually intended to be sliced into round slices for use in salads and sandwiches (or, in some cultures, ground up and mixed with milk or yogurt and salt to make a cool, refreshing drink). Harvest these varieties when the fruits are 15-25 cm (6-10 in) long. You can pickle slicing cucumbers as described above, but your pickles may not be quite as crispy.

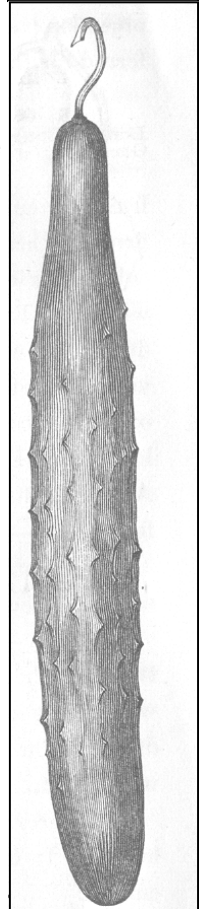
Harvest cucumbers at around sizes recommended above. You can still eat them if they get larger, but they are not as good to eat (in particular, do not leave them on the plant until they turn yellow). Make sure to harvest your plants regularly (every 2-3 days), as cucumbers grow quickly. Make sure to remove all harvestable fruit. If you leave large cucumbers on the vine, the plants will stop producing. Even if you do harvest your cucumbers regularly, it is normal for your plants to stop producing a few weeks to a month after your first harvest them. When this happens, you can pull the plants out and put in another vegetable in their place (DO NOT plant cucumbers or any other vine crop in the same space for 2-3 years!). Growers who have love cucumbers and have enough space put in two or three plantings of cucumbers at 2-3 week intervals to ensure a longer season.

Eggplant

Eggplant require heat throughout their lives and are almost always started in a greenhouse and transplanted outside. They have NO cold tolerance and should only go outside after all danger of frost has passed. They do best on **plastic mulch** (which provides heat and keeps down the weeds), but can be grown without it. In many gardens, eggplant plants need to be protected



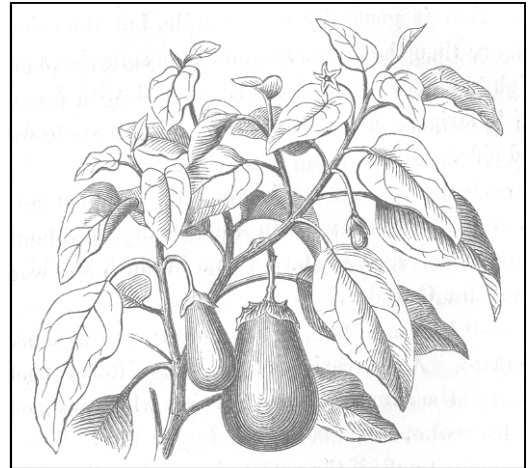
Pickling cucumbers (above) and a slicing cucumber (below). Notice that both types have been harvested while they are still relatively slender. If left on the vine, they would swell and become quite fat (and less tasty).



from flea beetles and/or Colorado potato beetles (see **pests**) with **floating row covers**. If you don't protect your plants, these pests can eat the plants leaves to death.

Eggplants need to be transplanted with a lot of fertilizer. See **transplanting** for the basics, and use about 125 ml (1/2 cup) of a standard organic **fertilizer** for each plant.

Unlike tomatoes and most other fruits, eggplants don't exactly get "ripe" – they just start keep growing and you can harvest them at any size. The longer you leave them, the more fruit you'll get, but do harvest them before they lose their shine and get brown. While traditional western eggplants are large and black, there are many Asian varieties of eggplants that are green, white, pink, or purple, and of widely varying sizes and flavors. Most good garden stores and farmers' markets sell plants of different varieties – you can buy one or two plants of half a dozen kinds to experiment!



A standard, large purple-black eggplant. Note that there are fruits of many different sizes. All of these could be harvested at once, but it makes sense to take only the largest fruits and let the smaller ones keep growing.

Eggplants do not store well – use them as soon as you harvest them, or put in the refrigerator for no more than two days.

Flowers

Like vegetables, flowers vary widely in their tolerance of cold, heat and drought. They also take varying amounts of time to mature. Some are easy to grow from seed, while others must be transplanted. Some are perennials, which means that you can plant them once and enjoy them for many years (if you protect them from weeds), and others are annuals that you must plant every year. Like vegetables, *flowers have seasons!* You cannot plant them once and expect to cut them (or look at them) all year long.

With care, however, even a beginning gardener can have some flowers from very early in the season until after the first frost. The following table shows some of the annual and perennial flowers that are easiest to grow. Some of the flowers should be planted as transplants (see **transplanting**); these can be purchased at many garden centers, or you can grow your own (see **starting plants inside**).

Some growers don't care about flowers at all and save all of their space for vegetables. Growers who like flowers and vegetables but don't have much space save most of their space for vegetables but plant a few annual flowers here and there – you may like (or leave room for) just one kind of flower. Flower lovers often reserve one or more **beds** for perennials (perhaps planting them together with perennial vegetables like rhubarb and asparagus), then fit in annuals here and there around their vegetables (or instead of vegetables!). If you are going to grow a lot of perennial flowers, you might want to buy some landscape fabric and plant your flowers into it (see **season extension techniques** and **laying and removing plastic mulch** for a discussion of what landscape fabric is and how to use it). It will help a lot with weed control. Some flowers such as larkspur, delphiniums, and sunflowers may need to be staked or caged (see the tomato crop page for a discussion of stakes and cages) to prevent them from falling over.

Some flowering plants flower all at once and are done, but many others will keep producing new flowers for days or weeks as you keep regularly harvesting flowers and/or removing old, dead flow-

ers (this is called “deadheading”). To harvest flowers, use a sharp scissors, a sharp knife, or good pruning shears. Cut the plants with stems that are long enough to put into a vase, but cut off as few leaves as you can in the process (the plants need them to make more flowers!). Put the cut flowers into water as soon as possible, adding a little sugar to the water. Change the water every two days or so to keep your flowers fresh longer. Many flowers can be dried instead (see the table for a few possibilities). In general, cut flowers for drying and hang them (*stem end up*) in a dark, warm, dry place for several weeks.

Some Easy Annual and Perennial Flowers

Notes:

- 1) If you only plant one variety, you may want to try a variety described as a “mix.” Mix varieties usually include flowers of many different colors and/or sizes. Avoid varieties called “dwarf,” as they will be short and not useful for cutting.
- 2) If no variety is listed, or if you cannot find one of the varieties listed here, do not worry. Go ahead and try whatever variety you can find!
- 3) Most of these flowers could be grown by the home gardener from seeds, but only if the plants were started inside months before the last frost date in the spring. In these cases, the table encourages you to buy transplants. If you have the space, try starting them inside.
- 4) If growing these plants in the garden from seed, plant multiple seeds in clumps at the recommended spacing, then thin them later (leaving the healthiest, largest plants) such that there is only one plant remaining from each clump.
- 5) If a range of plant spacings is given, use the larger distance for large varieties. These distances refer to the spacing between plants in the same row – if you plant multiple rows of the same plant, the rows should usually be a little farther apart than this distance.
- 5) These are only a few of hundreds of different flowers available. If you find something in a catalog or a garden store that sounds beautiful, try it. Be aware, however, that some flowers can be very difficult to grow. See resources for more information for tips on where to learn more about flowers.

Annual Flowers

Flower (and alternate name or names)	Variety or varieties to try	Plant as seeds, bulbs, or transplants?	Possible planting date(s)	Depth to Plant	Distance apart in row	Notes
Ageratum	Blue Horizon, Florist's White	Transplants	After danger of frost has passed	Match depth in pot to ground level.	30 cm/ 12 in	Start plants inside from seed two months before last frost date or buy plants later.
Amaranth	Love Lies Bleeding,	Seed	After danger of frost has passed	Cover seeds very lightly with soil.	30-45 cm/ 12-18 in	Leaves and seeds are edible (some varieties taste better than others)
Bachelor's button (Centaurea)	Blue Boy	Seed	Plant in fall or early in the spring; can be seeded several times at intervals to provide a longer flowering season	Cover seeds very lightly with soil.	15-25 cm/6-10 in	Dries well.
Cosmos	Cosmic Yellow, Sea Shells, Sensation Mix, Versailles, Imperial	Seed	After danger of frost has passed	0.5 cm/0.25 in	20-30 cm/8-12 in	Cut regularly to keep plants producing.
Celosia	Chief Mix, Cramers, Bombay	Seed or transplant	Two weeks after danger of frost has passed	Cover seeds very lightly with soil or match depth in pot to ground level.	30-45 cm/ 12-18 in	Dries well.

Some Easy Annual and Perennial Flowers (Continued)						
Flower (and alternate name or names)	Variety or varieties to try	Plant as seeds, bulbs, or transplants?	Possible planting date(s)	Depth to Plant	Distance apart in row	Notes
Dahlia	Rigoletto	Transplants or bulbs	After danger of frost has passed	Plant bulbs at a depth equal to 2 or 3 times the width of the bulb. For transplants, match depth in pot to ground level.	60 cm/24 in	Dahlias are actually perennials, but the bulbs will usually not survive northern winters unless you dig them out, let them dry, and store them at 4-10 C (40-50 F) over the winter.
Larkspur (Consolida)	Giant Imperial Mix, Sublime Mix	Seed	Plant in fall or as early in spring as you can get in the garden; seeds must be exposed to six or more weeks at temperatures below 12 C/ 55 F	Cover seeds very lightly with soil	25-30 cm/ 10-12 in	Produces many pretty flowers. Dries well. You may see transplants, but avoid them – larkspur doesn't transplant well.
Marigold	Gold Coin Mix, Queen Sophia, Brocade Mix, Jubilee	Seed or transplant	Plant 2 weeks before last frost; may want to put in a second planting after frost	0.5 cm/0.25 in	Small varieties can go 15-20 cm/6-8 in apart, larger varieties 30-45 cm/12-18 in apart	Marigolds are pretty and can also repel nematodes (see pests) if planted around tomatoes and other vegetables.
Nasturtium	Jewel Mix, Alaska Mix, Empress of India	Seed	Plant one or more weeks after last frost	1.3 cm/0.5 in; keep moist	Plant groups of 3 or 4 seeds 30 cm/12 in apart	Flowers are edible and pretty in salads.
Salvia	Caraviniere Red, Victoria Blue, Oxford Blue, Pink Sundae	Transplant	After danger of frost has passed	Match depth in pot to ground level.	30-90 cm/12-36 in (Some varieties are very large, others small)	Can be dried. Plant size and color vary widely.
Snapdragon (Antirrhinum)	Rocket, Liberty	Transplant	Plants are cold tolerant and can be transplanted up to a month before the last frost if protected with a floating row cover; otherwise wait until after frost	Match depth in pot to ground level.	22-30 cm/9-12 in	Produces many pretty flowers.
Statice	Anything that's available (try a mix)	Transplant	After danger of frost has passed	Match depth in pot to ground level.	30 cm/12 in	Excellent for drying.

Some Easy Annual and Perennial Flowers (Continued)						
Flower (and alternate name or names)	Variety or varieties to try	Plant as seeds, bulbs, or transplants?	Possible planting date(s)	Depth to Plant	Distance apart in row	Notes
Sunflower	Autumn Beauty, Joker, Mammoth, Prado Gold, Selma Suns, Sunbright; if possible, find out how big the variety you buy will get – heights range from 60 cm to 3 m (2-10 ft)	Seed or transplant (young plants only – older plants may not transplant well)	After danger of frost has passed	2.5 cm/1 in; keep moist after seed-ing	22-30 cm/9-12 in (some varieties grow very, very tall but are not very wide, so they can still be planted close together)	Some varieties (esp. Sunbright) can be dried. Leave the sunflowers in the garden after the flowers are gone; the seeds will feed migrating birds.
Zinnia	Benary's Giant Mix, Cactus Bright Jewel Mix, State Fair Mix, Oklahoma	Seed	After danger of frost has passed; can put in two successive plantings about 4-6 weeks apart to have flowers for months.	Cover seeds very lightly with soil	15-30 cm/6-12 in	One of the most beautiful, productive, and reliable of flowers. Most mixes include many bright, wonderful colors.

Perennial Flowers

Aster, New England	Anything that's available	Transplant	After danger of frost has passed	Match depth in pot to ground level.	60 cm/24 in	This prairie native does well in the Midwest. Plants that get large can be divided every three years or so.
Coneflower (Echinacea)	Magnus, Bright Star (or anything that's available)	Seed or transplant (plants grow readily but slowly from seed and may not flower the first year)	Can seed in late fall or early spring (before last frost) or transplant in early spring (before last frost)	Cover seeds very lightly with soil (seed thickly, as some will not grow) or match depth in pot to ground level.	60 cm/24 in	Varieties may be white, pink, or purple. This prairie native does well in the Midwest. Plants that get large can be divided every three years or so.
Daffodil (Narcissus)	Choose varieties based on pictures and descriptions – flowers vary a lot	Bulbs	Plant in fall (October-November)	15 cm/6 in	15 cm/6 in	Daffodil stems have sap that is harmful to other flowers – do not mix them with others in a vase. Cut flowers before they open for longest flower life.
Daisy	Any variety – choose based on color and size	Seed or transplant	Plant seeds in the fall or early spring (before last frost); transplant any time after the last frost	Place seeds on soil surface or match depth in pot to ground level.	30-60 cm/12-24 in	Keep an eye on these plants, as they can spread and take over your garden! Dig some of them out if this starts to happen.

Some Easy Annual and Perennial Flowers (Continued)

Flower (and alternate name or names)	Variety or varieties to try	Plant as seeds, bulbs, or transplants?	Possible planting date(s)	Depth to Plant	Distance apart in row	Notes
Delphinium	Belladonna, Aurora, Pacific Giant	Seeds or transplants	Plant seeds or transplants in fall; they need cool weather to get established.			Delphiniums do not do well in hot weather. Mulch around their roots and water regularly. Can be dried.
Gypsophila (Babies' Breath)	Snow fountain, Covent, Garden Market, or any other perennial variety available locally	Seed	Plant in the spring after danger of frost has passed, and (if you like it a lot) put in more at intervals of one or more weeks.	Cover seeds very lightly with soil. Keep moist.	Seed thickly, then thin to 25 cm/10 in as plants grow	There is an annual type as well as the perennial type. Both are pretty, but make sure to buy the perennial if it's what you want. Can be dried.
Foxgloves (Digitalis)	Foxy Mix	Seeds or transplants	Plant transplants in spring or seeds in late summer or fall (Sept.-Oct.)	Cover seeds lightly with soil. Keep moist.	45 cm/18 in	Usually does not flower the first year it is planted. Plants that get large can be divided every three years or so.
Iris	Any variety – choose based on color and size	Bulbs	Early fall (September) or early spring (late March or April)	2.5 cm/1 in	8-15 cm/3-6 in	There are several different types of irises that look very different from each other. Removing dead flowers is very important to encourage more.
Liatris (Blazing Star, Gay-feather)	Any variety – choose based on color and size	Plants or bulbs (also called "corms")	Spring or fall	Plant bulbs 5-8 cm/2-3 in deep or match depth in pot to ground level	15-20 cm/6-8 in	This prairie native does well in the Midwest.
Monarda (Bee Balm, Horse Mint)	Lambada, Panorama	Transplants	Spring or early summer	Match depth in pot to ground level.	45 cm/ 18 in	This prairie native does well in the Midwest.
Peony	Any variety available locally	Bulbs (roots, really); use roots with at least three "eyes" (growing points) each	Plant in the fall or early spring (before last frost)	Plant roots so eyes are 5 cm/2 in below the soil surface	120 cm/48 in	Plants can get very large! May not flower until the third year.
Rudbeckia (Black-eyed Susan)	Goldsturm or any other perennial variety available locally	Seeds or transplants	Plant seed 2-4 weeks before last frost date. Plant transplants in the spring after frost.	Place seeds on soil surface – do not cover with soil at all. For transplants, match depth in pot to ground level.	45 cm/18 in	There is an annual type as well as the perennial type. Both are pretty, but make sure to buy the perennial if it's what you want. Can be dried. Can divide large plants after 3-4 years.
Tulip	Any variety available locally	Bulbs	Plant in fall (October-November)	15 cm/6 in	15 cm/6 in	The petals are edible and pretty in salads.

Some Easy Annual and Perennial Flowers (Continued)

Flower (and alternate name or names)	Variety or varieties to try	Plant as seeds, bulbs, or transplants?	Possible planting date(s)	Depth to Plant	Distance apart in row	Notes
Yarrow (Achillea)	Cerise Queen, Colorado	Transplants	May-June	Match depth in pot to ground level.	45 cm/18 in	A very tough plant.

Fruits

Since even a small fruit tree needs an area 2.5-3 m (8-10 ft) on a side, most tree fruits are not appropriate for small gardens for space reasons alone. In addition, some fruits require more care than the average gardener can provide. Some (especially tree fruits like apples) are difficult to grow organically, at least if you want fruit that are cosmetically nice-looking. For other fruits this is not an issue. Pruning is often neglected by small gardeners, but with the exception of strawberries, almost all fruits (including fruits like raspberries and blackberries, which are sometimes known as “brambles”) really need at least some pruning every year to remain productive. If you are not willing to learn about pruning and do it regularly, don’t waste your limited space on fruits other than strawberries.

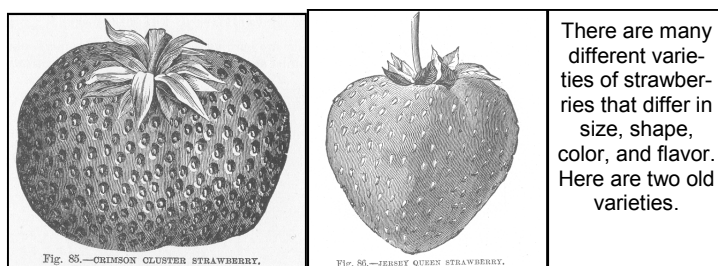
Raspberries and blackberries may work if you have the space, but they can spread and take over your garden if you aren’t careful. Strawberries are the most logical choice for small organic gardens, but blueberries, currants, gooseberries, and lingonberries are some other options that can work in limited space.

Information on planting strawberries is provided below, but other coverage of fruit is beyond the scope of this guide. See **resources for more information** for tips on where to learn more about fruit.

Growing strawberries

There are two major types of strawberries – June-bearing and everbearing. June-bearing varieties produce one large crop of berries in June and early July, while everbearing varieties produce two smaller crops, one in June and July and one in September and October. Overall, June-bearing varieties produce more fruit, but some people like the longer season.

Prepare one or more **beds** for your strawberries using **fertilizer** and **soil amendments**. If possible, prepare the bed(s) in the late fall – that way, all you will have to do in the spring (when the soil is wet and cold and hard to work in) is plant. However, you can also prepare a bed or beds in March or April, as soon as you can work in the soil.



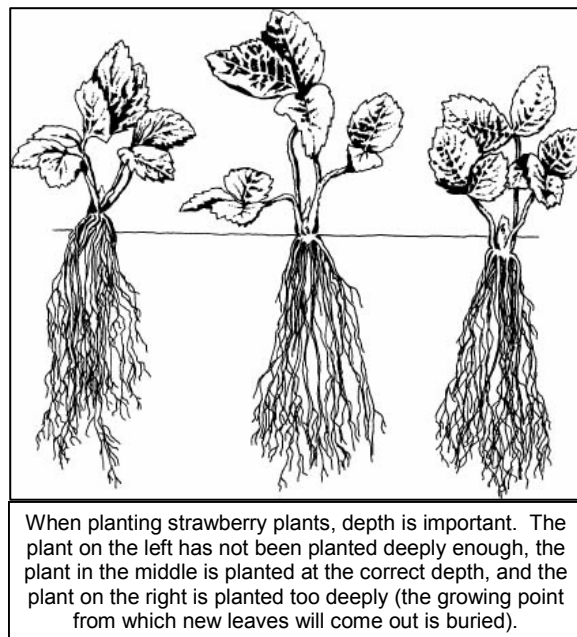
There are many different varieties of strawberries that differ in size, shape, color, and flavor. Here are two old varieties.

Strawberries are always planted as transplants. You may be able to buy as few as four or six plants at your local garden store, or you can order them by the dozen or the hundred over the internet. If you order them from a supplier, put your order in in January or February as popular

varieties can sell out. Plants should start to appear in garden centers (or be shipped) in March or April, just about the time when you can begin to work the soil. Put in your strawberries within a few days after you get them – they are frost-tolerant.

Plant strawberries 8-10 cm/3-4 in apart in rows 45 cm/18 in apart. When you plant strawberries, dig small holes for them and put them in the ground so that the roots are just covered. Press soil around the roots, but DO NOT cover the “crown,” the part of the plant that the leaves come out of (see picture at right).

The plants will produce some flowers and fruit their first year, but they will produce much more fruit the second year if you remove the flowers in the first year before they produce fruit (just pick the flowers off, being careful not to pull the plants out of the soil). It is VERY important to do three things to your strawberries: 1) weed around them thoroughly – strawberries do not compete well with weeds at all (you will need to be careful when weeding because the strawberry plants have shallow roots and you don't want to pull them out), 2) mulch around them with leaves or straw – this helps keep the plants' roots moist and keeps weeds to a minimum, and 3) water them thoroughly once each 1-2 weeks if it has not rained (**watering** with drip hoses is efficient and will keep your fruit from rotting). If you can only do one of these three things, weed!



The plants should yield well their second year. Pick strawberries when they are red all over, and go through your bed(s) every 2-3 days to catch newly ripened fruit (they ripen *fast* in hot weather!). When you pick, keep the green cap and stem on each strawberry. Put strawberries into a container lined with paper towels and put the fruit in the refrigerator as soon as possible. Eat within a few days.

To keep plants producing for years, keep weeding them and **fertilize** them each year AFTER the plants are done producing fruit. If you do these things, the plants should yield well for 3-5 years. They tend to spread by growing long, rootlike extensions above ground that are called “runners.” You can cut these off or let the plants spread, as you choose. After 3-5 years, the plants get too dense and start to produce less, and you should start a new bed or beds somewhere else. If the plants in your old bed(s) are still healthy, you can start new beds using plants from the old bed, but if your old plants have leaves with brown spots or other damage, buy new plants.

Like all fruits, strawberries are little balls of sugar and have many potential pests. There isn't much you can do about these except to weed, water, fertilize, and pick the fruits before they become over-ripe (which attracts slugs).

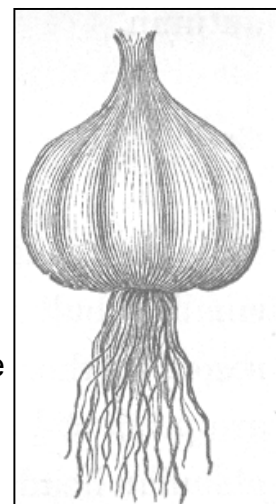
Garlic

Garlic is not too hard to grow on a garden scale, but taking care of it is different than taking care of many other vegetables. One of the biggest differences is that garlic is best planted in the fall, after most of your other garden plants have died. If you get your garden plot in the spring, you can still plant garlic, but the bulbs you harvest will not be as big as they would have been if you planted garlic in the fall. The following step-by-step guide to the basics of garlic production discusses both fall and

spring planting.

1) The first step in planting garlic is deciding where to put it. Any **bed(s)** you use for garlic should be in your best soil, well enriched with **fertilizer** and **soil amendments**. Identify these beds during the summer or early fall and add nutrients to them if necessary to prepare for garlic planting.

2) During the late summer, you should also figure out where your garlic for planting is going to come from. Garlic is not grown from seed – instead, it is planted as *cloves*, which are taken from *bulbs* (see picture at right). If you grew garlic the previous year, you may have saved some bulbs for replanting. If you do not have any of your own garlic, the best place to get it is from a local farmers' market – garlic sold by local farmers will be adapted to your local soils and climate, and will grow better as a result. If there is no farmers' market in your area, you can buy it at a garden center or through the mail. If it doesn't die over the winter, almost any garlic you buy will adapt itself to your local soils and weather over the course of a few growing seasons – garlic is good that way. Avoid using garlic purchased from a grocery store. This garlic will sometimes grow well, but at other times may be treated with different chemicals to prevent growth.



A garlic bulb. Note that the plant has very few roots — any water or fertilizer you provide must be placed very close to the plant or will not be available to it.

There are hundreds of different varieties of garlic, and some of them are very different from others. Some, for example, always produce small, red-skinned bulbs with the same number of cloves inside (6, for example), while others produce large bulbs with yellow skins and variable numbers of cloves. Flavor ranges from “sort of garlicky” to “very garlicky and spicy.” Every garlic variety is either a *hardneck* variety or a *softneck* variety. Hardnecks produce larger bulbs with larger, easier-to-peel cloves, and they do better in northern climates, so they are what you are likely to grow. Popular hardneck varieties include Spanish Roja, Music, Carpathian, German Red, and German Porcelain.

3) You should plan to plant your garlic between October 15 and November 5. The idea is to give your garlic time to grow roots (which it will do even in November), but to prevent it from growing leaves (which require warmer weather; if they grow, they will stick up out of the ground and freeze to death over the winter). The roots give the plant a significant head start in the spring, and make for bigger bulbs at harvest time.

A week or two before your planned planting date, take the time to carefully break up your garlic bulbs and separate out the individual cloves. If a clove breaks into pieces, use them for cooking but do not plant them. DO NOT peel the papery covers off the cloves, as you can damage them. If the papery covers come off by accident, that's fine – the cloves will usually still grow. Once you have all of your garlic bulbs separated into cloves, sort the cloves for both size and quality. Discard anything that is small, diseased (yellow, brown, or soft), or damaged. Weigh the high-quality cloves and decide how many of them you want to try to plant. If you take care of your garlic plants, the weight of your harvest of garlic will be 8-10 times the weight of the cloves you plant. Obviously, you need to have space to plant the number of cloves you want to work with.

If you are going to plant garlic in the spring rather than the fall, you should break the bulbs up in February and stick the loose cloves in a paper bag (not a plastic bag) in your refrigerator for a month. In late March or early April, plant them as described below.

4) Plant your garlic cloves 15 cm (6 in) apart in rows 30 cm (12 in) apart. Each garlic clove has a pointed end and a flat end. The flat end is known as the *basal plate*. The roots will grow out of the basal plate, and this end needs to go down when you plant. If your bed is well prepared, you should be able to push the cloves in with your finger. Push them in so that the pointed top of each clove is only about 2.5 cm (1 in) below the surface.

5) When you have planted all of your garlic, you can **mulch** it immediately or at any time in the next few weeks of late October or November. Mulching protects the garlic over the winter, keeps down weeds, and retains moisture. The best mulch to use is straw – if you put on 10-15 cm (4-6 in) of straw in the fall, your garlic will grow right through it in the spring and you never have to remove it. If you don't have straw, you can use the same thickness of dried leaves. If you use leaves, you will have to make sure to clear them away from the plants in the spring, as the wet leaves will pack down and keep your plants from growing.

If you are planting garlic in the spring, you should mulch your garlic immediately after planting, but only if you are mulching with straw. If you are using leaves, wait a few weeks until the leaves of your garlic plants are 10-15 cm (4-6 in) tall, then mulch very carefully around them, making sure not to bury the leaves.

6) Once you have mulched your garlic (either in the fall or the spring), your garlic should be fine for a while. Remove any weeds that manage to grow through the mulch, being careful to remove both the roots and the above-ground parts of the weeds. If you have more mulch, place it carefully around the garlic once the green garlic leaves get to be 15 cm (6 in) tall or taller. Preventing weeds from growing is much easier than pulling them up later!

7) Keep weeding your garlic as needed through the spring and early summer. **Water** your garlic thoroughly once a week if it hasn't rained.

8) Some time in May, June, or early July plants of hardneck varieties will start to grow flowering stalks. These stalks, or *scapes*, take energy away from the growth of the garlic bulb and should be removed as soon as you see them – just snap them off. The scapes are edible and taste nicely of garlic – chop them up and use them as you would garlic itself. Softneck varieties don't produce scapes like this.

9) Deciding when to harvest garlic is both important and little difficult. Garlic harvested too early will be smaller than ideal, since the bulbs do much of their growing just before they are mature. Garlic harvested too late may grow moldy, and the bulbs of hardneck varieties tend to fall apart underground. There is no magic rule for when to harvest, but the stems and leaves of garlic plants begin to get brown as the bulbs mature, and you can try to determine when the plants are about half brown (usually the top half gets brown first) and half green. In the upper Midwest, this is usually some time in mid to late July. If you aren't sure whether or not to harvest, the best way to tell is to dig up one bulb. The bulb should be rounded, dense, and have a tight, intact outer cover that is still attached to the stem of the plant. Overall, it's better to dig a little early than too late. Note that if you plant multiple different varieties of garlic, each variety may mature at a different time and need to be harvested separately.

10) It's tempting to pull garlic by hand, but you're better off using either a spade or a spading fork (see **tools**) to help you. Put the tool into the ground a little ways away from each garlic bulb so you don't damage the bulb, and then angle your tool away from the plant to lever it out of the ground. Gently shake as much soil off each bulb as you can, keeping each bulb attached to its stem (if you have some bulbs that break off their stems, keep them!). Use a hose to wash as much soil off the bulbs as you can; this will help you later when it comes to removing the roots and stems.

11) When you have harvested all of your garlic and cleaned it up as much as you want to, you need to hang it up to dry, or *cure*. Use rubber bands or pieces of wire to make the garlic plants into bundles with 6-8 plants in each bundle. Hang these bundles in a dry place with good air circulation that is out of direct sunlight. Leave them hanging for 2-6 weeks (if you have bulbs with no stems, leave

them on a plate in the same area). After this time, you can take them down and cut off the roots and stems. Cut the roots off so they are no more than 6 mm (1/4 in) long, and cut the stems so they are about 2.5 cm (1 in) long. Cutting the stems and roots may require a good set of garden clippers, but a scissors may be good enough. You can **compost** the stems and roots. By this time it will probably be some time in September.

12) After cleaning up your garlic bulbs, the first thing to do is sort out the largest bulbs to save as the next year's seed. Put these in paper bags in your refrigerator, if possible. If you don't have refrigerator space for this, put the bulbs in the coolest place you have that's above 0 C (32 F). If you store your seed garlic at room temperature, it may begin to sprout, but this will probably be o.k. since you will plant it within 6-8 weeks.

13) Once you have set aside your seed garlic, the rest of your garlic can be stored a couple of different ways. If you want, you can store it in a cool place as described above. If you have the time, however, you can have a garlic cleaning party. Break up all of the bulbs and peel all of the cloves, putting the cleaned cloves into a bowl. Take about 450 g (1 lb) of them at a time and put them in a food processor, chopping them until the pieces are only a couple of millimeters (1/8 in) across. You can do this with a knife if you don't have a food processor. Put the chopped garlic back into a bowl and add oil gradually (olive, canola, sunflower, or corn oil), adding and stirring until the garlic is almost covered with oil. Pack the oil/garlic mixture into clean jars, close the lids tightly, and put the jars (lid end up) in your freezer. To use the garlic, simply take a jar out and use a knife or fork to dig out some of the garlic. Garlic processed this way will keep for more than a year. You can also put a jar in your refrigerator and it will be usable for at least 2-3 months. The initial preparation is a lot of work, but it makes using garlic in your cooking very easy.

14) If your hands smell after working garlic, make a mixture of water and a small amount of lemon juice. After washing with soap, use the lemon water to rinse several times.

Greens

Many different greens can be planted, cared for, and harvested in just about the same way. Some of these may be familiar and others less so. A partial list of such plants, grouped to indicate the relationships between different plants:

- 1) *Sunflower family plants* (also called *Asteraceae*) -- lettuce (*many varieties*), endive, radicchio.
- 2) *Cabbage family plants* (also called *Brassicaceae*) – mizuna (also called kyona), komatsuna, broccoli raab, arugula, mustard, red mustard, Napa cabbage (also called Chinese cabbage), hon tsai tai, tat soi, canola (also called yu choi or edible rape), bok choy (also called pak choy).
- 3) *Goosefoot family plants* (also called *Chenopodiaceae*) -- spinach, amaranth, chard, beets (Note that chard and beets can be used in salads, but are also grown for other uses – see the “beets” and “chard” crop pages)
- 4) *Herbs* – fennel, parsley, basil, chervil, perilla. (Note that these herbs can be used in salads, but are also grown for other uses – see the “herbs” crop page for a discussion of growing herbs for drying and other food uses.)
- 5) *Miscellaneous other greens* – Purslane, sorrel, mâche (also called corn salad), dandelions

Most of these greens can be used uncooked in salads, at least when they are young. A few are

processed somehow or used in cooking (for example, Napa or Chinese cabbage, which is used to make the Korean dish kim chee). With the exception of sorrel, which is a long-lived perennial, all of these greens are grown as annuals.

Greens can be raised in one of two different ways:

1) Almost any greens can be raised for a salad mix, also called *mesclun*. To grow mesclun, the seeds of one or more greens are planted very densely and the plants' leaves are harvested when small (less than about 15 cm/6 in long). These young leaves are often called "baby greens," and several varieties of these baby greens are often mixed together to make the mesclun. Mesclun has less water in it than head lettuce and is often considered more flavorful. To grow a mesclun, you can either a) buy a pre-mixed mesclun mix containing seeds of many different plants, b) buy seeds of multiple plants, mix them together, and plant one or more rows of the mixed seeds, or c) buy seeds of multiple different greens and plant one or two "pure" rows of each green, cutting them and mixing the leaves together to make the mix. If there's one green you like very much (like lettuce, arugula or spinach) you can grow it the same way but just eat it on its own.

To grow a mesclun mix, choose the green or greens you want to grow, buy at least 50 g (about 2 oz) of each green, and follow these steps:

1a. Prepare the bed(s) where your salad mix will grow (see ***preparing a bed for planting***). Unlike most vegetables, greens do not need much in the way of ***fertilizer*** or ***soil amendments***. However, it doesn't hurt to enrich your beds a bit before planting.

1b. Mark each row you want to plant by using a stick or other tool to scrape a very shallow trench (no deeper than 0.5 cm/0.2 in). If you don't have much space, rows can be as little as 8 cm (3 in) apart, but you will have to do all of the weeding by hand. If you plant rows 15 cm (6 in) apart, you will be able to use a hoe (see ***tools***) to weed between the rows, though you will probably also need to do some hand weeding.

1c. Scatter the seed of your mesclun mix (or a single green) down the trench so that the seeds are less than 2.5 cm (1 in) apart.

1d. Take some very fine soil in one hand and use the fingers of your other hand to crumble the soil very finely over the seeds. DO NOT put more than 0.5 cm (0.2 in) of soil over them.

1e. When you have finished covering your row(s) of seeds, spread a hand and press lightly down along the length of the row. This gives the seeds good contact with the soil.

1f. Water the bed ***carefully and lightly*** (see ***watering***). If you splash a lot of water on the bed in large drops, you will wash the small, shallowly planted seeds right out of the bed.

1g. If you have it, cover the bed(s) with floating row cover (see ***use of floating row covers***). This will help keep the bed moist, speed up the growth of your greens, and keep them from being eaten by insects (especially flea beetles – see ***pests***) and other pests. Most greens will grow without floating row covers, but if you have problems with insects, a cover might be the first thing to try.

1h. Water the greens lightly once a week if there is no rain, or twice if it is very hot and dry.

1i. Your greens should start to grow. As the plants get to be 2.5-5 cm (1-2 in) tall, you should be able to identify what is a green and what is a weed. Use your hands and/or a hoe (see ***tools***) to remove the weeds. If you are using a floating row cover, leave the plants covered until they are at least 5 cm (2 in) tall, uncover them, weed them, recover them, and take the cover off only when the greens are ready to be harvested. If you are growing spinach, you should ***thin*** while you are weeding. Thin the spinach plants so they are 10 cm (4 in) apart.

1j. When the greens are about 15 cm/6 in long, you can begin harvesting them. This may be as little as 3 weeks after planting and as many as 5 weeks. To do this, take a sharp knife and carefully cut them 1-2 cm (0.5-1 in) above the surface of the ground, just mowing along the row(s) like a lawnmower. Cut only what you need for 4 or 5 days of eating (you can always come back to cut more

fresh greens!). If you cut high enough, you leave the living base of each plant and it will regrow at least one or two more times for you to harvest it again. If you choose to, you can pull up whole plants and cut the roots off, but obviously there will not be any second crop! Note that some plants, particularly spinach, are better off picked than cut (harvesting any leaves that are at least 8 cm/3 in long).

1k. Keep the greens out of the sun and heat and get them in a refrigerator or cold water as soon as possible (putting them in cold water quickly is best – it takes the heat out of the leaves). You can wash them right away, or wait to wash them until just before you want to eat them. To wash the greens, use a salad spinner (a kitchen tool available in many stores) or just swish them in a bowl of cold water. Pull out any dead or sick-looking leaves. Drain the leaves as best you can with a strainer and on a towel or paper towel. However you do it, getting water off the greens is important.

1l. Put the dried mesclun in your refrigerator. It will store longest in a plastic box with a tight-fitting lid. Before you put the greens in, line the box with paper towels. These will absorb water given off by the greens and will keep them from rotting.

2) Some kinds of greens (especially lettuce, endive, radicchio, bok choy, and Napa cabbage) are also raised for what are called *heads*. To do this, the seeds are planted much farther apart and the plants are allowed to form large, dense masses of leaves. Note that many other greens, like spinach, *never* form heads and should always be planted as described above – they only make a ring of loose leaves.

To grow greens as heads, buy 28 g (1 oz) or more of seed of a head-forming green and follow these steps:

2a. Prepare the bed(s) where your greens will grow (see ***preparing a bed for planting***). Unlike most vegetables, greens do not need much in the way of ***fertilizer*** or ***soil amendments***. However, it doesn't hurt to enrich your beds a bit before planting.

2b. Mark each row you want to plant by using a stick or other tool to scrape a shallow trench (no deeper than 1.3 cm/0.5 in). Rows should be 30-45 cm (12-18 in) apart. The closer spacing will keep the heads smaller, which can be nice.

2c. Plant your seeds about 2 cm apart (0.8 in, or 10 seeds/foot

2d. Take some very fine soil in one hand and use the fingers of your other hand to crumble the soil very finely over the seeds. DO NOT put more than 1.3 cm (0.5 in) of soil over them.

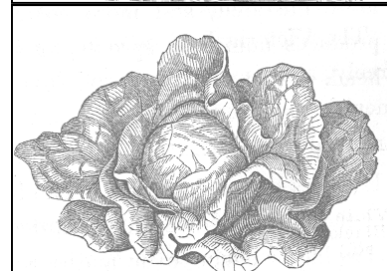
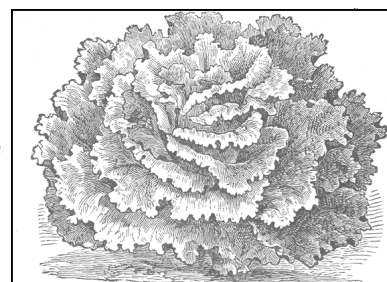
2e. When you have finished covering your row(s) of seeds, spread a hand and press lightly down along the length of the row. This gives the seeds good contact with the soil.

2f. Water the bed ***carefully and lightly*** (see ***watering***). If you splash a lot of water on the bed in large drops, you will wash the small, shallowly planted seeds right out of the bed.

2g. If you have it, cover the bed(s) with floating row cover (see ***use of floating row covers***). This will help keep the bed moist, speed up the growth of your greens, and keep them from being eaten by insects (especially flea beetles – see ***pests***) and other pests. Most greens will grow without floating row covers, but if you have problems with insects, a cover might be the first thing to try.

2h. ***Water*** the greens lightly once a week if there is no rain, or twice if it is very hot and dry.

2i. Your greens should start to grow. As the plants get to be 2.5-5 cm (1-2 in) tall, you should be able to identify what is a green and what is a weed. Use your hands and/or a hoe (see ***tools***) to remove the weeds. At the same time, ***thin*** the greens so that the plants are 15-20 cm (6-8 in) apart. If you are using a floating row cover, leave the plants covered until the are at least 5 cm (2 in) tall, uncover them, weed and then them, recover them, and take the cover off only when the heads are ready to be harvested.



Two of many different varieties of lettuce, here grown as heads.

2j. When the greens have made heads of a size you like (this takes 50-60 days for many common greens), you can begin harvesting them. Harvest using a knife to cut each plant off just above ground level. Cut only as many heads as you can eat in a week. Cutting every other head will let the remaining heads grow larger.

2k. Keep the heads out of the sun and heat and get them in a refrigerator or cold water as soon as possible (cold water is best for cooling down the heads quickly). Drain the heads as best you can by shaking them or letting them drip dry.

2l. Store head lettuce in a plastic bag together with a paper towel. The towel will absorb water given off by the greens and will keep them from rotting.

Some greens (especially lettuce, endive, radicchio, and spinach) do not do grow well in the hottest part of the summer. They may still grow for you, however, and **use of floating row covers** may improve your success growing these crops at that time. If you plant a green and it does not come up within two weeks, the most likely reasons are a) your seed was old (the seeds of many greens does not store well), or b) you did not keep the seed bed wet enough. Don't worry. Just go ahead and try again! You can replant the same bed or row immediately, perhaps with a different green or new seed.

Most greens are cool-weather crops, and some (especially spinach) can survive at least some frost. In hot weather, many greens will quickly *bolt*, or begin to flower (making a tall, thin flowering stalk in the center of the plant), often before you are ready to eat them. Greens that have bolted are usually not very good to eat, but they won't hurt you, and you may still be able to eat some of them.

As soon as you are done harvesting any planting of greens, rip out and **compost** any remaining plants. Plant the bed(s) to another crop or prepare the beds for winter (see **preparing your garden for winter**).

Herbs

The term "herb" is applied to a highly varied group of plants whose leaves are used in food preparation, healing, and other pursuits. Some popular herbs are annual plants (basil, for example) but many others (sage, rosemary, thyme, marjoram, and tarragon, for example) are perennials. Unfortunately, many common perennial herbs are from warm climates and are "tender," meaning that they can be hard to keep alive in the garden during our cold northern winters. To deal with this, some gardeners bring these herbs inside during the winter, while others buy transplants every year at stores or farmers' markets and grow these perennials as though they were annuals.

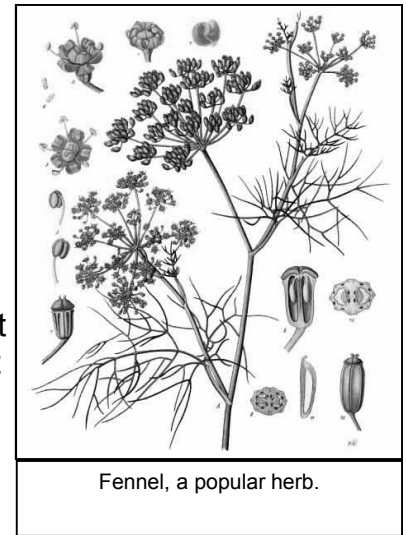
Some herbs are very easy to grow and others not so easy. The table below provides some basic information for common herbs. Herbs that are perennials but too tender to survive northern winters are listed as annuals.

Most herbs (both annuals and perennials) are harvested by picking off individual leaves or small branches. In general, a good rule of thumb is to remove 20-30% of a plants' leaves at a time, though some plants (basil, for example) will survive loss of almost all their leaves. As with flowers and some vegetables, it is actually important to harvest the plants regularly. If you do not do this, they will stop producing leaves and/or start flowering (which changes their flavor and may also affect growth of new leaves). If your herbs start to flower, you can generally just pick off the flowering stems to encourage more leaf growth.

Every herb listed here can be used either fresh, frozen, or dried. To freeze the leaves, simply pick what you want and put it in the freezer in a *tightly sealed* freezer bag. Take out what you need when

you need it, always making sure to close the bag well. Frozen herbs will turn dark green or even black when you thaw them, but they keep most of their flavor.

Herbs can be dried in several ways. If you have a dry place to hang them that's out of direct sunlight, you can tie some herbs into bundles, leave them hanging until the leaves crumble between your fingers, and then pick the leaves off, storing them in tightly closed jars or freezer bags. You can also leave them spread out on a paper towel. If you don't have the space to hang or spread out herbs, or you have the space but it isn't dry enough, or the stems of your herbs are short and impossible to tie up, you can dry them either in an oven or in a commercial food dryer. To dry herbs in an oven, your oven must have a "warm" or "low" setting. Spread your herbs thinly on a baking tray and put them in the warm oven. Depending on the warmth of the oven and the amount of moisture in the herb you are trying to dry, your herbs may take as little as half an hour or as much as 12 hours to dry. Check them regularly. Again, the leaves should crumble between your fingers when they are dry. When you are done, allow the herbs to cool, remove the leaves from the stems, and store the leaves in jars or bags. If you can afford it, you may wish to purchase a commercial food dryer (see ***sources for more information*** to learn where to buy one). A good electric food dryer is a tool that can help you efficiently dry many herbs, fruits, and vegetables. Any good dryer will come with instructions for use.



Fennel, a popular herb.

Annual herbs can be grown much like vegetables, that is, in rows in your garden. Perennial herbs are often put in beds with perennial flowers and/or perennial vegetables. A lot of perennial herbs do not compete well with weeds, so you may want to plant them in landscape fabric (see ***season extension techniques***) and/or ***mulch*** around them heavily to keep down the amount of hand weeding you have to do.

Some Easy Annual Herbs

Annual Herbs (and Perennial Herbs Grown as Annals)	How to plant it	Possibly useful information about the plant
Basil	Basil has absolutely no frost tolerance. It will also not grow in cold soils. You can start it yourself inside in late April or early May (see starting plants inside), buy transplants at a garden store in late May or early June, or wait until June to plant seeds directly in the garden. If you grow or buy transplants, put them in the garden after frost, spacing the plants 30 cm (12 in) apart in rows 30 cm (12 in) apart. If you plant seeds yourself, plant them about 5 cm (2 in) apart, very shallowly (3 mm/ 1/8 in), in rows 30 cm (12 in) apart. Germination is best if you use a floating row cover to create extra heat in the soil. Once the seedlings have 4 or more leaves, thin them so they are 30 cm (12 in) apart.	Basil is a mint and also a perennial, but it has no cold tolerance at all and never survives northern winters outside. There are many kinds of mint with leaves of different colors, sizes, and flavors. Basil leaves contain too much moisture for effective air drying. Freeze them or dry them in an oven if desired. The plant is most often used fresh. Basil plants grow slowly when they are small, but very quickly once they get bigger (as long as the weather is warm). Harvest them regularly, removing whole sections of the plant (up to 50% if the plant has gotten very large) to encourage new growth of stems and leaves. At some point, the plants will begin to produce flowering stalks and flowers. Pinch these off as soon as they appear to make the plant grow more leaves. For some growers, one planting of basil is enough. For real basil lovers, however, planting basil two or even three times during the summer is a good idea, since the plants do slow down their growth and flower eventually, no matter how much you try to stop them.

Some Easy Annual Herbs

Annual Herbs (and Perennial Herbs Grown as Annuals)	How to plant it	Possibly useful information about the plant
Chamomile	You may be able to buy transplants, which should be planted about 15 cm (6 in) apart after the danger of frost has passed. You can also grow chamomile from seed – after frost has passed, scatter seeds on the surface of the soil (do not bury them at all), keep the soil moist, and then thin the plants to 15 cm (6 in) once they have four or more leaves.	Chamomile is an annual, but it germinates easily in the garden, and if you let it go to seed, it will often reseed itself the next year. As a result, it can sometimes become an annoying weed in your garden. The leaves have some fragrance, but it's usually the flowers that are harvested and dried for use in tea and other forms.
Cilantro (also called culantro or coriander)	You can sometimes buy cilantro transplants, but the plant really does not transplant well. Instead, plant seeds 1 cm (½ in) deep as soon as all danger of frost has passed. Plant the seeds 5 cm (2 in) apart if you are growing the plant for its leaves, but 12 cm (5 in) apart if you are growing it for its seeds. Weed thoroughly and mulch around the plants if you can – cilantro does not compete well with weeds. Plant one or more times in the spring and the fall, and skip the hottest part of the summer.	Cilantro and coriander are the same plant, though the name cilantro is often used for the leaves of the plant and coriander for the seeds (the leaves and seeds have surprisingly different flavors). Unfortunately, cilantro tends to grow very fast and flower quickly (at which point it stops growing new leaves). It grows less quickly in the spring and fall than in the summer, and you can also lengthen its productive time by harvesting the plants heavily at regular intervals (cut off all of the leaves and stems about 5 cm/2 in above the ground and they will grow back within 1-2 weeks). If you want the seeds, let the plants flower and set seed. Cut off whole plants as soon as the plants turn brown and before the seed pods open. Hang the plants upside-down to dry out of direct sunlight, open the seed pods, and store the seeds in a jar or freezer bag. You can dry cilantro leaves, but they lose a lot of their flavor in drying.
Dill	You can sometimes buy dill transplants, but the plant really does not transplant well. Instead, plant seeds 6 mm (¼ in) deep as soon as danger of frost has passed. Plant the seeds 5 cm (2 in) apart if you are growing the plant for its leaves, but 12 cm (5 in) apart if you are growing it for its seeds.	Both the leaves and seeds of dill are used as flavorings. To keep plants producing leaves, cut off flowering stalks as soon as they appear. If you want the seeds, do not harvest leaves -- let the plants flower and set seed. Cut off whole plants as soon as the plants turn brown and before the seed pods open. Hang the plants upside-down to dry out of direct sunlight, open the seed pods, and store the seeds in a jar or freezer bag.
Fennel	You can sometimes buy fennel transplants, but the plant is easy to grow from seed. Plant seeds 3 mm (1/8 in) deep as soon as danger of frost has passed, and make sure to keep the seedbed moist until the plants are up. Plant the seeds 10-15 cm (4-6 in) apart if you are growing the plant for its leaves, but 30 cm (12 in) apart if you are growing it for its bulbs or seeds.	If protected with mulch, fennel can be a long-lived perennial. Most growers treat it as an annual, however. Fennel is a versatile plant in which the leaves, seeds, and (in some varieties) roots are all eaten. For leaves and seeds, treat the plants much as you would treat dill (above). For bulbs, make sure that you get a bulbing variety (often called "Florence" fennel) and plant in a bed with a lot of fertilizer. The bulbs grow slowly, but you can plant fennel as late as July or even August and get at least small bulbs. Once the bulbs are the size of a small egg, hill dirt up around the bulb to keep it growing and protect it from rodents. Remove any flowers the plants start to produce. The bulbs will keep in the ground through the winter if mulched, but can be harvested any time around or after the first frost in the fall. Chop them up for use in soups and stews.
Marjoram	Can be grown outside from seed, but is usually planted as a transplant after frost. Grow your own plants inside (plant seeds 3 mm/ 1/8 in deep 6 weeks before last frost; see starting plants inside). Otherwise wait until after frost and buy plants that are about 8 cm (3 in) tall at a garden store or farmers' market. Plant them 15-20 cm (6-8 in) apart.	Marjoram is a perennial, but is not cold-tolerant and is usually grown as an annual. To harvest marjoram, wait until the plants start to flower, then cut them off about 8 cm (3 in) above the soil. Wait for them to regrow and then repeat until the plants are killed by frost.

Some Easy Annual and Perennial Herbs

Annual Herbs (and Perennial Herbs Grown as Annuals)	How to plant it	Possibly useful information about the plant
Parsley	Parsley can be difficult to start yourself, and most gardeners just wait until after frost to buy a few small plants at a garden store or farmers' market. Put the plants about 20 cm (8 in) apart in each direction.	Parsley is actually a "biennial," meaning that if you protect it with heavy mulch, it will live through the winter and grow for a second year before flowering. However, it is usually grown as an annual. Once plants are established, they grow quickly and can be harvested often; pick the largest, longest leaves around the edge of the plant, removing 20-40% of the leaves each time you harvest. Parsley is very cold tolerant and can be harvested through several early frosts, after which you should either pull them out or mulch them.
Rosemary	Rosemary can be difficult to start yourself, and most gardeners wait until after frost to buy one or a few small plants (8 cm (3 in) tall is big enough) at a garden store or farmers' market. Put the plants about 60 cm (24 in) apart in each direction. This may seem too far apart, but the plants will grow very large if they are healthy, and the spacing helps promote the good air circulation rosemary needs.	Let your rosemary plants get about 20 cm (8 in) tall before you begin to harvest them. Harvest by removing small sections of stems together with their leaves. Do not remove more than 20% of the plant at any time. Rosemary is a perennial, but it is not cold-tolerant. Because rosemary grows slowly and is expensive to buy, people often try to bring their rosemary plants inside. Unfortunately, the plants need cool (15 C/60 F), humid conditions that are hard to match indoors in winter. To overwinter it, dig it from the garden in October and put it in a pot of very light ("soiless") potting mix. Water it and leave it outside in the pot for two weeks. Then, bring it inside and put it in a south-facing window away from any heat source. Spray the leaves with water every few days and water it just enough to keep the soil slightly moist. It will probably not grow much, and you shouldn't harvest it during the winter unless it does.
Perennial Herbs		
Chives	Chives can be difficult to start yourself, and most gardeners wait until after frost to buy a few plants at a garden store or farmers' market (or talk to a gardener you know and ask them to divide some of their existing large plants). Put the plants in 15 cm (6 in) apart.	Chives are a long-lived, cold-tolerant perennial related to onions and garlic. The plants grow into clumps that get quite large and should be dug up and divided every three years or so. To harvest chives, wait until the leaves are at least 15 cm (6 in) long, and then cut them off with a knife, leaving a minimum of 5 cm (2 in) of leaf above ground. They will regrow and can be cut several times during the season. At some point in the late summer, you should let them grow without cutting them all down, though if the plant(s) are well established, you can continue to harvest some leaves using the same technique. The plants may flower, and you can either remove the flowers when they are new and cook with them (they have a strong, pleasant chive flavor) or let them open and enjoy looking at them.
Lavender	Lavender can be difficult to start yourself, and most gardeners wait until after frost to buy one or a few plants at a garden store or farmers' market (or talk to a gardener you know and ask them to give you some; they can either physically divide some of their existing large plants, or cut off some shoots and let them grow roots in a jar of water on your windowsill). How far apart you put the plants will determine how big they get – if you want to grow a hedge of them, you can plant them less than 30 cm (12 in) apart. If you want only one or two large, healthy plants, plant them at least 60 cm (24 in) apart.	Lavender is a very long-lived, woody perennial that can grow into small bushes. It takes a plant about three years to reach its full size, but you can harvest it each year while it grows. Lavender is best known for its use in perfumes and flower arrangements, but it is also used in cooking along with (or in place of) other strong-flavored herbs like rosemary to add a sweet flavor. Both the flowers and the leaves are used. If you want the flowers for one reason or another, cut the flowering stalks before the topmost flowers have opened, and let them stand in an empty jar in a cool, dry place out of direct sunlight. Dry the leaves as you would other herbs.
Lovage	Lovage can be started indoors from seed before frost, but most gardeners buy transplants – given enough space, one or two plants will provide all the lovage you need. Plant lovage plants 60 cm (24 in) apart after danger of frost has passed.	Lovage is a close relative of celery, and its leaves and stems taste much like celery. Lovage is a tough, long-lived perennial.

Some Easy Perennial Herbs

Perennial herbs	How to plant it	Possibly useful information about the plant
Mint	Different mints have different needs. Lemon balm, a popular mint, can be grown from seed (plant in the spring, around frost, or in the late fall, just barely covering the seed with soil), but is more often grown by dividing an existing large plant. Put plants 30-60 cm (12-24 in) apart in each direction, though in most gardens, one plant will be enough. Peppermint, spearmint, and many other mints are grown the same way. You may want to keep your mints in pots to keep them from spreading too much.	There is no one plant called “mint” – mints are actually a large family of hundreds of different plants. All mints have square stems and similarly shaped leaves (though there are some plants with square stems that are not mints), but the flavors and odors of the plants vary tremendously (and some have to obvious smell or taste at all). Some are well known on their own (basil, lemon balm, pineapple mint, peppermint, catnip), while other equally interesting ones are less common. Some mints are cold-tolerant perennials, and some of them (like lemon balm) are fairly aggressive plants that will take over your garden unless you periodically remove some of their growth by digging it out. Most mints can be eaten fresh or dried. Harvest often to keep plants smaller. Most of them dry well, though some kinds lose most of their fragrance in drying.
Oregano	Oregano can be grown from seed, but most gardeners either buy plants or get them from another gardener who is dividing large plants. After danger of frost has passed, plant plants 20-25 cm (8-10 in) apart in each direction. During the year you plant them, remove any flowers that form to encourage more plant growth.	Oregano plants can live a long time and grow into small bushes. Over time they may get woody and produce fewer leaves, so some growers replace them after 3-5 years (others just prune them back). If you let the plants flower and drop seeds after their first year, some of the seeds may grow into new, young plants. Oregano dries very well.
Sage	Sage seeds do not store well and can be tricky to start – most growers buy sage transplants or dig up a piece of someone else’s large, established plant. Plant plants 60 cm (24 in) apart after danger of frost has passed (though in most gardens, one plant will be enough).	Sage is a long-lived perennial that can grow into quite large woody bushes. If you plant a small plant, do not harvest it the first year. After that, harvest it often and prune it back if it starts to get too big. Sage is nice when used fresh but it also dries well.
Tarragon	Tarragon is difficult to grow from seed, and most growers either purchase plants or find other gardeners with established plants that can be divided. Plant in a sunny place after all danger of frost has passed. Put plants 45 cm (18 in) apart.	Look for French tarragon rather than Russian tarragon. Tarragon is a somewhat delicate plant that will not always survive the winter outside. You can bring it indoors and treat it like rosemary (see above), but you can also mulch the roots heavily in the fall and hope that the plants survive (they often do!). Once you have plants established, prune off most of the small outer branches each spring in March or April so that the plants stay compact. Used either fresh or dried.
Thyme	Thyme is difficult to start from seed, and most growers buy plants. Plant plants about 20 cm (8 in) apart after danger of frost has passed.	Thyme is a tough, long-lived perennial. There are many varieties of thyme, each of looks and smells somewhat different from the others. English thyme is one of the most flavorful and popular, but others are also good. Thyme can grow into large, dense mats, and you may want to dig it up after 3-5 years and replant one or two small pieces of it.

Kale

See the broccoli crop page for information on how to start kale. Broccoli and kale are grown almost identically, except that one planting of kale put in the garden in April can continue to yield leaves until after frost. The plants have the same pests, but kale is sometimes more troubled by flea beetles (see **pests**) than broccoli. If you have bad flea beetle problems, you may need to keep your kale covered with a **floating row cover** all season long.

Kale plants get very large. You can begin to harvest leaves once the plants are at least 25 cm (10 in) tall, removing 2-3 medium-sized leaves from each plant approximately once a week and continuing this all season (the largest leaves will help the plant grow, and the smallest leaves are too small to be useful). Kale is incredibly cold tolerant, and if protected from intense cold with a **floating row**

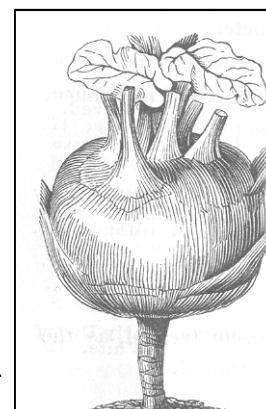
cover can yield leaves until mid-December. The leaves taste best after at least one frost. Kale leaves are usually steamed or otherwise cooked. Kale is one of the most nutritious vegetables there is, containing useful amounts of most vitamins and minerals.

There are several common types of kale – red, green, and lacinato (also called “dinosaur” kale because its leaves look the skin of a large, wrinkled animal). Red and green kale are more tolerant of flea beetles than lacinato kale and are more likely to grow well throughout the entire season, but all three of them taste good (if you like kale). Avoid ornamental varieties that are grown just for their looks.

Kohlrabi

See the broccoli crop page for information on how to start kohlrabi plants. Broccoli and kohlrabi are grown almost identically, except that kohlrabi is a little more heat tolerant and can be grown in the middle of the summer if you really like it. The plants have the same pests.

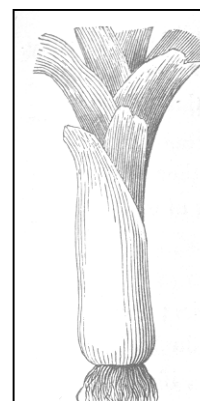
Kohlrabi plants grow a large, bulb-like stem that tastes like a mild, sweet turnip. Kohlrabi is usually eaten either unpeeled and fresh when small and young or peeled and steamed when older and larger. Plants are cold tolerant, and best flavor comes from plants planted midsummer that have experienced some cold or even light frost. Bulbs should be harvested when they are no more than 8 cm (3 in) across, as larger bulbs become woody. To harvest, cut off the leaves and roots.



Kohlrabi, with most of its leaves removed. The edible swollen part is actually part of the stem, not a root.

Leeks

Leeks are like giant scallions (green onions), but they have a milder, sweeter flavor that is excellent for soups and other cooked dishes. Leeks grow very, very slowly and though you can plant leek seeds outdoors, they are more commonly started indoors as early as the beginning of February and transplanted outdoors when they are about the size of a pencil. Very pest and cold-resistant, leeks will grow anywhere (though their final size depends a lot on soil fertility). Leeks can be harvested at any size and at any time, but they taste best after multiple frosts – you may wish to leave them in the field until late November or even early-mid December. Leeks must be washed very carefully, as soil tends to get in between tissue layers as the leeks grow. Leeks do not store very well in the refrigerator, but can be kept for up to two weeks (wrap loosely in plastic, and *do not* wash them before storing). Leeks can also be sliced and



A leek with most of its leaves removed.

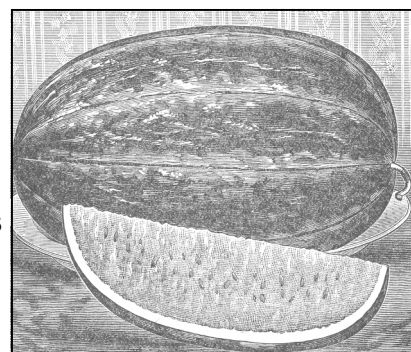
Melon, various

Melons are not particularly recommended for beginning gardeners. They take a lot of space, need to be started indoors (they require a lot of heat to germinate), and are often not very productive in zone 4 (southern Wisconsin). However, they can be fun when they work out. Melons are very cold sensitive and will not develop flavor without warm conditions. Transplants are often planted into **plastic mulch**, which helps to provide the heat they like.

Melons can be grouped broadly (and unscientifically) into two categories: sweet and non-sweet melons.

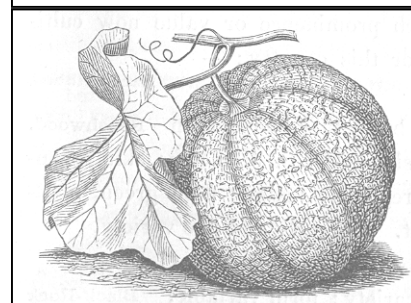
There are several common types of sweet melons, all of which are eaten fresh:

1) Watermelons – Watermelons come in many varieties. Food stores most often sell large, oval, green-and-white-striped melons with red flesh, but smaller, round varieties with red, yellow, or orange flesh are once again becoming popular (there are even blue watermelons). Smaller varieties can be good for home gardens because the plants may take up less space and the fruits mature faster. The large varieties (often called “Crimson” or “Crimson sweet” varieties) can be crisper and sweeter, however. It can be hard to know when a watermelon is ripe – read more about this online or in a book if interested (see **resources for more information**).



A large, crimson-type watermelon (above) and a cantaloupe (below).

2) Cantaloupes – A ripe cantaloupe has sweet orange flesh that tastes very different from watermelon. There are both large varieties (30 cm or 12 in across or larger) and small ones (about 10 cm or 4 in). Many cantaloupe varieties become tan in color and slightly soft when ripe.



3) Muskmelons – Muskmelons are sweet and pale green inside when ripe.

There are also several types of non-sweet melons, some of which are eaten fresh (when young) or cooked (when larger). These are all Asian in origin, though are they becoming more popular in the United States.

1) Bitter melon – Also called bitter gourd, foo gwah, and karaila (among many other names), bitter melons are very intensely bitter – too bitter for some eaters. The plants need very warm weather to germinate and are often started inside and then transplanted outside. Unlike most melons (which do well on flat ground), bitter melon does best growing up a trellis (a wood or metal structure that you build right over the plants), which can make it better for small gardens than other melons. Harvest fruits when they are still young and soft to the touch. Used for salads, soups, and stir-frying.

2) Pickling melon – Pickling melons look like cucumbers but have denser, thicker flesh. They are used either pickled or in salads. Harvest when they become smooth cylinders about 18 cm (7 in) long.

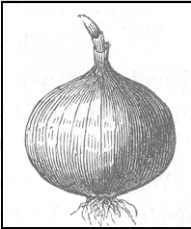
3) Winter melon – Also called wax gourds or tung kwa (among many other names), winter melons are fast-growing melons that can get very large (up to 20 kg, or 40+ lb). Small fruits are green and hairy, but mature fruits lose their hairs, become pale green or white (depending on the variety), and develop a waxy coating that helps them store well into the winter like winter squash. The plants produce long vines with large leaves and need a lot of space on the ground. The plants are eaten much like a winter squash.

Okra

Okra needs warm soil to germinate and emerges from the soil slowly but then grows well. Make sure to thin plants and weed or mulch, as okra does not compete with weeds. Okra will flower about 60 days after planting, and pods appear within a few days of flower opening. Harvest pods when less than 8 cm (3 in) long, as larger pods are tough. Harvest every 1-2 days to keep plants producing. Can be eaten boiled, fried, and in soups and stews. Also good pickled. Okra lovers may wish

to grow this on **plastic mulch**, as the plant benefits from the added heat.

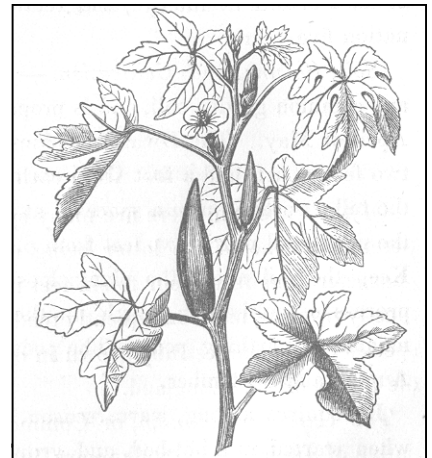
Onions



A representative onion with its top removed.

Onion varieties vary greatly in flavor, shape, size, days to maturity, and end use (fresh, pickling, storage, etc.) — make sure you choose varieties that match what you want (some onions do not store well at all, for example, while others store for months). Can be grown directly from seed in the garden, but are very commonly grown from transplants called “sets,” which are readily available in garden stores and through the mail, and which may more reliably produce large onions. Sets look like very

small onions. Onions compete poorly with weeds — they must be weeded thoroughly and often (especially if grown from seed) or mulched to keep down weeds. To plant an onion set, you can simply push the set into the soil with your finger (if your soil is soft) or make a small hole with a stick, put the set in, and push the soil in around the set with your fingers. If you grow onions from seed, they grow very slowly at first and you must be patient. Do not plant seeds or sets too deeply! Onions need good soil fertility — make sure to fertilize the planting bed as discussed under **fertilizer**.

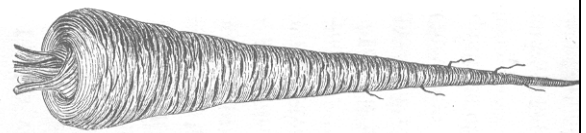


An okra plant with flowers and fruits of various sizes.

Parsnip

Read the carrot crop page for some tips on planting parsnips. Though closely related to carrots (parsnips look like white carrots), parsnips have a very different flavor, rich and nutty (if you like carrot cake, try a parsnip cake sometime!). Parsnips germinate and grow very slowly, so they must be planted early and (unlike carrots) will take up

space in the garden all season long. Water regularly and thoroughly. Harvest after frost or (better) leave them in the ground over the winter and eat them in the spring.



A parsnip with its leaves removed. Parsnips look like carrots except that they are tan or white, not orange.

Peas

There are many different kinds of peas, but most can be grouped as either shell peas (sometimes called “snap” peas) or edible pod peas. Shell peas should be picked when pods are full-looking but not swollen-looking. Take the peas out of the pods and discard the pods. Edible pod peas should be picked when peas are still very small.

You can eat the pod and the peas together. Peas (and/or pods) can be eaten fresh, used in cooking,

or frozen. Peas are easy to grow but **MUST** be given a trellis (a wood, string, or metal structure that you build right over the plants) to grow on. Peas are generally a spring-only crop. They can be planted before frost (in April, for example), but they will often fail to produce pods if planted in hot weather. Peas can also be grown (even during hot weather) as an edible salad green. To do this, seed them very densely (1 seed every 1 cm/0.4 in) and cut the greens off 2 cm/1 in above ground with a knife when they are about 15 cm/6 in tall. Mix with lettuce for a fine salad. Greens will regrow and can be cut again a couple of times.



A group of impossibly prolific pea plants from an old gardening manual.

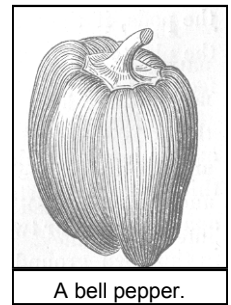
Peppers

Peppers are almost always transplanted into the garden after all danger of frost has passed. Unlike most plants, you should put pepper transplants into your garden substantially deeper (5 cm/2 in, or even more if the plants are very tall) than they sat in their original pots or plastic trays — they will grow roots from their stems and end up healthier than they would have been otherwise. There are many different kinds of peppers that need different kinds of peppers. See the **CP** for a discussion of pepper varieties and more tips on growing peppers.

An introduction Peppers are not hard too hard to grow, but can be more difficult than tomatoes. They grow slowly and need very warm weather to do well, especially when they're small. Mature plants are smaller than tomatoes, so they can fit well into even small gardens.

Information about different kinds of peppers There are three main types of peppers. It is important to know which of these you want to grow before you go to a garden store or farmers' market looking for plants. The types are:

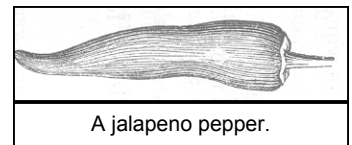
Large, sweet peppers (often called bell peppers) – These peppers can get very big given good growing conditions, perhaps fist-sized or even larger. They tend to be more or less square, and heavy with thick walls. Most varieties of these peppers used to be green, but breeders have now produced varieties that turn red, orange, or yellow. These varieties tend to be sweeter than the green varieties, but they can take a long time to turn color (they start out green) and can be damaged by pests or diseases before they do. If you are having pest problems partway through the growing season, or if you are impatient to eat a pepper, bell peppers (including the brightly colored varieties) can be harvested and eaten at any size, though it can be a waste to harvest them when they are small. Bell peppers are sweet and mild and can be used in salads or almost any other fresh or cooked dish. Most varieties of bell peppers have the word “bell” in their names. You can try the varieties that promise to get brightly colored, but green bell peppers can be more reliable.



A bell pepper.

Medium-sized sweet peppers -- These are varieties that are sweet, smaller than bell peppers, and either green, yellow, or red when mature. They vary in shape, though many of them are wide at one end and taper to a point at the other end. These are often used for frying. Common varieties of sweet peppers include sweet banana (which becomes first yellow and then sometimes red when ready), and pimientos (which are green or red when ready).

Smaller, hot peppers – There are many, many types of hot peppers. Most of these are small (some smaller than your little finger), and some are so hot as to be almost inedible. Most hot peppers do not achieve their full heat until they are ripe. In some varieties ripeness is indicated by a color change (hot peppers can be yellow, orange, red, and even black or purple when ripe), and in some cases the peppers stay green but just stop growing. The shape of hot peppers is quite variable. Some are small and round like cherries, while others are long and thin like beans or somewhere in between. Hot peppers are popular in some world cuisines, but should be used with caution by inexperienced growers and cooks. Hot peppers are often dried (see **resources for more information** for where to learn more about drying). Common varieties of hot peppers include, from mildest to hottest: Anaheim (green to red when ready, warm but o.k. for many eaters), poblano (green to red when ready), jalapeno (blackish green to red when ready), serrano (green to red when ready), cayenne



A jalapeno pepper.

(green to red when ready), tabasco (green to red when ready), and habanero (very small, green becoming orange when really ripe, *dangerously* hot!).

Information about pepper planting dates Peppers have *no* frost tolerance and must be protected carefully if they are planted while there is still risk of frost (see ***season extension techniques***). It's safest to wait until all risk of frost has passed (late May or early June, in much of the upper Midwest) before planting peppers. You will probably not want to plant peppers after July 1, as many peppers planted after this date won't mature fully or produce much fruit before frost.

Plant as seed or transplant? Peppers require a lot of heat to germinate. They also grow very slowly, especially when they're small, and the period of warm weather in the upper Midwest is too short to allow them to reach their full potential unless they're started indoors well before the last frost. As a result, most gardeners purchase their plants at local garden stores or farmers' markets, which should make the plants available at (though sometimes before!) the time when it's safe to plant them outside. Pepper plants can carry a number of diseases, so make sure to buy plants that are all green, with no limp or yellow leaves.

Preparing for planting Peppers *must* be planted in full sun—they don't like shade at all! Like most vegetables, tomatoes do best in relatively loose ***soil*** rich in organic matter. If you don't have soil like this, you'll want to work in some compost, composted manure, or another ***soil amendment*** a week or more before planting into the bed(s) where your peppers will be planted.

Many growers use plastic mulch for their peppers because the plastic can increase yields, reduce disease, and give you an earlier crop with little or no weeding. See ***laying and removing plastic mulch*** for tips on putting in plastic mulch. You can lay plastic on the same day you plant, or you can put the plastic in as much as a week or two earlier. You do not need to use plastic to have healthy, productive peppers, but if you don't you will want to mulch with something else (leaves, straw, cardboard, etc.) to prevent weed problems and conserve moisture.

On the day of planting, you should have some ***tools*** (a trowel and a hose connected to water), and some organic ***fertilizer*** handy.

Plant spacing It's tempting to plant peppers too close together because they're small when you transplant them. If you do this, your plants will compete with each other for light, water, and nutrients and/or grow into each other such that harvesting is difficult. Bell and sweet peppers get larger than hot peppers and should be planted farther apart (60 cm/24 in for bell and sweet peppers, 45 cm/18 in for hot peppers). Put the rows about the same distance apart.

How to plant See ***transplanting*** for the basics. Peppers need a lot of fertilizer -- use about 125 ml (1/2 cup) of a standard organic ***fertilizer*** for each plant. Note that peppers (like tomatoes and eggplant, but unlike most other plants) can be transplanted very deeply such that part of the stem of the plant ends up underground. The part of the stem that goes underground will produce roots and make for a stronger plant.

Care after planting Once your peppers are planted, they don't need much care besides occasional ***watering*** if the weather is very dry (one thorough watering a week should do if it has not rained). If you have used plastic mulch, you may not need to weed at all. If you haven't, you will want to weed around the plants thoroughly until mid-June and then ***mulch*** with something else (leaves, straw, newspapers, etc.).

Pest problems Peppers do not have a lot of pest problems, but aphids (small, green insects that suck plant sap) can sometimes establish themselves on the undersides of leaves (see ***pests*** for pictures and suggestions for how to deal with them). Peppers do suffer from a number of diseases. If

you smoke, wash your hands before touching peppers, as tobacco can carry these diseases. Buying healthy plants (and avoiding overwatering, which can encourage disease) is the best protection you can get.

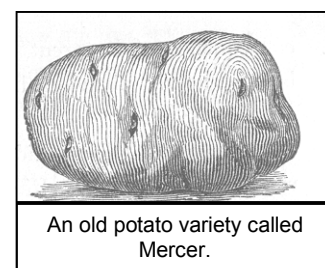
Harvesting As mentioned before, bell peppers and sweet peppers can be harvested at any size, though you will get the most from your plants if you wait until the fruits are at least 8-10 cm long (3-4 in). Bell peppers are green at maturity unless you've planted a variety that is supposed to turn red, yellow, or orange. Fruits should break easily off the plant when they are ready, but cutting them off with a knife or scissors is less likely to damage the plant. Most hot peppers are harvested when they are red, though a few become yellow, black, orange, or other colors.

Post-harvest handling and storage Peppers can be stored on a countertop for several days, but unlike tomatoes, they can also be stored in your refrigerator for up to two weeks. Do not store them in a plastic bag, as this will cause them to rot. Wash peppers just before you cook with them (washing them earlier removes a natural layer of wax that protects them from drying out). All types of peppers can be dried (see **resources for more information** for tips on where to learn more about this) or frozen (chop them into small pieces, put them on a tray in your freezer for several hours so they freeze without sticking to each other, and then put them in freezer bags for long-term storage). Hot peppers are often dried by putting them in strings, or *ristras*, that are hung in kitchens and used pepper by pepper. To make a ristra, take a needle and pass thread through the stems of your peppers to make either a chain or a loop. Always be careful when handling hot peppers, making sure not to touch your face (especially your eyes). Washing your hands with a mixture of water and lemon juice can help to remove the hotness of hot peppers.

At the end of the season Most pepper varieties keep producing until they are hit by frost, which kills them. At that point, pull the plants out and **compost** them. Pull up and throw away your plastic mulch if you have used it. Either plant a cold-tolerant crop like spinach in the bed(s) the tomatoes were in or get the bed(s) ready for winter (see **the garden through the season**).

Potato, “Irish”

Potatoes are easy to grow, though they can have some disease and pest problems. Potatoes are not grown from seed, but from the roots themselves (also known as “seed potatoes,” tubers, or sets). To grow potatoes, buy seed potatoes from a garden store or seed supplier. You can use potatoes from the grocery store if they have begun to sprout, but the varieties you find there may not be suitable for your area. There are hundreds of potato varieties out there that are fun to experiment with. To prepare for planting, cut the larger potatoes up such that there are at least 2-3 “eyes,” or dents, in each piece (these “eyes” are the places from which roots and shoots will emerge, if they haven’t already started to do so). Each piece of potato you end up with should also be at least 5 cm (2 in) thick. Small potatoes will not need to be cut. Allow the cut pieces to sit out of direct sunlight for at least a day (and up to 10 days) so that the cut faces can seal over. Prepare a **bed** of the desired size in your garden using **soil amendments** and some **fertilizer**, then dig shallow trenches 3-10 cm (1-3 in) deep and 30 cm (12 in) apart. Put the seed potatoes about 30 cm (12 in) apart in the trenches, pressing each one firmly into the soil. Fill in the trenches. If you have straw, **mulch** the plants with 5-10 cm (2-4 in) of straw immediately after planting. If you only have dried leaves for mulching, wait to mulch your potatoes until the first potato leaves emerge, then mulch around them (the potato leaves may not be able to push through your leaf mulch if it is wet and dense). Mulching with either straw or leaves holds water in the soil and can greatly reduce weeding.



An old potato variety called Mercer.

You can dig small “new” potatoes within a month after the leaves emerge from the ground, but

you'll get a much larger harvest if you wait until the plants die in August or September. Use a pitchfork or spade to dig carefully for potatoes.

The simplest way to store potatoes is just to leave them in the ground and dig a few out at a time as you need them. They will keep all winter this way. They will also keep at room temperature (18-21 C/65-70 F) for multiple weeks, but after a few weeks they may start to sprout (grow roots and leaves). Potatoes that have started to sprout can still be eaten – just pull the sprouts off and cut the potatoes up. For longer storage indoors, Potatoes should be kept in a cool (4-10 C/40-50 F), dark place with good air circulation. DO NOT store potatoes in the refrigerator, as it will make them taste bad. Potatoes exposed to light will begin to get green. You can peel off the green skin and eat the potatoes, though they may be a little bitter. If you have harvested a lot of potatoes and have no good place to keep them inside, you can dig a hole at least 60 cm (24 in) deep in your garden, line it with straw, and put the potatoes in it (covering them first with straw and then soil) until you want to dig them out and eat them. Again, they will store all winter long this way.

If you want to, you can harvest potatoes and plant your crop for the next year at the same time. If you wait to harvest until late September (or as late as November), prepare a potato planting bed and plant and mulch as described above, but put the potatoes deeper in the ground (10-15 cm/4-6 in). The potatoes will be fine through the winter. If possible, make sure to plant in a place where you have not had potatoes, tomatoes, eggplant, or peppers for several years.

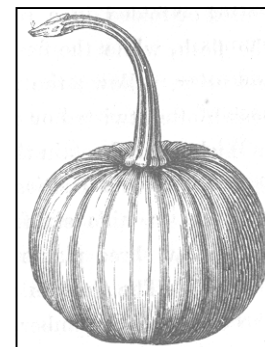
Potato, sweet

Perhaps not a crop for the beginning gardener, but fun if they work out. Sweet potato roots (or “tubers”) look somewhat similar on the outside to standard “Irish” potatoes, but they are orange on the inside and taste very different (sweet!). The plants that produce sweet potatoes are vines more closely related to morning glories (a common weed) than “Irish” potatoes. Unlike potatoes, sweet potatoes are not cold resistant and must be planted after all danger of frost has passed. They grow slowly and are usually planted as transplants known as “sprouts” or “slips” (available from some stores and mail-order companies; you can start your own if you look for instructions online). They do best when planted into plastic mulch, which provides extra heat, as can row covers. Flea beetles can be a problem (**floating row covers** can keep them away), as can mice. Harvest just after first frost, removing vines (and plastic, if used) before digging potatoes. Dig with care as the skins are easily damaged. Store in a warm room (>22 C/70 F) for a week, then store in a cooler place (but above 10 C/50 F — do not refrigerate!).

Pumpkin

Pumpkins are not particularly recommended for small gardens because of the plants' size (they MUST be planted at least as far apart as specified in the “quick reference guide to vegetable planting”) but they are not difficult to grow and are fun for children. Pumpkins are closely related to winter squash and to other vining crops like cucumbers. They are also grown very much like winter squash – see the winter squash crop page for more information.

Pumpkins can be eaten cooked, either boiled, steamed, baked, or microwaved – see the winter squash crop page for brief notes on how to bake them. Large varieties grown for carving at Halloween tend not to be flavorful and don't store well. Smaller traditional varieties are better for eating on their own, for use in pies, and for storage (these varieties are only about 20 cm/8 in across and feel very dense). Most pumpkins turn orange when they are mature and develop a hard rind that resists pressure. In general, harvest pumpkins after the first frost kills the vines but before a hard frost (they may have turned orange before the first frost, but will store better if left outside for a while). Cut stems of mature pumpkins

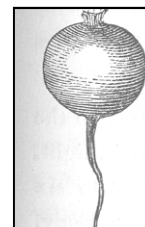


A small, sweet pumpkin intended for cooking rather than for Halloween.

about 5 cm (2 in) from the pumpkin. Store pumpkins in a warm, well-ventilated room to dry (or “cure”) for about a week, then store in a dry, cooler place (12 C/55 F) for up to 6 months, checking regularly for soft rotting spots.

Radish

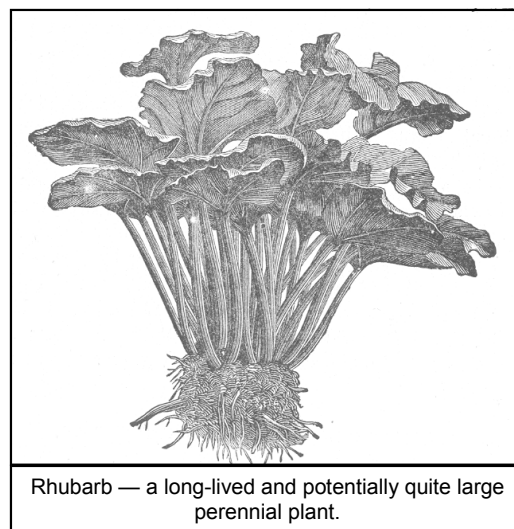
There are many diverse kinds of radishes. Some are as small as grapes, while others are as big as soccer balls or as long as a baseball bat. Some varieties are very mild, while others are intensely spicy. Small, mild, red-and-white radishes are most common in the US, though daikon (a large, white, spicy Japanese type) and others are getting more common. Radishes are a cool-season crop and do best in the spring, though you can grow them all season long (in multiple successive plantings) if you always water them well. Radishes will get woody and bitter if not watered. In general, harvest radishes as soon as decent-sized bulbs form—radishes will begin to split otherwise. Remove tops and store refrigerated in a plastic bag with a dry paper towel. Most radishes are eaten fresh and do not store well, though there are some large Asian varieties (and western “winter” varieties) that are pickled or stir-fried and can be stored for weeks or months (they will keep for several weeks in the ground after a frost, and can then be kept indoors in a cool place for weeks or months).



A standard, pinkish-red, globe-shaped radish.

Rhubarb

A perennial of which the leaf stems are eaten. *Do not* eat the leaves themselves, which can be toxic. The stems are very acidic and are almost never eaten raw. Stems are usually cut up and mixed with a sugar to make sauces and pies. Almost always grown from roots rather than from seed. Do not harvest the year of planting. Harvest for 1-2 weeks during the spring of the second year (removing some but not all of the stalks just above ground level with a sharp knife), then 8-10 weeks in the spring of the third year and following years. Plants can remain healthy for many decades, but as the plants grow they can crowd themselves. Many gardeners choose healthy, large plants that are 5-10 years old, dig them up in the spring, and cut the roots into pieces that they then use to start a new planting.



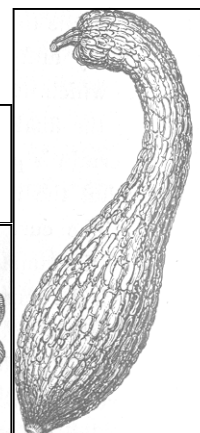
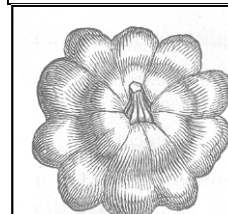
Rhubarb — a long-lived and potentially quite large perennial plant.

Squash, summer (includes zucchini, yellow squash, pattypan, and others)

Summer squash are grown very much like winter squash – see the winter squash crop page for more information. Though related to vining plants such as cucumbers and winter squash, most varieties of summer squash produce only short vines or no vines at all. This can make them more appropriate for small gardens than are winter squash.

Summer squash, also called marrows, have their name because they produce fruit that are harvested during the summer, while they are still immature, rather than after frost. The fruits are highly variable. Pattypan (or “patty pan”) varieties are white, yellow, or greenish, flattened, and have scalloped edges. Yellow squash (also called “crookneck” or “straightneck” squash, depending on the shape of their stems) are longer, somewhat pear shaped, and either smooth or warty (and, of course, yellow). Zucchini are green and usually cylindrical. All are

A yellow crookneck squash (right) and a pattypan (below).



mild-flavored and are usually eaten cooked. The plants are very productive, though some varieties are vulnerable to viral and fungal diseases (especially in cold, wet weather) that kill the plants quickly. Can be seeded or transplanted—use of transplants may be necessary if you have problems with cucumber or flea beetles, which can eat the young plants to death. Fruits mature quickly and plants should be harvested often to encourage continued production. Harvest fruit when fairly small (no more than 20 cm/8 in long, or 12 cm/5 in across for pattipans). Large fruits are woody with overly large seeds and are not often eaten (with the exception of large zucchini, which are grated and used in desserts such as chocolate zucchini cake). Summer squash do not keep very well and should be kept at room temperature for only a few days or in sealed containers in the refrigerator for no more than a week.

Squash, winter

Winter squash are not particularly recommended for small gardens because of the plants' size – some plants can send vines out that are 8 m (25 ft) long or longer – but if you have the space for them, the plants are not very difficult to grow. There are many hundreds of varieties of winter squash that vary in size, flavor, texture, sweetness, productivity, and storage properties. Some can be stored from harvest until the following May, while others keep for no more than a month after harvest. In general, the larger squash with the thicker rinds are the ones that keep best.

Described below are some types of winter squash that are common in the United States. Note that fruit size, flavor, and storage capability can all vary depending on how you grow the squash and the temperature at which you store them.

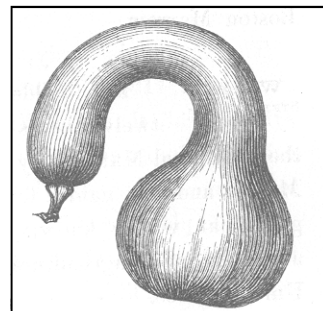
- **Acorn** – With butternut, one of the two most widely grown winter squash. Acorn squash are shaped somewhat like acorns with their caps removed, with ribs that stick out all around the fruit. Fruits are dark green when mature (except for some new varieties that are golden). Compared to most varieties of winter squash, acorn squash are fairly small. They can be very good on occasion, but are not one of the most flavorful squash. They store reasonably (2-3 months).

- **Butternut** (also called crookneck) – With acorn, one of the two most widely grown winter squash. Butternut squash are tan and usually have at least a short “neck.” Arguably better-tasting than acorns, with a pleasant nutty flavor, they are still not one of the most flavorful squash. Fruits vary in size – some are small, some quite large. Large butternut squash store better than most other squash (2-5 months).

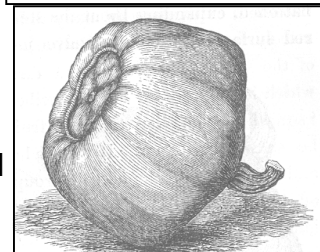
- **Buttercup** (also called kabocha; includes the related types amercup and autumn cup) – Buttercup squash are shaped like flattened soccer balls. They are green, sometimes with lighter stripes (except for amercup, which is orange). Often a very flavorful squash. Some fruits are small, but the larger ones can be more flavorful. Buttercup squash have a small point that sticks out the bottom. Buttercup squash can store quite well (3-4 months) if they are not injured (a common injury involves breaking the point off). Amercup stores particularly well.

- **Carnival** (and the related types Festival and Sweet Dumpling) – Carnival and related types are cream-colored with highly variable streaks of orange and green. They are often very sweet and not very large. They do not store very well (1-2 months at most).

- **Delicata** – Delicata squash are small cylinders, white to yellow with greenish stripes. They are among the most sweet and flavorful of squash, and they cook quickly because



Above, a butternut squash, also called a crookneck. The neck is usually not this long or this bent. Below, a buttercup squash.



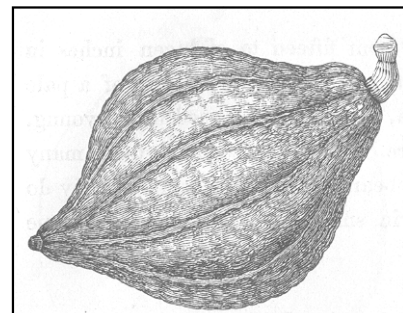
they have thin walls. They store poorly, however (1-2 months at most).

- Calabasa (also spelled calabaza) – Calabasa squash are common in Latin America, the Caribbean, and the Philippines, but are not yet as widely grown in the U.S. as they should be. The fruits are large (often larger than a basketball), and can be either green, tan, or reddish-orange. Calabasa are sweet and a little nutty, but do not store very well (1-2 months).

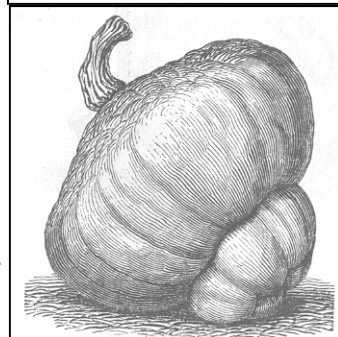
- Hubbard – Hubbards are one of the oldest types of squash still grown. Traditionally, hubbards were very large (fruits weighing more than 10 kg/22 lbs are not uncommon), but there are now much smaller varieties available. Hubbards can be blue, gray, green, or red, sometimes with stripes. Hubbards are very flavorful but also dense, and they cook slowly (most cooks cut them up into many small pieces for steaming or baking). They store very well (up to 6 months), but storage is best if the stem is cut down very close to the end of the squash.

- Spaghetti – Spaghetti squash are oval-shaped and tan or a pale yellow. They have very little flavor of their own, but when cooked they break into spaghetti-like strands. They do not store very well (1-2 months).

- Turban (also called Turk's turban or Terk's turban) – Turban squash look like turbans (they also look like acorns with their caps on). Turban squash are not so flavorful as other related squash (like buttercup), but turbans can be beautiful colors (with a red cap and green, white-striped bottom, for example) and are often used for decorating. Like buttercup, they can store well (3-4 months).



Above, a hubbard squash, one of the largest and tastiest of all squash. Below, a turban squash.



Plant winter squash (and pumpkins and summer squash) as described in the “quick reference guide for vegetable planting,” making use of the following additional information. Whether seeding or transplanting, you *must* wait until all danger of frost has passed. Winter squash will not germinate in cold soil, and they cannot tolerate frost, so you must wait to plant them until frost is past *and* the soil has begun to warm up (late May or early June in the upper Midwest). Whether you use seed or transplants, you will want to have ready a good amount of organic **fertilizer** (60 ml or ¼ cup per plant), and possibly a **floating row cover**. Use of fertilizer increases yield of these plants, which need a lot of nutrients. Work the fertilizer into the soil right around where you are going to plant the seeds or transplants. A floating row cover may be necessary, as cucumber beetles (see **pests**) can eat your young squash to death unless you protect them. You can put the row cover on immediately after planting, or you can wait and see if cucumber beetles attack your squash, covering them only if the beetles seem to be eating them. Either way, make sure to leave slack row cover over the plants or seeds so that they have room to grow. Uncover the plants once they have a fair number of leaves – the cucumber beetles shouldn't be able to harm them at this point, and the plants flowers need to be exposed so that insects can pollinate them.

After you have uncovered your squash (assuming you used a floating row cover), you won't need to do much until harvest time. When mature, most winter squash develop a hard rind that resists pressure; many varieties also develop an orange spot where the squash has rested on the ground. While squash may appear to be ripe as early as August, they will store longer and taste better if you let them sit outside through at least one frost (one or more nights with temperatures below 0 C/32 F). Do harvest the squash before you get a hard frost (a night with temperatures below -4 C/25 F). To harvest the squash, cut the stems with a knife or garden clippers about 5 cm (2 in) from the fruit. Store the fruit in a warm, well-ventilated room to dry (or “cure”) for about a week, then store in a dry, cooler place (12 C/55 F). As noted above, some varieties store much better than others; pick up and check each of your stored squash regularly for soft rotting spots.

All winter squash are typically eaten cooked, either boiled, steamed, baked, or microwaved. To cook all but the largest varieties of winter squash, cut the squash in half, scoop out the seeds (which can be discarded or roasted and eaten), and put the halves open side down on a greased baking tray with a raised edge. Bake at around 175-200 C (350-400 F) until you can stick a fork into the squash easily (about 20 minutes for small varieties like acorn and delicata, but up to an hour or more for larger varieties). The largest squash varieties (calabasa, hubbards) are usually cut up into multiple small pieces before cooking.

Tomato

An introduction Tomatoes are very popular and not hard to grow, though some simple steps can make plants much more productive. To help would-be tomato growers, this entry on tomatoes is long.

Information about tomato varieties As with other crops, each tomato variety is either a variety bred in modern times (often a hybrid, the offspring of two very different varieties) or a traditional, open-pollinated variety (often called an “heirloom”). See ***hybrid vs. open pollinated plants*** for a discussion of the benefits and drawbacks of each. Within each of these two large groups, there are several importantly different types of tomatoes: 1) slicers (large, fairly round tomatoes, often red, with a high water content, for use in sandwiches, etc.), 2) Roma, plum, or paste tomatoes (smaller, oval, with a lower water content, useful for drying or making tomato paste), and 3) small, bite-sized tomatoes of varied colors, shapes, and flavors, including yellow pear tomatoes and red cherry or grape tomatoes (good for eating whole, like grapes). It’s good to know which of these you want before you plant!



A traditional or “heirloom” tomato variety known as “Delicious” whose fruits can reach up to 3 kg (6 pounds). As its shape suggests, Delicious is a slicing variety.

Every tomato variety is also either *determinate* or *indeterminate*. Determinate tomato plants grow to a certain size (about 1.2-1.5 m, or 4-5 ft) and then stop growing. All of their fruit becomes ripe in a short time window, usually about 2 weeks, and then the plants begin to die, producing *no additional fruit*. Indeterminate tomato plants, by contrast, grow from the time you plant them until they are killed by frost, and can reach heights of 2-3 m (6-10 ft) if they are supported. They produce and ripen new fruit steadily until frost.

Both indeterminate and determinate tomatoes need to be caged or staked, even so-called “dwarf” varieties (see below under “growth and care”). Most (but not all) modern hybrid varieties are determinate, including most large red slicing tomatoes and most Roma or “paste” tomatoes. Most (but not all) traditional or “heirloom” varieties are indeterminate. Most (but not all) cherry tomatoes are indeterminate and can grow very, very tall. *Before you plant a tomato, find out if it is indeterminate or determinate! Many people are disappointed when their determinate tomato plants die in July or early August, even though it’s completely natural.*



Roma or paste tomato (above); yellow pear tomato (below).

Information about tomato planting dates Tomatoes have *no* frost tolerance and must be protected carefully if they are planted while there is still risk of frost (see ***season extension techniques***). It’s safest to wait until all risk of frost has passed before planting tomatoes. Many growers plant a first planting of determinate tomatoes as early as possible, then put in a second planting of indeterminate tomatoes 4 to 6 weeks later. The determinate tomatoes will yield a large amount of fruit quickly (good for summer canning, freezing, and eating), after which they stop producing and can be removed to make space for other crops. The indeterminate tomatoes start producing soon after and keep going until frost. You will probably not



want to plant tomatoes after July 1, as many tomatoes planted after this date won't mature fully or produce much fruit before frost.

Plant as seed or transplant? Almost all growers use tomato transplants, either ones they have grown themselves or purchased. Most garden stores and farmers' markets sell tomato seedlings during the planting season. If you are interested in starting your own tomato plants from seed, see ***starting plants inside*** in the glossary.

Preparing for planting Tomatoes *must* be planted in full sun—they don't like shade at all! Like most vegetables, tomatoes do best in relatively loose **soil** rich in organic matter. If you don't have soil like this, you'll want to work in some compost, composted manure, or another **soil amendment** a week or more before planting into the bed(s) where your tomatoes will be planted.

Many growers use plastic mulch for their tomatoes because the plastic can increase yields, reduce disease, and give you an earlier crop with little or no weeding. See ***laying and removing plastic mulch*** for tips on putting in plastic mulch. You may want to use plastic for all of your tomatoes, or you may do it only for your early planting of tomatoes (the extra heat from the plastic helps when the weather is still cool). You can lay plastic on the same day you plant, or you can put the plastic in as much as a week or two earlier. You do not need to use plastic to have healthy, productive tomatoes, but if you don't you will want to mulch with something else (leaves, straw, cardboard, etc.) to prevent weed problems.

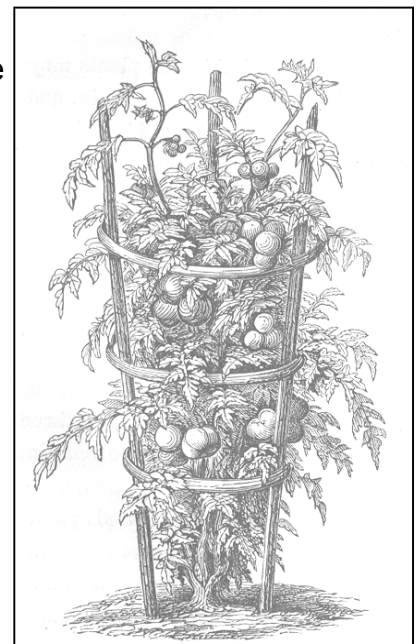
On the day of planting, you should have some **tools** (a trowel and a hose connected to water), and some organic **fertilizer** handy.

Plant spacing It's tempting to plant tomatoes too close together because they're small when you transplant them. If you do this, your plants will compete with each other for light, water, and nutrients and/or grow into each other such that harvesting is difficult. Most tomato varieties should be planted at least 60 cm (2 ft) apart, and 90 cm (3 ft) is better. Cherry tomatoes should be planted 1.2 m (4 ft) apart.

How to plant See ***transplanting*** for the basics. Tomatoes need a lot of fertilizer -- use about 125 ml (1/2 cup) of a standard organic **fertilizer** for each plant. Note that tomatoes (like peppers and eggplant, but unlike most other plants) can be transplanted very deeply such that part of the stem of the plant ends up underground. The part of the stem that goes underground will produce roots and make for a stronger plant.

Care after planting Once your tomatoes are planted, they don't need much care besides caging or staking and perhaps occasional watering. If you have used plastic mulch, you may not need to weed at all. If you haven't, you will want to weed around them thoroughly until mid-June and then **mulch** with something else.

All tomatoes should be caged or staked and tied beginning shortly after transplanting. Cages are simplest and work well, but **ONLY IF** you buy or make cages that are tall enough and strong enough to hold up a mature tomato plant. The short, narrow wire style (about 60 cm or 2 ft tall, with three little pieces you stick into the ground) sold in many lawn and garden stores is **completely useless** for most common tomatoes. Though you can buy good cages, the best cages are homemade wire cages made of concrete reinforcing wire or woven-wire stock fencing. If made properly, these can be used for many years (and you can store them in the garden over the winter). Find some heavy duty wire fencing



A tomato in a wooden cage. Most cages today are made of wire but look similar to this one. Caging tomatoes improves their yield and reduces problems with disease, rodent damage, and water damage.

at a hardware store with holes big enough to let you reach through for harvesting. Buy a roll about 8 m (25 ft) long and at least 1.2 m (4 ft) high (together with a good pair of wire cutters and a roll of thinner wire), cut it into pieces long enough to make cylinders 60 cm (2 ft) wide, and use thinner wire to bind each cylinder closed. Put a cage around each small tomato plant and anchor it very firmly to the ground with stakes (which can be wood or metal). As the tomato grows, if its topmost growing tip or any of its largest branches are headed out of the cage, you can steer them back in. The plant may grow out of the top of the cage, but most of it will be contained.

Some growers stake tomatoes instead of caging them. Metal stakes are recommended (either steel “t-posts,” used for fencing and available at any hardware store, or concrete reinforcing rod, “rebar,” available at many hardware stores). Any stake used should be 1.8 m (6 ft) long or longer. After planting a tomato you should use a hammer or stone to pound a stake into the ground about 10 cm (4 in) away from the tomato such that at least 45 cm (18 in) of the stake is underground. Every time the tomato grows about 15 cm (6 in), use strong twine or string to tie the main stem of the plant securely to the stake. If the plant has branched or is otherwise spreading out, gather it together gently and tie it up. You may fear that you are going to break the plant when you do this, but tomatoes are tough and will recover if they do break.

If your stakes or cages are too short, too weak, or not anchored well into the ground, they will fall over. A mature tomato plant with fruit is extremely heavy!

If you are planting a lot of tomatoes (4 or more) in a straight row, you can do what’s called “basket weaving.” Instead of tying each tomato plant to its own stake, put a stake in after every second plant (meaning stake, plant, plant, stake, plant, plant, etc., ending with another stake). Then, use string or twine to weave a wall around the plants as they grow, tying it each stake as you pass.

If all of this sounds like too much trouble or expense, then just do whatever you can to keep your tomatoes off the ground (some gardeners build structures with dead branches and string, for example). This will prevent disease and improve yields. If your plants are otherwise healthy, you will probably still get some fruit if you do nothing at all to keep them off the ground.

Water requirements Tomatoes are drought tolerant, but water them thoroughly once a week if it has not rained for more than two weeks (see ***watering***). Do not water more often than this. Over-watering your tomatoes can cause them to produce a lot of extra vegetation without any extra fruit, and it can make the fruit crack.

Weed and pest problems When they’re small, tomatoes don’t compete well with weeds. You should either use plastic ***mulch*** to avoid weeding or weed until the weather is warm and then mulch.

Small-scale gardeners are usually spared severe tomato pest problems, but you might possibly have problems with flea beetles, stink bugs, tomato hornworms, or Colorado potato beetles (see ***pests*** for pictures and control measures). Tomato root nematodes (tiny, wormlike creatures that eat tomato roots) can be kept away by planting marigolds between each of your tomato plants. As tomatoes become ripe, you might also have problems with raccoons, squirrels, slugs, and other creatures. See harvesting, below, for suggestions on dealing with this. Tomatoes do suffer from a number of diseases. If you smoke, wash your hands before touching tomatoes, as tobacco can carry these diseases.

Harvesting Vine-ripened tomatoes are wonderful to eat, but for many reasons it can actually make sense to pick tomatoes before they are fully ripe. Ripe tomatoes are very soft, for example, and are easily damaged during picking. Ripe tomatoes are also very attractive to pests like raccoons and ground squirrels, and it’s common to find that all of your ripe tomatoes on the vine have one or more bites taken out of them.

To prevent these and other problems, you may choose to harvest your tomatoes when they are *beginning* to get ripe (if it’s a red variety, this is when they’ve turned orange; you’ll have to experiment with varieties that are pink, yellow, purple, or other colors when ripe). Harvest a tomato by pulling

gently on the tomato and twisting at the same time. Once you've removed the tomato, gently remove the stem from the tomato if possible, since it will poke holes in other tomatoes if you put it in a bag or box. If you are harvesting many tomatoes at once, be sure not to stack them more than two deep — even unripe tomatoes are easily bruised. Make sure to let your tomatoes start the ripening process on the vine — they have to get at least a little bit ripe before you pick them, or they may never ripen at all.

There are many recipes that call for green tomatoes, and you may want to try some of these out. The other time to pick green tomatoes is when the first fall frost is approaching. This is a time when many growers pick all of their tomatoes and put them on trays indoors, hoping that some of them will get ripe.

Post-harvest handling and storage To begin with, NEVER PUT TOMATOES IN THE REFRIGERATOR! (except, perhaps, one you have partially eaten). Refrigeration keeps tomatoes from ripening, and while you might think that would be good, it quickly changes their flavor and can make them spoil.

If you have harvested ripe tomatoes, leave them on a countertop, plate, or windowsill indoors, and eat or process them within a few days. You can buy inexpensive electric food dryers that allow you to convert thinly sliced tomatoes (and other foods) into a form that is tasty, compact, and stores for years without refrigeration. You can also make tomatoes into paste, sauce, salsa, and many other forms that can be eaten fresh or canned. See **resources for more information** for information on canning and drying.

If you have harvested not-quite-ripe tomatoes as discussed above, set them on a plate or tray or windowsill and wait for them to get ripe. Check them often, since they can go sometimes go from underripe to soft and rotting in just a few days.

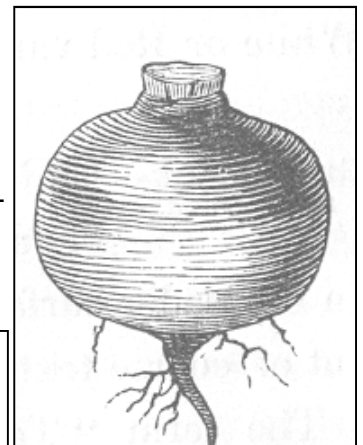
At the end of the season When your tomato plants die (either because they are determinate varieties that are genetically “programmed” to die midseason or because they have been killed by frost), they should be fairly easy to pull up. Put them in the **compost** pile. If you have used cages or stakes, clean the cages or stakes off and leave them stacked in the garden over the winter (if theft is not an issue) - the cold can help by killing disease-causing organisms. Pull up and throw away your plastic mulch if you have used it. Either plant a cold-tolerant crop like spinach in the bed(s) the tomatoes were in or get the bed(s) ready for winter (see **the garden through the season**).

Turnip

Turnips and rutabagas are closely related to cabbage (rutabagas are actually a hybrid between turnips and cabbages). Both the white, bulblike stalks (which look like roots) and the leaves are edible. Most traditional varieties produce large, dense bulbs that are harvested after the first frost, store several months, and are eaten either baked or steamed (the leaves, called “turnip greens” are usually eaten either steamed or, if small, added to salads with other greens).

Newer varieties of turnips like White Egg and White Lady (and traditional varieties if harvested when small) produce small (5 cm/2 in), mild-flavored bulbs even during the summer that do not store very well but are excellent for eating fresh like radishes. Most varieties are grown either for fresh consumption, for fall harvest, or for greens. In general, store turnips at in a relatively cool (0-4 C/32-40 F) and humid place like your refrigerator's crisper

A typical turnip, pinkish on top and white near the bottom. The leaves (which look like the tops of beets) have been removed.



Resources for more information

Your local public library

Public libraries are a great place to start looking for information about any aspect of gardening. If you have a public library of any significant size near you, it should have a collection of books you can check out. There may also be computers if you need internet access to look up information online, and there are hopefully one or more helpful reference librarians who can assist you in navigating both the book collection and the internet.

Most public libraries in the United States organize their books using the Dewey Decimal System, which organizes all books by subject under numbers ranging from 0 to 1000. Books about gardening in general (including organic gardening) are generally filed around the number 635. Books about related topics are filed elsewhere, though often close to the gardening books (composting, for example, is often filed near 631). Most good libraries have books that cover a lot of related subjects – fruit growing, food preservation (canning, drying, etc.), cooking with your produce, etc.

Web sites with information about various aspects of growing crops

There are many thousands of web sites that contain useful gardening information, and thousands more whose information is of questionable quality. The web sites below are only a few of the better ones out there — use your favorite search engine to look around elsewhere, perhaps with the help of an experienced gardener and/or a librarian to focus your search. As with books (below) do make sure that any web site you rely on for information is a) focused on *organic* methods, and b) provides information about plants, planting dates, etc. that is appropriate for your geographic location. All web addresses are current as of the date on the cover of this manual. Apologies to you if they have changed since then.

Vegetable Planting and Harvesting Dates for Wisconsin

<http://wihort.uwex.edu/fruitveggies/HarvestDates.htm>

Most of the information contained on this page is also included in this manual, but this page serves as one example of the many similar pages put out by federal, state, and local government agencies, as well as companies and non-profit groups. If you live outside of Wisconsin, you should be able to find a similar table for your area.

Vegetable Varieties for Gardeners

<http://vegvariety.cce.cornell.edu/mainSearch/showAllCrops.php>

You know you want to grow tomatoes (or peppers, or cucumbers, or lettuce), but what variety should you plant? This site lists many common varieties, gives brief descriptions of each variety, and includes scores of 0-5 stars submitted by gardeners like you.

Several sites with good quality, thorough information about growing vegetables, herbs, flowers, and fruits

- <http://www.urbanext.uiuc.edu/veggies/index.html> (NOT focused on organic gardening, but one of the best sites around in terms of thoroughness and careful writing)
- <http://www.essentialgardenguide.com/>
- <http://www.usagardener.com/index.php>

Starting seedlings indoors

<http://www.ipm.iastate.edu/ipm/hortnews/1998/1-16-1998/startseed.html>

If you want to grow start plants like tomatoes, peppers, and eggplants indoors in the late winter (NOT necessarily recommended for beginning gardeners), this site is one of many that provides basic, clear instructions.

Books on growing particular crops (and other subjects)

There are many, many good books about gardening available, and it's not really necessary to recommend particular ones – whatever you find at your local public library, garden store, bookstore, or favorite online bookseller is likely to cover the basics reasonably well. As with web sites (above) do make sure that the book you check out, borrow, or buy is a) focused on *organic* methods, and b) provides information about plants, planting dates, etc. that is appropriate for your geographic location.

If you become very serious about gardening, one book in particular that you may want to buy Eliot Coleman's *The New Organic Grower*, which is a fine reference work. Coleman is like a practical Martha Stewart.

Many of the things you can grow in your garden need some preparation in the kitchen. There are thousands of great cookbooks out there, but one that is specifically designed to work with seasonally available produce is the book *From Asparagus to Zucchini: A Guide to Cooking With Farm-Fresh Produce*, by the Madison Area Community Supported Agriculture Coalition.

Seed companies

If you are just getting started with gardening, there's nothing wrong at all with going to your local garden store (or even a good hardware store) and buying your seeds and plants and other supplies there – in fact it's probably the best thing you could do to avoid unnecessary complexity. If you are interested in buying some different plants, however, or you want organically grown seeds and they aren't available in your area, there are many large and small companies across the country doing excellent work to create and preserve our heritage of vegetable, herb, fruit, and flower varieties. A comprehensive listing is impossible here, but a few representative companies are listed below (the exclusion of any company from this list does NOT reflect badly on that company!). Get online and use a search engine to search for terms like "organic seed," possibly adding in the name of your state as a search term, to find companies closer to your home that offer similar products. Most companies will send a paper catalog for free whether or not they support online ordering.

All of the companies listed here are fairly large and ship nationwide, but it's well worth your time looking around for local or regional companies that provide the same products and services – the seeds, bulbs, and other plant materials they sell may be better adapted to your soils and climate than those that come from far away. Supporting local business is always good, too. To find appropriate businesses, look in your yellow pages under terms like "garden," "seeds," "nursery," etc. When you need to buy transplants, you will almost always end up going with a local garden store or farmers' market, since shipping live plants through the mail is an expensive and uncertain business.

Fedco

<http://www.fedcoseeds.com/>

Fedco Seeds, PO Box 520, Waterville, ME 04903

207-873-7333

The only major cooperatively owned seed company, and one of the most dedicated of all to the production and sale of organically grown seeds and plant materials of various sorts. The company also has a branches (no pun intended) that supplies gardening supplies.

Johnny's Selected Seeds

<http://www.johnnyseeds.com/>

Johnny's Selected Seeds, 955 Benton Avenue, Winslow, ME 04901
1-877-564-6697

Supplies a wide variety of vegetable, herb, and flower seeds, as well as some bulbs and other plant materials. Many organically grown products.

Evergreen Seeds

<http://www.evergreenseeds.com/>

Evergreen Y.H. Enterprises, P.O. Box 17538, Anaheim, CA 92817
714-637-5769

Supplies seed of Asian vegetables that can otherwise be hard to find.

Peaceful Valley Farm & Garden Supply

<http://www.groworganic.com/default.html>

P.O. Box 2209, 125 Clydesdale Court, Grass Valley, CA 95945
530-272-4769

Though Peaceful Valley sells seeds and other plant materials, they also carry an unusually wide range of garden tools, equipment, and books. They are strongly oriented toward organic gardeners and farmers.

Seed Savers Exchange

<http://www.seedsavers.org/>

3094 North Winn Road, Decorah, IA 52101
563-382-5990

If you are interested in helping to keep old, "heirloom" varieties of plants around, you might be interested in getting involved with Seed Savers.

Finding a place to garden

If you don't have a place to garden and are looking for one, you may be able to get a plot in a neighborhood community garden (or start your own community garden!). Check out the American Community Gardening Association web site at <http://www.communitygarden.org/> and click "finding a garden" or "starting a garden."

Directory of farmers' markets

This manual often discusses farmers' markets as sources of plants for your garden. To find the nearest market to you, go to the United States Department of Agriculture's Agricultural Marketing Service web page on the subject at <http://www.ams.usda.gov/farmersmarkets/> Farmers' markets are also just great places to buy food!

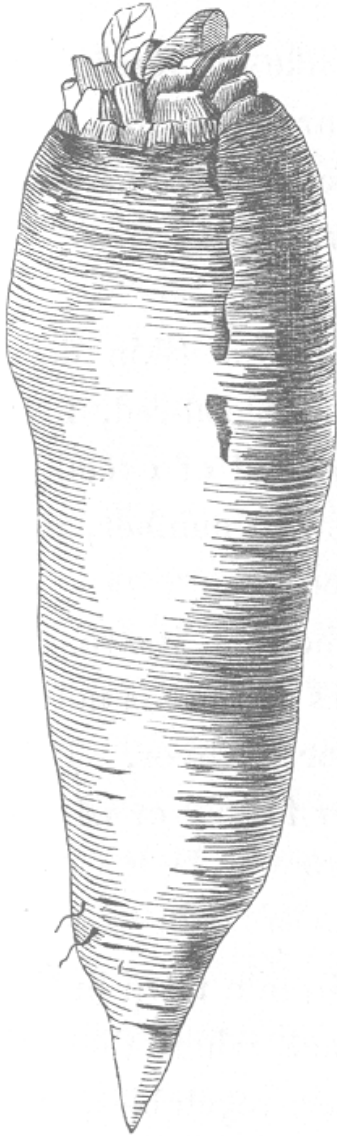
Finding a local extensionist or experienced gardener

The United States is fortunate to have a government-sponsored network of experts, called cooperative extensionists, whose job it is to help people like you with their gardening and food-related problems and questions. Your local extensionist can, among other things, help you learn more about the soil in your garden and any pest problems you may be having. Search a directory of extensionists at <http://www.csrees.usda.gov/Extension/index.html>

Many communities also have active “master gardener” programs, which can be a good way to meet gardeners in your area. Search the American Horticultural Society’s directory of such programs at http://www.ahs.org/master_gardeners/index.htm

Contact the author

If you want more information, you are also welcome to contact the author of this manual, Robin Mittenenthal. His e-mail address is <mittenenthal@gmail.com> (replace the “at” with an @ symbol). He may not know the answer to your question, but he’ll be happy to try to help you find it.



A long, yellow
mangel wurzel
(a tasty, unusual
vegetable related to beets)

About the author

Robin Mittenenthal has been a farm worker, a farmer, an agricultural research assistant, and a librarian, among other things. He is, and hopefully always will be, a gardener. He has an undergraduate degree in biology and Chinese together with M.S. degrees in nutrition and library science. He lives in Madison, Wisconsin, where he will start a Ph.D. in entomology in the summer of 2007 doing work involving organic farmers. He is indebted to his wife for her help with this manual and with life in general.

Robin likes parenthetical comments, the words “mangel wurzel,” and the metric system. He can’t figure out how the United States has managed to survive for so long without going metric.