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EXTENSION

MISSISSIPPI VEGETABLE GARDENER'S GUIDE

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BENEFITS OF GARDENING

Gardening in Mississippi offers numerous benefits, from providing access to fresh, nutritious produce to promoting physical activity and mental well-being. Freshly harvested vegetables often have superior taste and a longer shelf life compared to store-bought produce, which may travel up to 1,800 miles and take days to reach consumers. In addition, growing your own vegetables allows you to enjoy a wider variety of crops than what is typically available in stores.

Historically, vegetable gardening was vital in Mississippi households, providing families with essential food. Today, gardening is a popular recreational activity that offers numerous health benefits, including improved flexibility, strength, and cardiovascular health. Gardening is associated with reduced stress, anxiety, and depression, thanks to its ability to lower cortisol levels and boost serotonin. It can also improve focus, cognitive performance, and gut health while reducing inflammation and the risk of osteoporosis. These therapeutic benefits are even used in clinical settings to help individuals cope with post-traumatic stress disorder.

Mississippi's long growing season, warm climate, and diverse hardiness zones make it ideal for vegetable gardening. Gardeners can enjoy success with both cool-season and warm-season crops nearly year-round. However, the state's hot, humid conditions can also present challenges, such as increased pest and disease pressure.

This guide provides specific recommendations to address these challenges and maximize your garden's productivity. It is organized into sections that cover each stage of gardening, from planning and soil preparation to pest management and harvesting. You can read it cover to cover for an in-depth understanding or use it as a quick reference to find information on specific topics.

PLANNING YOUR GARDEN

What to Plant

While Mississippi's climate is not suitable for all fruits and vegetables, we can grow a tremendous assortment because of our long growing season. You can grow many types of produce, but there's no sense in planting something your family won't eat.

When choosing what you want to grow, consider your available garden space. Watermelons and pumpkins are perfect for large gardens since most varieties require a lot of space. For gardens with limited space, consider planting smaller vegetables, like bush-type snap and lima beans; leafy greens, like lettuce, spinach, mustard, collards, Swiss chard, and turnips; green onions; tomatoes; sweet peppers; and eggplant. Add broccoli, cabbage, hot peppers, okra, summer squash, southern peas, and pole beans as space permits. Cucumbers normally take up a lot of ground space, but they can be grown vertically on a trellis to save space. For gardeners with only a patio available, many vegetables have been developed for containers, such as the Patio Snacker cucumber and the Micro Tom tomato. They are very small but produce abundantly for their size. See the Container Gardening section on page 7 for more information.

Choose varieties recommended for growing in hot, humid climates. Look for varieties labeled as having "good" or "excellent" disease resistance to multiple diseases. Many new varieties offer better disease resistance, higher yields, and great flavor. For example, some tomato varieties available today are highly resistant to multiple diseases, yield over 20 pounds of tomatoes per plant, and have exceptional flavor.

Compare New Varieties to Established Varieties

Every year, companies release new varieties advertised as having superior yield, taste, and disease resistance. Such claims are often true, but advertised claims may not hold true in your own garden. You can compare new varieties with old favorites by planting them side by side in your garden. You may be surprised to find that your go-to variety has been outmatched.

In addition to trialing new varieties on your own, universities regularly conduct trials throughout the country, and their results are usually available online. It is important to note that trials conducted in the southeastern U.S. are likely more reliable for Mississippi gardeners than trials conducted in other parts of the country.

The varieties you choose can make a big difference in how successful you will be. Keep a gardening journal to track what you liked, what worked, and what didn't.

The calendar largely dictates what can be grown. Some vegetables grow best in summer months, while others perform better in cooler temperatures.

Cool-Season Vegetables

Cool-season crops, such as broccoli, cabbage, spinach, and lettuce, grow best in early spring or fall's cooler temperatures. They typically can handle frosts and even light freezes with minimal damage. Cool-season crops often produce higher-quality harvests in the fall, when cooler nights and shorter days slow bolting and improve flavor.

Warm-Season Vegetables

Warm-season crops, including tomatoes, peppers, eggplant, okra, and sweet corn, require warmer temperatures and should be planted after the last frost date. They are intolerant of frost and freezing. Many of these crops, like tomatoes and pole beans, can produce continuously throughout the season, while others, like melons and squash, have a more concentrated harvest period. Sweet corn requires considerable garden space, but many gardeners find it worthwhile for its unmatched sweetness when freshly harvested.

Herbs

Common herbs for Mississippi gardens include basil, parsley, cilantro, dill, oregano, and thyme. Herbs are often low-maintenance and can be grown alongside vegetables or in dedicated beds. Pay attention to their specific growing requirements, as some herbs, like cilantro, prefer cooler weather, while others, like basil, thrive in the heat. See Tables 6, 7, and 12 and the Herb Gardening section on page 52 for more details.

How Much to Plant

After deciding what to plant, the next consideration is how much of each crop should be grown to provide enough for your household to eat fresh and preserve. Table 1 offers yield estimates for various crops. Keep in mind that the estimated yields given for some vegetables (tomatoes, peppers, okra, pole beans, and eggplant, for example) are for multiple harvests over a period.

Table 1. Planting and yield guide.

Crop	Seeds or Plants per 100 ft	Depth (inches)	Spacing (inches)	Expected Yield per 100 ft	Days to Maturity
Asparagus	1 oz 65 plants	1 (seeds) 6–8 (bareroot)	18	30 lb	2 years
Beans, snap bush	½ lb	1	3–6	60 lb	50–55
Beans, snap pole	½ lb	1	4–12	80 lb	55–65
Beans, lima bush	½ lb	1	3–6	47 lb (in shell) 18 lb (shelled)	65
Beans, lima pole	½ lb	1	4–12	66 lb (in shell) 25 lb (shelled)	75–80
Beets	1 oz	½	2	75 lb	65
Broccoli	⅛ oz 50–65 plants	¼–½	18–24	50 lb	55–75
Cabbage	⅛ oz 65–100 plants	¼–½	12–18	150 lb	65–80
Chinese cabbage	¼ oz	¼–½	12	100 lb	45–75
Carrots	⅛ oz	¼–½	2	100 lb	60–75
Cauliflower	⅛ oz 50–65 plants	¼–½	18–24	80 lb	55–75
Collards and kale	¼ oz	¼–½	8–16	150 lb	55
Corn, sweet	3–4 oz	1–2	12	120 ears	65–80
Cucumbers	½ oz	1	12–18	100 lb	55
Eggplant	50 plants	—	24	150 lb	65–80
Kohlrabi	⅛ oz	¼–½	3–4	75 lb	55
Lettuce, head	¼ oz 75–100 plants	¼	12–14	75 heads	65–80
Lettuce, leaf	¼ oz	¼	8–12	50 lb	35–50
Muskmelons	¼ oz	1	36–48	100 fruits	70–90
Mustard greens	¼ oz	¼–½	2	100 lb	30–45
Okra	1 oz	1	12–18	90 lb	50–65
Onions, green	600 sets or plants	—	2	100 bunches	35
Onions, bulb	220 sets or plants	—	6	100 lb	90–110
Parsley	⅛ oz	¼	4–6	30 lb	70–90
Peanuts	½ lb	1–2	3–4	45 lb (green) 15 lb (dry)	110
Peas, English	1 lb	1–2	2	30 lb (in shell)	50–65
Peas, southern	½ lb	1	4–6	40 lb (in hull)	65
Peppers, bell	50 plants	—	24	150 lb	75
Potatoes, Irish	10 lb	4	12	150 lb	75–100
Potatoes, sweet	75–100 plants	—	12	100 lb	90–120
Pumpkins	½ oz	1–2	48	300 lb	85–110
Radishes	1 oz	½	1	40 lb	28

Crop	Seeds or Plants per 100 ft	Depth (inches)	Spacing (inches)	Expected Yield per 100 ft	Days to Maturity
Rutabagas	½ oz	¼–½	12	90 lb	70–90
Spinach	½ oz	½	4	70 lb	35–45
Squash, summer	½ oz	1	36	150 lb	40–55
Squash, winter	½ oz	1	48	100 lb	90
Swiss chard	1 oz	¼–½	6	75 lb	40–50
Tomatoes	35–65 plants	—	18–36	125 lb	60–70
Turnips (greens)	¼ oz	¼–½	2–3	50–100 lb	30–50
Turnips (roots)	¼ oz	¼–½	2–3	50–100 lb	45–60
Watermelons	½ oz	1½	48–72	60 fruits	70–85

Succession Planting

Many people who grow gardens only plant once during the spring. But in Mississippi, we can grow and harvest produce almost year-round. The long growing season combined with succession plantings (growing more than one vegetable in the same space during the year) optimizes what the garden can produce.

Replacing crops after harvest is a type of succession planting. For this process, a vegetable is harvested, then the space is cleared, prepped, and planted with another. For example, follow an early-spring planting of English peas with a late-spring planting of cucumbers; then replant the space with fall bush snap beans, leafy greens, or late southern peas. Another example is to follow early sweet corn with winter squash and pumpkins in early July. Spring Irish potatoes can be followed by lima beans or southern peas, which can be followed by fall greens. Figure 1 provides more examples.

Planting the same crop at staggered intervals—often every 2 weeks—is another way to extend the harvest window. This method of succession planting is known as successive planting. By planting only as much as your family can eat before the next planting begins to produce, you can enjoy a continuous supply of fresh vegetables. However, if you plan to can or freeze your harvest in addition to eating fresh, planting larger amounts at one time will help ensure you have enough for preserving. Successive planting suggestions are provided in Tables 6 and 7.

Some crops, like indeterminate tomatoes, peppers, okra, pole beans, and eggplant, yield fruits over an extended period without needing successive plantings. However, a midsummer second planting can lead to higher yields of better-quality vegetables in the fall. For example, replanting okra 6 weeks after the first planting can boost late-season yield. Alternatively, cutting the first planting to 3 to 4 feet in late summer can help replenish the crop and control plant height for easier picking, but it creates a gap in harvest as the plants regrow.

Crop rotation is not a form of succession planting. Instead, it means changing what you plant in a garden bed each season to keep the soil healthy and reduce pests and diseases. Instead of growing the same crop in the same spot each year, rotate between plant families. For example, after growing tomatoes (a nightshade), plant beans (a legume) the next year to restore nutrients, then plant leafy greens or root vegetables the following year. This helps prevent soil-borne diseases, like blight, and keeps plants productive. See Table 2 for more information. Crop rotation windows can be narrowed by using cover crops. See the Cover Crop Use section on page 8 for more information.

Getting the most from a garden will require a detailed plan that includes:

- vegetable varieties
- number of successive plantings for each vegetable (if applicable)
- planting dates and locations
- row length and spacing

Garden Layout

Design your garden to meet your needs. Careful planning reduces work and can make the garden more productive. Randomly planting seeds and plants will likely result in waste and disappointment.

Consider your available equipment when designing the shape of your garden. If using a tractor, long rows are practical, making a long, narrow, rectangular garden more suitable than a square-shaped one. When cultivating by hand, the shape is much more flexible, but mound the soil for each row to improve drainage.

Sample Garden Plan

Row	Spring Crop	Spring Planting Date	Summer Crop	Summer Planting Date	Fall Crop	Fall Planting Date
1	**Onions** (plants)	Feb–Mar	**Bush Lima Beans**	Jun–Jul	**Spinach**	Sep–Oct
2	**Cabbage** (plants)	Feb–Mar	**Bush Lima Beans**	Jun–Jul	**Turnips**	Sep
3	**English Peas**	Jan–Feb	**Cucumbers**	May–Jun	**Mustard**	Sep–Oct
4	**English Peas**	Jan–Feb	(summer cover crop)		**Cabbage**	Aug–Sep
5	**Lettuce**	Feb–Mar	**Summer Squash**	May–Jun	**Cauliflower**	Aug–Sep
6	**Beets** **Swiss Chard**	Feb–Mar	(leave unplanted)		**Lettuce**	Sep
7	**Broccoli** (plants)	Feb–Mar	(leave unplanted)		**Carrots**	Sep
8	**Mustard** **Turnips**	Feb–Mar	**Southern Peas**	May–Jun	**Onions** (seeds)	Sep–Oct
9	**Bush Snap Beans**	Mar–Apr			**Broccoli**	Aug–Sep
10	**Okra**	Apr–May			**Collards**	Oct
11	**Bell Peppers** **Eggplant** (plants)	Apr–May				
12	**Tomatoes** (plants)	Apr–May			**Cucumbers**	Aug
13	**Southern Peas**	Apr–May			**Beets** **Swiss Chard**	Sep–Oct
14	**Sweet Corn**	Mar–Apr			**Bush Snap Beans**	Aug
15	**Sweet Corn**	Mar–Apr			**Bush Snap Beans**	Aug
16	**Sweet Corn**	Mar–Apr	**Tomatoes** (plants)	Jul–Aug		

3 ft

50 ft

20 ft

Total: 1,000 sq ft

Figure 1. Sample garden plan.

Also, consider the slope of the land; run rows perpendicular to the slope, especially on sandy-textured soils that tend to wash and erode. If necessary, level or terrace the beds in an uneven area to reduce excessive runoff.

Rows for small vegetable plants, like carrots, onions, and radishes, can be placed closer together for hand cultivation but require more space if larger farming equipment is used. Planting them in double rows or a broad band in a row can increase the yield from a small garden plot.

Closely spaced rows and vegetable plants help shade out weeds and reduce water loss from the soil surface. However, this also reduces air movement and increases the chance of diseases. Be sure to leave enough space between the rows to work around the plants comfortably, but keep rows close enough together to get more produce from a smaller area. Also, cover the rows with mulch. See the Mulching Section on page 27 for more details.

Plant perennial vegetables, like asparagus, where they won't interfere with yearly land preparation. Plant long-season vegetables, like tomatoes, okra, peppers, and eggplant, together where they won't interfere with short-term vegetables and replanting. Plant corn, okra, pole beans, staked tomatoes, and other tall vegetables on the north side of the garden so they won't shade or interfere with the growth of shorter vegetables.

Table 2. Crop families and rotation recommendations.

Family	Crops	Rotation Interval	Diseases and Pests Reduced
Alliums	Onions, garlic, leeks, shallots	3–4 years	White rot, onion maggots
Amaranth	Beets, Swiss chard, spinach	2–3 years	Leaf spot, downy mildew
Asters	Lettuce, endive, sunflowers	2–3 years	Bottom rot, sclerotinia
Brassicas	Cabbage, broccoli, cauliflower, kale, mustard	3 years	Clubroot, black rot
Cucurbits	Squash, cucumbers, watermelon, pumpkins, melons	3–4 years	Gummy stem blight, bacterial wilt
Grasses	Corn, sorghum, millet	2–3 years	Corn earworm, smut, rust
Legumes	Southern peas, beans, peanuts	2–3 years	Root rot, nematodes
Mallows	Okra, cotton	3–4 years	Nematodes, fusarium wilt
Morning glory	Sweet potatoes	3–4 years	Nematodes, scurf, soil rot
Nightshades	Tomatoes, peppers, eggplant, potatoes	3–4 years	Early/late blight, bacterial wilt, nematodes
Umbellifers	Carrots, parsnips, celery, dill	3 years	Carrot rust fly, nematodes

Garden Location

The ideal garden site is close to the house but out in the open, where it receives full sun and is not shaded by trees or buildings. Choose a place near a water supply with loose, fertile, well-drained soil.

Few gardeners are fortunate enough to have the ideal site or soil, but growing a successful garden is still possible. If you select the right vegetables and carefully manage the soil, some vegetables can grow in almost any location. Vegetables grown for their fruits or seeds, such as sweet corn, tomatoes, squash, cucumbers, eggplant, peppers, beans, and peas, should be planted in the sunniest spots. Leaf and root vegetables, like beets, cabbage, lettuce, mustard, Swiss chard, spinach, and turnips, can grow in partial shade. However, they perform better in direct sunlight.

Select a site free of serious weeds. Nutsedge, torpedograss, bermudagrass, cocklebur, and morning glory are just a few of the difficult weeds.

Protect the site with fencing. For rabbits, use a 2-foot wire fence buried a few inches. For deer, use fencing at least 8 feet high or a double electric fence with strands at 30 and 48 inches. Heavy-duty plastic bird netting or hardware cloth (half-inch or smaller openings), secured tightly, helps keep out birds and squirrels. Remove low-hanging tree limbs and promptly pick up dropped produce to help reduce animal visits.

Special Considerations

Raised Beds

Raised beds can help when gardening space is limited or the soil quality is poor. For example, if the site is low and collects water or the soil drains poorly, using raised beds will avoid these problems. Raised beds are planting areas where the soil is several inches higher than the natural grade. This is accomplished by adding soil to the growing area or incorporating soil amendments, such as compost, sand, composted sawdust, or bark, into the existing soil.

In areas where the soil is extremely poor, you can excavate and replace it with a homemade custom soil blend, a commercial soil blend, a soilless potting mix, or topsoil. Before going to this extreme, it is recommended that you first get the soil tested and amend the existing soil as directed. A soil test could potentially save you a significant amount of time, labor, and money. See the Soil Testing section on page 10 for more information.

Where the native soil is adequate, you can make raised beds by pulling the soil from the walkways and placing it on the beds. Then, fill the walkways with mulch materials, like pine straw.

Raised beds can be framed with wood, bricks, or concrete blocks, or they can be left unframed. The framing adds to the appearance and keeps the soil in place. Depending on the materials and design, it may even provide seating.

Ideally, raised beds should be no wider than 4 feet so you can easily reach the center from either side, and no longer than 25 feet unless crossovers are provided. Beds 4 feet wide and 25 feet long contain 100 square feet, making fertilizer rate calculations easier. Beds accessible from only one side should be narrower than 4 feet so you can reach across the whole bed from one side. All framed beds should be the same width so that covering materials—such as shade frames or sashes for cold frames—fit all beds, making crop rotation easy.

Raised-bed soil that has been improved by adding organic matter and sand often allows excellent root crop development. Select vegetables that produce a lot for the space they occupy. Trellis vining crops, like cucumbers, pole beans, Malabar spinach, and melons. Support melon fruits with slings. Raised beds require more water than ground-level beds, but it's worth the extra effort when the alternative is no garden at all.

Here are some additional advantages of raised-bed gardening:

- Raised beds produce more vegetables per unit of garden space because space is not wasted with walkways between every row.
- Soil in raised beds dries and warms more quickly in spring, which permits earlier planting and harvest of spring vegetables.
- Soil does not become compacted because you don't walk on it.
- Closely spaced plants in raised beds shade out weeds and reduce the need for frequent cultivation.

Raised-bed gardening, however, does have some disadvantages:

- It can be difficult to space plants properly. Plants without adequate space will take over other plants' space.
- Closer plant spacing can reduce airflow and increase disease problems.
- Raised beds require more frequent watering because of improved drainage.
- Raised beds may require more frequent fertilization because of the leaching that results from frequent watering and improved drainage.
- Raised beds may not be compatible with equipment.
- Raised beds are more expensive to create.

Container Gardening

Container gardening is available to anybody with sunlight and a water source. Appropriate containers for growing vegetables have a low center of gravity, keep the growing medium from washing away, and allow water to drain from the bottom. Quart-sized (or larger) pots, fabric grow bags, and cans can grow herbs, radishes, lettuce, strawberries, and other small plants. Tomatoes, peppers, squash, eggplant, and other large plants need containers that will hold 5 gallons or more. Old ice chests, bathtubs, barrels, and other large containers can support several plants, but don't forget to add drainage holes.

Fill containers with potting mix free from diseases, insects, and weeds. Do not use garden soil in containers. You can make your own blend with compost, peat moss, or other organic material and sand. Sand helps with drainage and provides weight for stability. Organic or synthetic fertilizers supply needed nutrients. Water is the most limiting factor in container gardening because plant roots are confined to a small volume of soil, which holds less water than native soil over a larger area. Container gardens often need to be watered twice on hot summer days.

GARDEN SOIL AND PREPARATION

Garden Soil Characteristics

The ideal garden soil is deep, loose, fertile, and well-drained internally and on the surface. It has plenty of organic matter and is free of weeds and diseases. Such soils can sometimes be difficult to find, but less-than-ideal soils can be just as productive with proper preparation and management.

Water flows quickly through well-drained soil, which has a balanced mix of pores that allow water and air to move freely. Soil porosity—the amount of open space between soil particles—determines how well water drains and how much air reaches plant roots. Good drainage is crucial

because, without oxygen, roots cannot grow, survive, or function. Clay soils have low porosity because their tiny particles pack tightly together, making it difficult for water to flow through them. On the other hand, sandy soils have high porosity, with large spaces between particles that allow rapid drainage. Because of these differences in soil porosity, clay soils retain moisture longer than sandy soils, directly impacting crops' watering needs.

Garden soil affects the way vegetable plants grow and look. Poor soil conditions—such as cold, wet, compacted, crusty, or cloddy—can slow seedlings from emerging and increase root rot diseases. Other soil-related plant symptoms are stunted plants, slow growth, poor color, and shallow, malformed roots. Signs of poor soil structure are crusts, hard soil layers below the surface known as hardpans or fragipans, standing water, and erosion.

Improving Soil

Organic matter improves the porosity of both clay and sandy soils. It also enhances soil tilth—the looseness and structure that make the soil easier to work and allow roots to grow more freely. In sandy soil, organic matter increases water-holding capacity and boosts fertility, while in clay soil, it helps break up compacted layers, improving drainage and aeration.

Increase soil organic matter by adding compost, well-aged manure, shredded leaves, sawdust, bark, or peat moss. Turning under disease-free plant residues from crops, like sweet corn, southern peas, and rye, after harvest further enriches the soil. Cover crops, such as clovers and vetch, also improve soil by preventing erosion, reducing nutrient loss, and adding organic matter when tilled under in spring.

Manures vary in nutrient levels, and the amount of straw, age, exposure to weather, and degree of composting changes their composition. Be careful not to overfertilize when applying chicken litter to garden soil. Use no more than 200 pounds per 1,000 square feet of garden space. Cow and horse manure is lower in nutrient content than poultry manure and can be applied at 250 to 300 pounds per 1,000 square feet. For best results, use manure that has been aged (composted) for at least 3 months to avoid nitrogen depletion from composting it in the garden.

Fresh manure applied in the garden can tie up nitrogen, causing plants to suffer. Also, ensure the manures are free of persistent herbicides. See the Composting section on page 9 for more information.

While adding organic matter improves soil fertility, overusing manures (especially chicken litter) can lead to excessive phosphorus and salt buildup. High phosphorus levels may cause nutrient imbalances, while salt accumulation can reduce seed germination and water uptake. Manures and plant residues provide valuable nutrients but are not balanced fertilizers. Therefore, additional fertilizer may be required. Test the soil every year or two and adjust fertilization as needed. See the Organic Gardening section on page 55 for more information.

Cover Crop Use

Cover crops, often called green manure, are temporary plantings that improve soil health, prevent erosion, suppress weeds, and add organic matter. In Mississippi, where heavy rains can wash away nutrients and summer heat depletes soil, cover crops help maintain soil fertility and structure between growing seasons.

The best cover crops depend on the season. Cool-season cover crops, such as crimson clover, vetch, cereal rye, and Austrian winter peas, are typically planted in the fall and grow over the winter. Warm-season cover crops, including buckwheat, cowpeas, and sorghum-sudangrass, thrive in the heat and are useful for weed suppression and organic matter buildup. Table 3 provides suitable cover crops and planting times.

Cover Crop Termination

To prevent cover crops from becoming weeds or competing with garden crops, they must be terminated at the right time. The best time to cut them down is before they flower or go to seed.

- **Crimson clover, vetch, Austrian winter peas.** Terminate at early flowering for maximum nitrogen release.
- **Cereal rye, sorghum-sudangrass.** Cut or mow before seed heads form to prevent reseeding.

Table 3. Cover crop recommendations.

Season	Recommended Cover Crops	Primary Benefits	Typical Planting Dates
Fall and winter	Crimson clover, hairy vetch, cereal rye, Austrian winter peas	Nitrogen fixation, erosion control, weed suppression	North MS: Sept. 15–Oct. 15 Central and South MS: Oct. 1–Nov. 1
Spring and summer	Buckwheat, southern peas, sorghum-sudangrass	Quick weed suppression, organic matter increase, soil conditioning	Statewide: April–July

- **Buckwheat.** Mow at first flowering to avoid reseeding.
- **Cowpeas.** Cut before seed pods develop to prevent regrowth.

There are several methods of termination:

- **Mowing or cutting.** Best for cowpeas, buckwheat, and sorghum-sudangrass.
- **Tilling into the soil.** Done 2 to 4 weeks before planting vegetables to allow decomposition.
- **Rolling/crimping.** A no-till method used for cereal rye and vetch.
- **Occultation (smothering).** Covering with black plastic or a tarp for several weeks to kill the cover crop.

Cover crops require proper timing, planting methods, and termination for maximum benefits. To learn more, refer to these Mississippi State University Extension publications:

- *Cover Crops: Benefits and Limitations* (P3330)
- *Cover Crops: Establishment and Termination Guide* (P3417)
- *Cover Crops: Seeding Rates and Planting Depths for Cool-Season Species* (P3425)

Composting

Compost is organic material broken down by microorganisms into simpler compounds. It is a potent soil conditioner that reduces poor soil porosity and improves tilth. It also provides slow-releasing nutrients like nitrogen, phosphorus, and potassium, which are less prone to leaching than synthetic fertilizers.

While compost can be purchased, high-quality compost can be made at home. Build your compost pile in an out-of-sight location—on open ground or in a bin made of cinder blocks, scrap wood, or wire fencing. The sides of the bin should not be airtight. A removable cover can help prevent nutrient loss from heavy rain.

To build the pile, alternate nitrogen-rich (green) materials—grass clippings, vegetable scraps, and coffee grounds—with carbon-rich (brown) materials—dry leaves, straw, hay, and sawdust—in a 1:3 ratio by volume. An optional 1-inch soil layer can be added over every 6-inch layer of organic material to further reduce odors, deter pests, and retain moisture. To speed up decomposition, sprinkle 1 cup of balanced granular fertilizer (e.g., 6-8-8) per 10 square feet of surface area over each 6-inch layer of organic material before adding the next layer. Keep

the pile moist but not soggy, and build it 4 to 5 feet high, making the top concave to capture rainwater.

Turning the pile accelerates decomposition and prevents foul odors. Without soil layers, turn the pile every 1 to 2 weeks. As composting slows, turn less frequently, every 4 to 5 weeks.

As organic matter decomposes, microbial activity generates heat, which can be harnessed for hot composting—a method that kills weed seeds and pathogens and accelerates breakdown. A compost thermometer, available at garden centers and online, helps monitor temperature. Aim for 130 to 160°F—hot enough to kill weeds and pathogens but not so hot that microbes die. Check the temperature every few days and turn the pile when it drops below 130°F or exceeds 160°F. Compost is ready to use when it reaches ambient temperatures (usually 80°F or lower) and the compost has a dark, crumbly texture and smells earthy.

To avoid problems, never add meat, dairy, greasy foods, or pet waste, as they attract pests and slow decomposition. Also, before using straw or hay, ensure it has not been treated with pyridine carboxylic acid-based herbicides (such as aminopyralid, clopyralid, or picloram), as these chemicals do not break down easily and can damage crops.

A gardener may not have enough materials to build a full compost pile all at once. Instead, composting can be done gradually by adding kitchen scraps and yard waste as they are generated; then, cover it with brown material. As the compost pile grows, it will naturally begin to decompose.

For a continuous composting system, a three-bin setup works well: Bin 1 holds fresh materials; Bin 2 contains partially decomposed compost that is turned regularly; and Bin 3 stores finished compost ready for use. Once Bin 1 is full, transfer it to Bin 2, aerating the compost in

the process. When Bin 2 is nearly finished decomposing, move it to Bin 3 for final curing. This system ensures that there is always a bin available for new compost materials.

Composting slows in cold weather, so piles built in fall decompose gradually over winter but speed up in spring and summer as temperatures rise. See MSU Extension Publication 1782 *Composting for the Mississippi Gardener* for more information.

Soil Testing

Soil reaction refers to the acidity or alkalinity of soil, which is measured using the pH scale. The pH scale ranges from 1 to 14, where a pH of 7.0 is considered neutral. Soils with a pH below 7.0 are acidic, while those above 7.0 are basic or alkaline. For most garden plants, the ideal soil pH falls between 6.0 and 7.0, as this range provides the best conditions for nutrient availability and healthy plant growth. You should test your soil to determine its pH. Vegetables do not grow well in acidic soils with a pH of 4.5 to 5.5 or in alkaline soils above 7.5.

Contact your county Extension office for a soil test box and instructions for collecting a soil sample. Proper sampling is essential for accurate results. Follow these general guidelines:

- Use a spade or trowel to collect a slice of soil about 6 inches deep.
- Repeat this process in several random spots throughout your garden for a representative sample.
- Combine all the samples in a clean bucket or container.
- Mix the soil thoroughly to ensure it is well blended.
- Take about 1 pint of the mixed soil and let it dry at room temperature.
- Place the dried soil in the soil test box or another clean container.

Avoid taking samples from areas where fertilizer or manure has been spilled or piled. Also, exclude debris, such as leaves, sticks, roots, or large stones, from your sample. Once prepared, deliver your soil sample to your county Extension office for testing.

A routine soil test costs $10 per sample for a complete analysis, including pH and nutrient levels, along with lime and fertilizer recommendations. The limestone (lime) recommendation is the most important information on a soil test report.

Soils are generally acidic in areas with ample rainfall, like Mississippi, which receives an average of 55 to 60 inches per year. However, there are exceptions, particularly in the Delta and Blackland Prairie, and the pH can easily fall outside of the optimal range for vegetable gardening. Of all soil samples analyzed at Mississippi State University's Soil Testing Laboratory between 2020 and 2024, 54 percent had a pH of 5.9 or lower. For garden samples, soil pH in this range would trigger a lime recommendation. Only 33 percent of soil samples had a pH between 6.0 and 7.0.

The soil test tells you if and how much lime is needed. Lime is the most effective and inexpensive amendment available for soil improvement. The soil's calcium and magnesium levels tell you what form of lime to apply—dolomitic (magnesium and calcium) or calcitic (calcium). An acidic soil tested medium-low to very low in magnesium should be limed with dolomitic (high-magnesium) lime. An acidic soil high in magnesium can be limed with calcitic or dolomitic limestone.

Plants in highly acidic (or basic) soils will grow slowly, partly because of poor root growth. This makes them more susceptible to drought stress and less efficient at absorbing soil nutrients, and they may develop symptoms of nutrient deficiencies.

Lime should be applied to acidic soils well before planting (2 to 3 months) to allow it to dissolve and change the soil pH. However, lime begins to react as soon as it

is incorporated into the soil, so it can be applied at any time to increase soil pH levels. The best time to apply lime is in the fall.

Apply lime evenly over the entire area and work it into the top 4 or 5 inches of soil. Incomplete mixing may cause future tests to show a need for more lime, which can result in applying too much lime and poor plant growth. Lime raises the soil pH and improves soil fertility. It also improves the structure of clay soils and makes them easier to work with.

Adding lime to the soil is not a once-in-a-lifetime event. Over time, limed soils gradually return to an acidic state, so it is important to test the soil every year or two to determine if more lime is needed. Sandy soils become acidic more quickly than clay soils.

Several factors contribute to a drop in soil pH, including:

- The use of acid-forming fertilizers
- Lime leaching from the soil due to rain or irrigation
- The decomposition of organic matter, which releases organic acids

Fertilizer Needs

The amount of fertilizer your garden needs depends on your soil's fertility, organic matter, type of fertilizer, and the vegetables you're growing. A soil test can help determine the amount of nutrients to apply.

Once you've tested your soil, you must measure your garden to determine its square footage. Fertilizer recommendations are based on 1,000 square feet, and an area of 1,000 square feet could measure 25 by 40, 20 by 50, 30 by 33, or other dimensions according to your plot layout.

If your garden is smaller than 1,000 square feet, calculate the area as a fraction of 1,000 by dividing your garden's size by 1,000. Then, multiply that fraction by the recommended lime and fertilizer rates. For example, if your plot measures 16 by 24 feet, the area is 384 square feet. Divide 384 by 1,000 to get 0.384, then multiply 0.384 by the recommended fertilizer rate to determine how much fertilizer to apply.

Vegetable plants require many different nutrients for good growth and production. Yet the three major nutrients that usually require the most attention from gardeners are nitrogen (N), phosphorus (P), and potassium (K). Calcium (Ca) and magnesium (Mg) are also very important, but they are supplied by limestone. All other nutrients are obtained from air, water, and soil.

Mixed fertilizers are normally sold by grade (signified by their "N-P-K" numbers) and contain two or three major plant nutrients. The N-P-K refers to the percent nitrogen (N), available phosphate (P_2O_5), and available potash (K_2O).

Fertilizer sources of the major plant nutrients are ammonium sulfate (21 percent N, 21-0-0), a blend of ammonium sulfate and urea (34 percent N, 34-0-0), blood meal (~12 percent N, ~12-0-0), calcium nitrate (15.5 percent N, 15.5-0-0, plus 19 percent Ca), urea (46 percent N), triple superphosphate (46 percent P_2O_5, 0-46-0), and muriate of potash (60 percent K_2O, 0-0-60). Phosphorus and potassium do not easily leach from garden soils like nitrogen; therefore, they can build up to very high levels in regularly fertilized gardens. In these cases, nitrogen is the only fertilizer recommended since additional phosphorus and potassium are unnecessary.

Where nitrogen is the only fertilizer recommended, the usual recommendation is 3 pounds of 33-0-0 (3 pints) per 1,000 square feet of garden space before planting. Measuring the amount of fertilizer to apply is important because adding too much can damage plants and adjacent water sources. It can even leach into the underground water supply. Table 4 contains specific estimates for commonly used fertilizers and amendments for when a scale is not available.

Vegetables differ in their fertilizer requirements. Leafy greens, like mustard, turnips, collards, cabbage, and spinach, are heavy nitrogen users. Broccoli and sweet corn also require more nitrogen than some other vegetables. While nitrogen is important to the plant growth

Table 4. Approximate fertilizer weight (lb) per pint.

Fertilizer	N-P-K or Nutrients	Approx. Weight
Nitrogen (N)		
Urea	46-0-0	0.9
Urea + ammonium sulfate (33-0-0)	33-0-0	1
Ammonium sulfate	21-0-0 + 24% S	1.1
Calcium nitrate	15.5-0-0 + 19% Ca	1.0–1.1
Phosphorus (P)		
Triple superphosphate	0-46-0	1
Potassium (K)		
Muriate of potash	0-0-60	1
Blends		
Granular synthetic (e.g., 10-10-10, 13-13-13)	10-10-10; 13-13-13	1
Secondary Nutrients and pH Amendments		
Dolomitic lime	0-0-0 + Ca & Mg	1.25
Calcitic lime	0-0-0 + Ca	1.2–1.3
Elemental sulfur	0-0-0 + S	1.0–1.1
Gypsum	0-0-0 + Ca & S	1.2

of fruit and root vegetables, phosphorus and potassium are important for proper root and seed development. Peanuts, southern peas, and beans get nitrogen from the air and do not require heavy nitrogen fertilization. Over-fertilizing these vegetables with nitrogen causes excessive growth of leaves at the expense of the fruit.

Fertilizer should be applied either before or at planting. Two common application methods are "in the row" and "broadcast," with broadcasting being the most practical for most gardeners. To broadcast, spread the fertilizer evenly at the recommended rate over the soil surface and thoroughly mix it into the soil as you prepare the planting beds. Heavy-feeding vegetables need additional fertilizer (side-dressing) after the plants are well established. Table 5 contains crop-specific information.

For row applications, apply the recommended fertilizer and mix it thoroughly with the soil to avoid damaging seeds and tender plants.

Fertilizers can be applied in a combination of broadcast and row applications. Broadcast two-thirds of the recommended fertilizer over the garden surface and mix it into the soil. Apply the remaining one-third in furrows spaced 3 inches to the side of the row and slightly below the level of the seeds.

Nitrogen fertilizer applied before or at planting time usually does not supply all the nitrogen needed for heavy- and medium-feeding vegetables during the growing season. Also, irrigation and rain can leach water-soluble nutrients, especially nitrogen, into deeper soils beyond the reach of shallow-rooted vegetables.

Side-dress additional nitrogen fertilizer along the row, 4 to 6 inches from the base of established plants, being careful to keep all fertilizer off plant leaves.

Organic Versus Synthetic Fertilizers

Both organic and synthetic fertilizers play a role in maintaining soil fertility and supporting healthy vegetable growth. Organic fertilizers, such as compost, manure, and bone meal, should be incorporated into the soil well before planting to allow microbial activity to break down nutrients into forms plants can absorb. These materials improve soil structure and water retention, making them ideal for long-term soil health.

Synthetic fertilizers, such as balanced N-P-K blends (e.g., 10-10-10 or 6-8-8), provide immediate nutrient

Table 5. Side-dress applications of nitrogen.*

Crop	Timing
Beans	At three- to four-leaf stage
Peppers, eggplant, tomatoes	After first fruit set and again at 4- to 6-week intervals
Broccoli, cabbage, cauliflower, Brussels sprouts	3 weeks after transplanting or after danger of late freeze; broccoli again when heads begin to show
Cucumbers, watermelons, cantaloupes (muskmelons), pumpkins, winter squash	When vines begin to run; pumpkins when vines are 12–18 inches long
English peas	When plants are 4–6 inches tall
Irish potatoes	When sprouts break through the soil surface
Leafy greens (mustard, turnips, Swiss chard, collards)	When plants are about one-third grown
Lettuce, kohlrabi, Chinese cabbage	2 weeks after transplanting; 4 weeks after sowing seed
Okra	After first pods are harvested
Onions (green and bulb)	From sets: when tops are 6 inches high; from transplants: when established and actively growing
Peanuts, radishes, southern peas, sweet potatoes	None
Spinach, beets, carrots, turnips (roots), rutabagas	4–6 weeks after sowing seeds
Summer squash, zucchini	Before bloom when plants are 8–10 inches tall and again in 4 weeks
Sweet corn	When 8 inches high and again when knee high

*1 pint of 34-0-0 per 100 feet of row, 3⅓ tablespoons per 10 feet of row.

availability and are best applied before planting and as side-dressings during the growing season. However, synthetic fertilizers are more prone to leaching, which can contribute to water pollution and nutrient runoff. Applying them in small, measured doses—following soil test recommendations—reduces excess nutrient buildup and environmental impact.

Synthetic nitrogen fertilizers are produced using the Haber-Bosch reaction, which converts atmospheric nitrogen (N_2) into ammonia (NH_3). This process is energy-intensive and typically requires fossil fuels. In contrast, organic fertilizers rely on natural decomposition to release nutrients slowly, reducing runoff risks and fostering soil microbial life. However, organic fertilizers often require larger application amounts and take longer to release nutrients, making them less effective for immediate plant needs.

For optimal results, many gardeners use a combined approach: incorporating organic matter to enhance long-term soil health while applying synthetic fertilizers strategically when crops require an immediate nutrient boost. This balanced method helps maintain healthy soil, reduce environmental impact, and promote high-yield vegetable production.

Soil Preparation

Plants and seeds are easier to establish and grow better in well-prepared soil. The initial prep work is typically best started in the fall, except in areas where erosion could be problematic. Consider using an approved herbicide to kill existing weeds or turfgrass before working the soil for new garden plots. Apply lime, if needed, at the rate recommended from your soil test. Break the soil with a plow, rototiller, or spade. Plow or turn the soil to a depth of 7 to 8 inches. (Many smaller garden tillers will struggle or fail at this task.) Leave fall-plowed land rough until spring.

In early spring, you can disc or rake the soil several times at regular intervals to keep down weeds, break up clods, and smooth the soil.

If you did not plow or spade the garden site in the fall, turn the soil in the spring as soon as it is dry enough to work. Most soils are dry enough when you can shape a handful of soil into a ball that crumbles when you press it with your thumb. Excessively wet soil will be sticky, and the ball will stay intact. Avoid working wet soils.

Just before planting, apply fertilizer (and lime if it was not added in the fall or earlier in the spring) as recommended. Then, pulverize the soil with a rototiller (or harrow) to get a smooth, level surface. This helps to firm the soil, break up clods, and leave a smooth surface for seeding. Soil left in rough condition for several days after turning in the spring may dry out and form hard clods, making it much more difficult to prepare a good seedbed. Especially where the soil is clay, flat (i.e., level), and likely to stay wet, use a hoe, rake, or rototiller to pull the soil into raised rows that are 10 to 12 inches across on the tops. Let the sides slope gently to the walkways to provide good surface drainage.

Conventional row spacing is 36 to 40 inches apart, but spacing depends on the farming equipment, garden size, and vegetables being grown. Rows for large, vining vegetables, like watermelons, cantaloupes, pumpkins, and winter squash, are usually 6 to 8 feet apart.

PLANTING

Seeds Versus Transplants

Gardeners can start vegetables from either seeds or transplants (i.e., young plants), depending on the crop and growing conditions. Transplants offer a head start on the season, while direct-seeding is often better for crops that don't transplant well. Understanding which method works best for each vegetable can lead to healthier plants and better harvests.

Seeds and vegetable transplants are available in many local and online stores. Transplants can give certain vegetables a head start on the growing season and help avoid diseases and insects that can develop later.

Planting transplants of warm-season vegetables, like tomatoes, tomatillos, peppers, and eggplant, is standard practice and recommended over direct-sowing these crops. Grafted versions of these transplants are available and are increasing in popularity, offering enhanced disease resistance and higher yields.

Cool-season cabbage, broccoli, cauliflower, and head lettuce transplants are also recommended. While you can purchase transplants of cucumbers, squash, cantaloupes, and watermelons, the extra time needed to become established after transplanted is often longer than directly sowing seeds into the garden, so you may want to seed these crops directly. An exception would be seedless watermelon, which generally germinates poorly compared to seeded watermelon. Therefore, transplants are recommended for triploid or seedless watermelons. To aid germination, sow watermelon seeds with the rounded end pointing down and the tip end pointing up.

Some vegetables, such as sweet potatoes, Irish potatoes, and garlic, are typically grown from vegetative structures rather than true seeds. Sweet potatoes are grown from slips, garlic from separated cloves, and Irish potatoes from tubers called "seed potatoes." Despite the name, seed potatoes are not actual seeds but tubers cut into pieces before planting. However, true potato seeds—such

as those used to grow Clancy potatoes, a recent All-America Selections (AAS) winner—are an alternative method for growing potatoes. These true seeds come from potato flowers and are planted like other seeded crops, but their planting dates and handling differ from seed potato tubers traditionally used in home gardening.

Transplant Production at Home

You can purchase or grow your vegetable transplants in a cold frame, in a hotbed, in a greenhouse, on a light bench, on a sunny porch, or by a sunny window. See MSU Extension Publication 3436 *Homegrown Flower, Herb, and Vegetable Transplants* for more details.

There are many advantages of growing your own plants:

- They are substantially less expensive.
- They are available when you need them.
- You can grow the specific varieties you want.
- You reduce the chances of introducing new diseases and insects into your garden.

You can successfully grow transplants of many vegetables by following a few simple guidelines.

Seed Starting Mix

Do not use garden soil because it does not provide proper drainage and can be contaminated with disease and weed seeds. Several commercial sterile, soilless seed-starting mixes are available, or you can prepare your own:

- 2 quarts sphagnum peat moss (remove any large sticks)
- 1 quart vermiculite
- 1 quart perlite
- 1 tablespoon limestone

Transplant Containers

Containers for seed germination can be plastic or Styrofoam egg cartons, half-pint milk cartons, plug trays, aluminum foil loaf pans, pie tins, peat pots, or peat pellets. Dry, soilless media repels water, so lightly moisten it before filling containers. Make sure larger containers have drainage holes before filling them. Small containers, like egg cartons, do not require drainage holes if watered carefully.

Expandable peat pellets (available at nurseries and garden supply stores) eliminate the need for a mix. Place dry, flat pellets in a shallow tray and sprinkle them several times with warm water until they are completely expanded. Allow a little time between sprinklings. Surround the expanded pellets with sand or vermiculite to hold them upright and slow their drying between watering.

Planting and Storing Seeds

Plant only as many seeds as needed; excess can lead to overcrowding. Plant them at the depth recommended on the back of the seed packet. Generally, larger seeds are planted deeper than smaller seeds. When using trays or pans, plant the seeds in rows and cover with one-fourth of an inch of the potting mix or vermiculite. Vermiculite is a great medium to cover the seeds since it has a contrasting color from the seed starting mix and helps keep seeds moist. When using individual containers, plant two or three seeds per container. With the expanded pellets, make a small depression in the top and drop in one or two seeds.

Transplants require several weeks to grow, so plan ahead. Purchase seeds early in the season for the best selection and before they sell out. Start them at the appropriate time so they will be large enough to handle for transplanting but not so large that they outgrow their containers and become unwieldy to manage. See Tables 6 and 7 for recommended transplant ages.

Moisture and high temperatures are the biggest contributors to seed decline, so avoid storing seeds in sheds, garages, vehicles, or outdoors, where temperature and humidity fluctuate. Some seeds naturally last longer than others, but all seeds benefit from proper storage. For best results, store seeds below 50°F and at 30 to 50 percent relative humidity. The refrigerator is an ideal place to store seeds. They can remain viable for many years if placed in an airtight container in the fridge.

To keep seeds dry, use desiccants, like silica gel, calcium chloride, or powdered milk, inside airtight containers. However, bean and okra seeds should be stored separately from desiccants to prevent overdrying, which can make them too hard to germinate.

If removing seeds from cold storage, allow the container to warm to room temperature before opening to prevent condensation, which can damage seeds.

You can test the viability of old seeds by placing 10 or so seeds between two moistened paper towels inside an airtight container or plastic bag. Store them in a warm, dark place (70 to 80°F) for most vegetables. However, some seeds, like spinach and lettuce, germinate best at 50 to 60°F and should be tested in a cooler, dark place.

Check the bag every couple of days for signs of germination. If few or no seeds sprout, it's best to discard the packet and use fresh seeds. Alternatively, purchasing new seeds each year helps avoid germination issues and ensures a strong start for your garden.

Seeds can also be stored in the freezer for long-term preservation (5 or more years), but they must be fully dried first (to about 6 to 8 percent moisture). Repeated freeze/thaw cycles can damage seeds, so only freeze seeds that will remain undisturbed until needed.

Do not store chemically treated seeds near food; some may leave residues over time. Pelleted seeds (coated for easier handling) tend to deteriorate faster, so only buy what you plan to use in a season.

Germination

Cover containers with a germination dome or a piece of plastic, or slip them into a clear plastic bag to keep the humidity high. The best temperature for the germination of most crops is 75 to 80°F. Germination heating mats are helpful to reach these temperatures. Lower temperatures will slow down germination. Tomato, pepper, and eggplant seeds won't germinate below 60°F. Even at the optimum temperature, eggplant and pepper seeds may take 2 weeks to germinate. If you're using an egg carton, keep the lid on until the seeds germinate. Ensure the soil stays moist but is not overly saturated, which may cause the seeds to rot.

Most seeds do not require light to germinate. But as soon as the seedlings begin to emerge from the mix, remove the cover, lower the temperature, and increase the amount of light to prevent spindly growth. Place cool, white (4000K+), 40-watt fluorescent or LED tube lights several inches above the seedlings. Provide 18 hours of supplemental light per day. An outlet timer may be helpful. If the weather is warm during the day, you can set the trays outside, but be sure the soil stays moist. Bring trays inside during cool or cold nights.

Tomato, pepper, and eggplant seedlings grow best when the day temperature is 70 to 75°F and the night temperature is 60 to 65°F. Broccoli, cabbage, and cauliflower prefer cooler temperatures—65 to 70°F during the day and 55 to 60°F at night. At these temperatures, broccoli, cabbage, and cauliflower take 5 to 7 weeks to reach an appropriate size for transplanting to the garden. Peppers and eggplant may need 8 to 10 weeks. Seedless watermelon requires about 3 weeks.

Thinning and Transplanting

Individual containers with more than one seedling must be thinned to one plant. Pinch out or cut off the extra seedlings while the first leaves are still small.

Seedlings germinated in trays must be transplanted to individual containers while still small. Lift and separate the seedlings and replant them into individual containers, such as peat pots, plastic cell packs (saved from previously purchased transplants; be sure to wash them), peat pellets, or other small containers. Use a commercial soilless potting mix or prepare your own.

Fertilizing Transplants

Commercial seed-starting mixes may contain enough fertilizer to grow the seedlings. Mixes with fertilizer are said to be "charged." Check the packaging for details. Homemade mixes of peat, vermiculite, and perlite contain no fertilizer. Fertilize seedlings for optimal growth as the first true leaves develop from the cotyledons.

An all-purpose, water-soluble fertilizer (such as 20-20-20) can be mixed at a rate of 50 to 75 ppm nitrogen. Fertilizer packaging often has a table listing the amount of fertilizer required to reach the target ppm concentration per gallon of water. Fertilize one to three times weekly. Do not overfertilize, as this can damage tender seedlings.

Store excess fertilizer solution in an airtight container in a dark, cool place to prevent evaporation. Use it as the plants grow.

As the plants develop more true leaves, fertilizer rates can be increased to 75 to 150 ppm. It is important to supply an appropriate amount of fertilizer. Plants suffer from both insufficient and excessive amounts of fertilizer. Too

little fertilizer is better than too much because more fertilizer can be added later.

Seedling Pathogens

Damping-off is a major disease that attacks seedlings, especially when the medium is excessively wet. Seedlings suffering from damping-off appear pinched at the soil line, fall over, and die. For more information, see the Vegetable Diseases section on page 42.

Hardening Off

Transplants grown in a cold frame are stockier and better able to withstand outside garden conditions than transplants grown indoors or in a greenhouse. Before setting out tender transplants, place them in a cold frame for 1 to 2 weeks to acclimate them to colder temperatures, brighter light, and wind. This greatly increases their chances of survival once they are set in the garden.

If a cold frame is unavailable, move plants outdoors for an increasing amount of time during the day over 1 to 2 weeks to harden them off. If the nights are cool, bring them back inside. Not doing so often causes excess stress on the transplants and slows their establishment in the garden.

Cold Frame

Cabbage, broccoli, and cauliflower transplants are easy to grow in an outside cold frame. Build a simple frame and cover it with polyethylene. Plants grown in a cold frame require 8 to 10 weeks to reach a size suitable for setting in the garden, so start early. Place the cold frame in a sunny location with the low side facing south and the high back facing north. Paint the inside white to reflect light and promote uniform growth.

Since temperatures in a cold frame are frequently below the optimum for seed germination, plant seeds in trays in a soilless mix and germinate them indoors; once the seeds have germinated, move them to the cold frame. On clear days when the air temperature is 45°F or higher, open or remove the cold frame cover for ventilation. Thin the seedlings so they stand a half-inch or more apart. Crowding results in spindly, weak transplants. Fertilize to promote growth.

Growing onion transplants requires considerable time. Start by planting seeds in a cold frame in September or October in closely spaced rows. Transplants will be ready for planting in January and February. To have transplants of cabbage, broccoli, and other cool-season vegetables ready in time for spring planting, you must start very early in the year, which may not be practical. However, these vegetables can be grown as transplants for the fall garden.

Sweet potato transplants (slips) are produced by sprouting sweet potatoes (mother roots) in beds of sawdust or sand kept near 80°F. However, diseases in the mother roots can be transmitted to the slips. Gardeners should purchase certified disease-free slips or use vine cuttings to reduce the risk of disease. Vine cuttings are taken from the aboveground vines of the plant, which are less likely to carry soilborne pathogens. These cuttings root quickly when planted in warm, moist garden soil.

Buying Transplants

When buying vegetable transplants, select recommended varieties. Plants that have good, healthy roots (white, not brown or black) and that are stocky, medium-sized, and free of diseases or insects are best. Avoid yellow, spindly, or oversized plants and those with spotted foliage, brown marks on the stems, or knots on the roots.

Transplanting to the Garden

When it is time to plant, dig a hole in the prepared soil. Remove the transplants from their plastic pots, being careful not to damage them. Place your hand over the top of the pot, with the stem between your index and middle fingers, and invert the plant into your hand. Then, carefully loosen the root ball and place it into the hole.

Before planting, do not remove transplants grown in fiber pots, such as peat pots. Cover the fiber pots completely with soil, including their upper edges. Plant tall tomato transplants deeply so that the lowest set of leaves is close to the soil surface.

Protecting Transplants

Protecting newly planted plants from extreme sun, cold, and wind may be necessary, depending on the weather. Homemade shelters include boxes, baskets, pots, and plastic milk containers. Commercial hot paper or plastic caps protect young, tender plants from frost. A wooden shingle stuck in the ground at a slant on the south side of a plant serves as a sunshade. A newspaper or a paper bag pinned down protects tender plants from sunscald.

Wrap the bottom 12 to 18 inches of wire tomato cages with clear plastic to protect transplants from wind, cold, and blowing sand. You may prefer to avoid this hassle altogether by planting the garden a week or two later when the weather is warmer. Also, warm-season vegetables do not grow well in cold soil and cool air temperatures. Therefore, planting extra early—before the weather warms in the spring—may not give earlier or higher yields.

Sowing and Thinning Tips

Start with fresh seeds or properly stored older seeds with good germination rates. While older seeds can be used, compensate for their lower germination by planting more. If they show poor germination or low vigor, purchase fresh seed.

Begin by marking straight rows using stakes and a string or cord. Clear the seedbed of clods, rocks, and debris, and add fertilizer if it hasn't already been applied. Use the handle of a hoe to create shallow furrows for small seeds or the corner of the blade for deeper furrows. In spring, plant seeds shallowly to speed up germination. As the season progresses, plant them slightly deeper to prevent them from drying out during germination.

Distributing small seeds thinly and evenly can be challenging. Mix them with dry sand or pulverized soil for more even sowing. To mark the rows for slow-germinating seeds, like carrots, intercrop them by sowing a quick-germinating crop, like radishes. The radishes will sprout quickly, making it easier to care for the row while waiting for the carrots to emerge.

Seeds large enough to handle, such as sweet corn, squash, pumpkins, watermelons, and okra, can be planted in groups (hills) or spaced evenly in rows (drilled). For hills, create evenly spaced mounds of soil at the recommended spacing, then sow several seeds in each mound. When planting rows, evenly space seeds, like beans, peas, beets, chard, and carrots, about 1 inch apart, adjusting for the final plant spacing.

After placing the seeds, cover them with soil according to the recommended planting depths on the seed packet or from Table 1 on page 3. Firm the soil gently over the seeds with the flat blade of a hoe, being careful not to pack it too tightly. Avoid planting seeds too deeply, as this can hinder germination.

Once seedlings emerge and are established, thin them to prevent overcrowding. For plants like sweet corn, okra, and squash, thin to one plant per hill, and for pumpkins and melons, keep two plants per hill. While thinning may seem wasteful, avoiding competition for water, space, nutrients, and sunlight is essential because it can reduce yields and increase susceptibility to disease.

Choose the strongest seedlings to keep and carefully remove excess plants using a hoe, rake, or your fingers. In densely planted areas, pinch or cut excess seedlings to avoid disturbing the roots of the remaining plants. Some seedlings, like lettuce and greens, can be transplanted to fill gaps or shared with other gardeners. Edible thinnings can also be harvested and eaten.

Soil temperature plays a critical role in seed germination. Cool-season vegetables typically germinate at 60°F, while warm-season vegetables germinate best at 75°F. Seeds left in the soil too long without sprouting may succumb to diseases or pests. To raise soil temperature for early planting of warm-season crops, use black plastic mulch.

Plastic row tunnels, floating row covers, and black plastic mulch can extend the growing season and provide some protection from cold weather. Floating row covers, made of non-woven polyester, also help shield early plants from insects. Combining these tools with black plastic mulch can create an ideal environment for early planting.

Spring Gardening

Spring Planting Dates

Planting at the right time is essential for crops to grow and yield successfully because they have specific light and temperature requirements. Use Figure 2 and Table 6 to determine the spring planting dates for your garden. Start by locating your garden's location on the map in Figure 2. This will show you your spring planting area (1, 2, 3, 4, or 5). Remember that some counties fall into two or more areas due to varying local conditions.

The planting areas are based in part on weather data for the median (most common) dates of the last spring freeze (32°F or lower). While freezes can occur after these dates, such events are rare. (Note: These planting areas are not the same as USDA plant hardiness zones.)

Table 6 includes planting recommendations for both cool-season and warm-season crops. Most crops are listed

by plant family to assist with crop rotation, and optimal planting dates are provided for each area. The table also indicates whether crops should be sown directly into the soil or transplanted as seedlings. When this information is not provided (e.g., carrots), they should be sown directly into the soil. Additional notes, such as successive planting information and minimum soil temperatures for germination, are included to help you succeed.

Cool-season vegetables, such as broccoli, cabbage, Chinese cabbage, cauliflower, collards, kale, spinach, Swiss chard, and rutabagas, can be planted in spring and fall. In the fall, however, they often yield higher-quality produce with better flavor and texture and may offer a longer harvest window. Cooler temperatures and shorter days slow bolting and prolong growth, making fall an ideal season for these crops. Warm-season vegetables are typically planted in the spring but can often be replanted in summer for a fall harvest. See the Fall Planting Dates section on page 22 for more information.

The planting dates for specific crops are designed to align with their temperature requirements for germination and growth. For example, beets are recommended for planting in Area 1 from January 15 to March 15. This window ensures that soil temperatures are warm enough for germination and allows the plants to mature before the summer heat arrives. Similarly, tomatoes in Area 1 have an ideal planting window from March 1 to March 15, when soil temperatures are warm enough to support root growth. Planting later may result in reduced yields, as high temperatures can prevent tomato flowers from forming fruits.

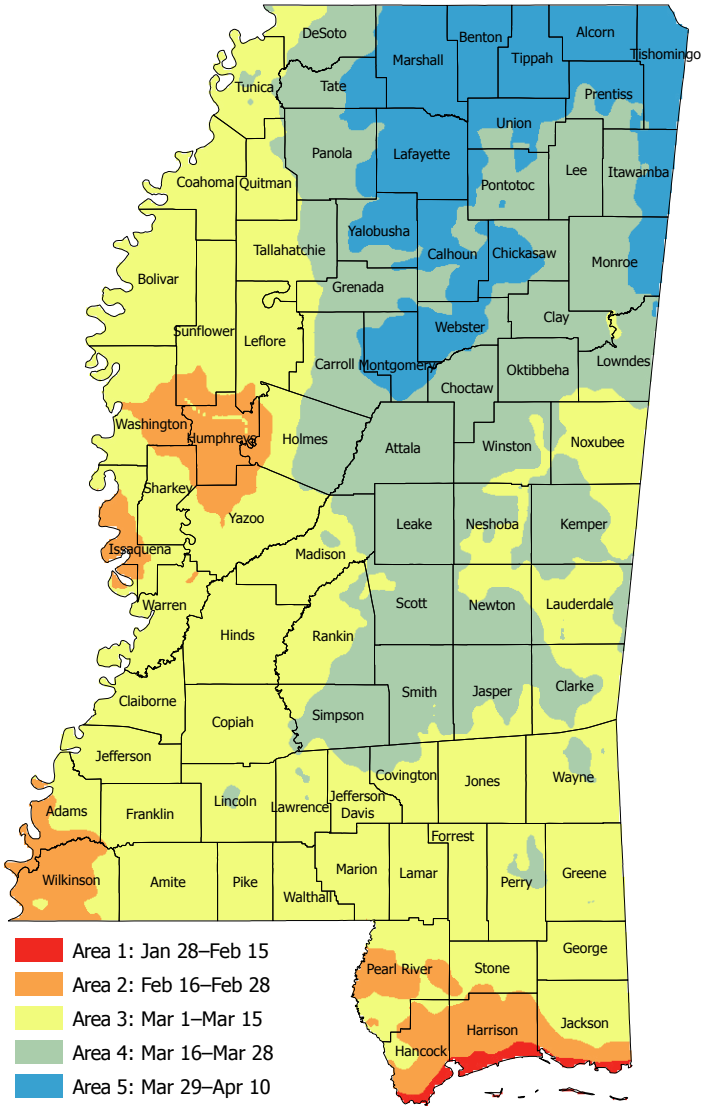


Figure 2. Median dates of last freezes in spring. Use this map to locate your area for Table 6. Climate data obtained from PRISM Climate Group, Oregon State University; data created for 1991–2023.

Table 6. Spring planting dates.

Cool-Season Crops	Area 1	Area 2	Area 3	Area 4	Area 5	Successive Planting/Notes
Alliums						
Leeks (plants, 8–10 weeks old)	Jan 15–Feb 15	Feb 1–Mar 1	Feb 15–Mar 15	Mar 1–Apr 1	Mar 15–Apr 15	Sow in fall for spring harvest
Dry bulb onions (sets or plants, 10–12 weeks old)	Jan 15–Feb 15	Jan 15–Feb 20	Feb 1–Mar 1	Feb 15–Mar 15	Mar 1–Apr 1	Sow in fall for spring harvest
Green onions (scallions)	Jan 15–Mar 1	Jan 20–Mar 5	Feb 1–Mar 15	Feb 15–Apr 1	Mar 1–Apr 15	2–3 weeks when entire plant is harvested
Shallots (sets or plants, 10–12 weeks old)	Jan 15–Feb 15	Jan 15–Feb 20	Feb 1–Mar 1	Feb 15–Mar 15	Mar 1–Apr 1	Sow in fall for spring harvest
Brassicas (Cole Crops)						
Asian greens (direct sow or plants, 4–6 weeks)	Jan 15–Mar 15	Feb 1–Apr 1	Feb 15–Apr 15	Mar 1–Apr 15	Mar 15–Apr 30	2–3 weeks (e.g., tatsoi, mizuna, komatsuna)
Bok choy (pak choi, plants, 4–6 weeks old)	Jan 15–Mar 1	Feb 1–Mar 15	Feb 15–Apr 1	Mar 1–Apr 15	Mar 15–Apr 15	2–3 weeks
Broccoli (plants, 6–8 weeks old)	Jan 15–Mar 10	Jan 15–Mar 10	Feb 15–Mar 15	Mar 1–Mar 20	Mar 15–Apr 1	2–3 weeks
Brussels sprouts (plants, 6–8 weeks old)	Jan 15–Mar 1	Jan 15–Mar 1	Feb 15–Mar 1	Mar 1–Mar 15	Mar 15–Apr 1	Fall planting may be more successful than spring
Cabbage (plants, 6–8 weeks old)	Jan 15–Mar 15	Jan 15–Mar 15	Feb 5–Apr 1	Mar 1–Mar 20	Mar 15–Apr 1	2–3 weeks
Chinese cabbage (plants, 4–6 weeks old)	Jan 1–Feb 1	Jan 15–Feb 15	Feb 1–Mar 1	Feb 1–Mar 15	Mar 1–Apr 1	2–3 weeks
Cauliflower (plants, 6–8 weeks old)	Jan 15–Mar 10	Jan 15–Mar 10	Feb 15–Mar 15	Mar 1–Mar 20	Mar 15–Apr 1	2–3 weeks
Collards (plants, 4–6 weeks old or direct sow)	Jan 15–Apr 1	Jan 15–Apr 1	Feb 1–Apr 1	Feb 15–Apr 1	Mar 1–Apr 1	
Kale (plants, 4–6 weeks old or direct sow)	Jan 15–Apr 1	Jan 15–Apr 1	Feb 1–Apr 1	Feb 15–Apr 1	Mar 1–Apr 1	
Kohlrabi (plants 4–6 weeks old or direct sow)	Feb 1–Apr 1	Feb 1–Apr 1	Feb 15–Apr 1	Mar 1–Apr 1	Mar 15–Apr 1	2–3 weeks
Mustard greens	Jan 15–Mar 1	Feb 1–Mar 15	Feb 15–Apr 1	Mar 1–Apr 15	Mar 15–Apr 15	2 weeks when entire plant is harvested; soil 45–85°F for germination
Leafy Greens						
Arugula	Jan 15–Mar 1	Feb 1–Mar 15	Feb 15–Apr 1	Mar 1–Apr 15	Mar 15–Apr 15	2 weeks
Head lettuce (plants, 4–6 weeks old)	Jan 15–Apr 1	Jan 15–Apr 1	Feb 1–Apr 10	Feb 15–Apr 15	Mar 1–Apr 15	2 weeks
Leaf lettuce	Jan 15–Apr 1	Jan 15–Apr 1	Feb 1–Apr 10	Feb 15–Apr 15	Mar 1–Apr 15	2–3 weeks when entire plant is harvested
Spinach (plants, 4–6 weeks old or direct sow)	Jan 15–Mar 1	Feb 1–Mar 10	Feb 15–Mar 20	Mar 1–Apr 1	Mar10–Apr 10	2 weeks; soil >45°F for germination
Swiss chard (plants, 4–6 weeks old or direct sow)	Jan 15–Mar 1	Feb 1–Mar 15	Feb 15–Apr 1	Mar 1–Apr 15	Mar 15–Apr 15	2–3 weeks when entire plant is harvested

Cool-Season Crops	Area 1	Area 2	Area 3	Area 4	Area 5	Successive Planting/Notes
Legumes						
English peas (snow/ sugar)	Jan 15–Mar 1	Feb 1–Mar 5	Feb 10–Mar 15	Feb 20–Mar 25	Mar 1–Apr 1	
Nightshades						
Irish potatoes (tuber pieces)	Jan 20–Mar 1	Jan 25–Mar 10	Feb 1–Mar 15	Feb 15–Mar 20	Feb 20–Apr 1	Soil >40°F for consistent sprouting
Root Vegetables						
Beets	Jan 15–Mar 15	Feb 1–Mar 15	Feb 15–Apr 1	Mar 1–Mar 20	Mar 15–Apr 1	3 weeks
Carrots	Jan 15–Mar 1	Feb 1–Mar 15	Feb 15–Apr 1	Mar 1–Apr 15	Mar 15–Apr 20	3 weeks; soil >40°F for germination
Parsnips	Jan 15–Feb 15	Jan 15–Feb 20	Feb 1–Mar 1	Feb 15–Mar 15	Mar 1–Apr 1	Warm soil with black plastic before sowing; plant late summer/early fall plantings for best quality
Radishes	Jan 15–Apr 15	Feb 1–Apr 15	Feb 15–Apr 15	Mar 1–May 1	Mar 15–May 1	1–2 weeks; soil >50°F for germination
Rutabagas	Jan 15–Feb 15	Feb 1–Mar 1	Feb 15–Mar 15	Mar 1–Mar 25	Mar 10–Apr 1	Soil >50°F for germination
Turnips	Jan 15–Mar 1	Feb 1–Mar 15	Feb 15–Apr 1	Mar 1–Apr 15	Mar 15–May 1	2–3 weeks; soil >50°F for germination
Herbs						
Chives (plants, 8–10 weeks old or direct sow)	Jan 15–Mar 1	Jan 20–Mar 15	Feb 1–Apr 1	Feb 15–Apr 15	Mar 1–May 1	
Cilantro	Jan 15–Feb 15	Feb 1–Mar 1	Feb 15–Mar 15	Mar 1–Apr 1	Mar 15–May 15	2 weeks
Dill	Jan 1–Feb 15	Jan 15–Mar 1	Feb 1–Mar 15	Feb 15–Apr 1	Mar 1–Apr 15	3 weeks
Fennel (plants, 6–8 weeks old)	Jan 15–Mar 1	Feb 1–Mar 15	Feb 15–Apr 1	Mar 1–Apr 15	Mar 15–Apr 15	3–4 weeks
Parsley (plants, 8–10 weeks old)	Jan 15–Mar 1	Feb 1–Mar 15	Feb 15–Apr 1	Mar 1–Apr 15	Mar 15–Apr 15	
Miscellaneous						
Celery (plants, 8–10 weeks old)	Jan 15–Feb 15	Feb 1–Mar 1	Feb 15–Mar 15	Mar 1–Apr 1	Mar 15–Apr 15	

Warm-Season Crops	Area 1	Area 2	Area 3	Area 4	Area 5	Successive Planting/Notes
Grasses						
Corn (field, popcorn)	Mar 15–Apr 15	Mar 20–Apr 20	Apr 1–May 1	Apr 10–May 10	Apr 15–May 15	Soil >50°F for germination
Sweetcorn	Feb 25–Mar 15	Mar 1–Apr 1	Mar 20–Apr 15	Apr 1–Apr 20	Apr 5–May 1	2 weeks; soil >60°F for standard varieties, >70°F for supersweet types (sh2)
Cucurbits						
Cucumbers	Mar 15–Jul 1	Mar 25–Jun 20	Apr 1–Jun 15	Apr 10–Jun 10	Apr 15–Jun 5	3–6 weeks; soil >60°F for good germination
Melons (cantaloupe, watermelon, etc.)	Mar 1–May 15	Mar 15–May 20	Apr 1–May 15	Apr 10–Jun 1	Apr 15–Jun 1	3–6 weeks
Summer squash (crookneck, zucchini, etc.)	Feb 15–May 15	Mar 15–May 20	Apr 1–May 25	Apr 10–Jun 1	Apr 15–Jun 1	3–6 weeks; soil >60°F for good germination
Winter squash (pumpkins, gourds, acorn squash, etc.)	Mar 15–May 15	Mar 25–May 20	Apr 1–Jun 1	Apr 10–Jun 5	Apr 15–Jun 15	Soil >70°F for germination

Warm-Season Crops	Area 1	Area 2	Area 3	Area 4	Area 5	Successive Planting/Notes
Seedless watermelons (plants, 3–4 weeks old)	Mar 1–May 1	Mar 15–May 10	Apr 10–May 20	Apr 20–Jun 1	Apr 25–Jun 1	Seedless watermelons can be challenging to direct sow
Leafy Greens						
Malabar spinach	Mar 1–Apr 15	Apr 1–May 1	Apr 10–May 15	Apr 15–Jun 1	Apr 20–Jun 15	3–4 weeks
New Zealand spinach	Mar 1–Apr 15	Mar 5–Apr 20	10 Mar–25 Apr	Apr 15–Jun 1	Apr 20–Jun 15	3–4 weeks
Legumes						
Dry/shelling beans	Mar 15–Jun 15	Mar 20–Jun 10	Mar 25–Jun 1	Apr 1–May 25	Apr 10–May 20	Soil >60°F; avoid wet weather during harvest
Snap bean	Mar 15–Jun 15	Mar 20–Jun 10	Mar 25–Jun 1	Apr 1–May 14	Apr 10–May 20	2–3 weeks; soil ≥60°F
Lima/yardlong bean	Mar 15–Jul 15	Mar 20–Jul 1	25 Mar–25 Jun	Apr 1–Jun 20	Apr 10–Jun 15	Small-seeded varieties mature faster; soil ≥65°F
Edamame (soybean)	Mar 15–Jun 15	Mar 20–Jun 10	25 Mar–5 Jun	Apr 1–Jun 1	Apr 10–Jun 1	Ensure consistent irrigation; harvest pods before yellowing; let pods fully mature for soybean production
Peanuts	Mar 15–May 15	Mar 20–May 20	Apr 1–May 25	Apr 10–Jun 1	Apr 15–Jun 1	
Southern peas	Mar 1–Jun 15	Mar 15–Jun 15	Apr 10–Jun 25	Apr 15–Jul 1	Apr 20–Jul 15	2–3 weeks; soil >60°F for germination
Jicama	Mar 1–Apr 15	Mar 15–May 1	Apr 1–May 15	Apr 15–May 25	May 1–Jun 1	
Nightshades						
Eggplant (plants, 6–8 weeks old)	Mar 25–Jun 20	Apr 1–Jun 10	Apr 10–Jun 5	Apr 15–Jun 1	Apr 20–May 20	3 weeks for determinant varieties; soil >65°F for good growth
Ground cherries (plants, 6–8 weeks old)	Mar 20–May 15	Mar 25–Jun 1	Apr 1–Jun 1	Apr 10–Jun 1	Apr 15–Jun 1	2–3 weeks
Peppers (plants, 6–8 weeks old)	Mar 20–May 15	Apr 1–May 15	Apr 10–May 15	Apr 15–Jun 1	Apr 20–Jun 1	3 weeks for determinant varieties; can plant earlier if soil is consistently >60°F
Tomatillos (plants, 6–8 weeks old)	Mar 1–Mar 15	Mar 10–Apr 5	Apr 1–May 1	Apr 15–Jun 15	Apr 20–Jul 1	Soil >60°F for transplant growth
Tomatoes (plants, 6–8 weeks old)	Mar 1–Mar 15	Mar 10–Apr 5	Apr 1–May 1	Apr 15–Jun 15	Apr 20–Jul 1	2–3 weeks for determinant varieties; soil >60°F for transplant growth
True seed Irish potatoes (plants, 8–10 weeks old)	Feb 15–Mar 1	Feb 20–Mar 10	Mar 1–Mar 15	Mar 15–Apr 1	Mar 20–Apr 1	Use heat-tolerant varieties like Clancy; harden off seedlings
Herbs						
Basil (plants, 4–6 weeks old)	Mar 15–Aug 1	Mar 20–Jul 15	Apr 1–Jul 10	Apr 10–Jun 25	Apr 20–Jul 1	3–4 weeks; soil >65°F at planting
Summer savory (plants, 4–6 weeks old)	Mar 15–Aug 10	Mar 20–Jul 20	Apr 1–Jul 15	Apr 10–Jul 1	Apr 20–Jul 5	3–4 weeks
Miscellaneous						
Jerusalem artichoke (tubers)	Feb 15–Mar 15	Mar 1–Apr 1	Mar 15–Apr 20	Mar 20–May 1	Mar 25–May 15	
Okra	Mar 15–May 15	Apr 1–May 20	Apr 10–May 25	Apr 15–May 25	May 1–Jun 1	3–4 weeks
Sweet potatoes (plants/slips)	Apr 15–Jun 15	Apr 20–May 20	Apr 25–May 25	May 1–Jul 1	May 5–Jul 1	

Fall Gardening

Fall is one of the best times to garden in Mississippi, offering the unique advantage of growing both cool-season and warm-season crops simultaneously. With careful planning, a fall garden can provide fresh vegetables right into winter and even into early spring. Many cool-weather crops, such as broccoli, kale, and spinach, thrive in cooler temperatures and with shorter fall days, often producing higher-quality harvests than in spring. Warm-season crops like tomatoes, okra, and peppers can continue producing until the first frost if properly cared for or replanted midsummer for a fall harvest.

Fall gardening is particularly beneficial for crops that struggle in the spring. For example, Chinese cabbage, which is sensitive to heat, and rutabagas, which need an extended period of cool weather, often perform better when planted in late summer or early fall. Some crops, such as garlic, must be planted in the fall and harvested in spring, while others, like cilantro and parsley, can be planted in the fall and harvested periodically until the following spring.

Planning is essential for fall gardening. Seeds and transplants may be difficult to find in late summer, so it's best to purchase seeds in winter or early spring and store them in an airtight container in the refrigerator until you are ready to plant them. A fall garden also provides a second opportunity to grow crops that may not have performed well in spring due to wet weather or other challenges.

Fall Planting Dates

Timing is crucial for a successful fall garden. As with spring gardening, planting crops at the right time in the fall ensures they have enough time to mature before cold temperatures and shorter days impact growth and yield. Refer to Figure 3 and Table 7 to find the recommended planting windows for your crops. These areas are partly based on the median first freeze dates in the fall and differ from USDA plant hardiness zones.

The table divides crops into cool- and warm-season categories. It provides planting windows for each fall planting area and information about which crops should be transplanted or directly sown into the soil. As with the spring planting table, if no details are provided about transplants, it should be assumed they should be sown directly, similar to carrots. Successive planting and other cultural notes are included to help maximize yields.

Many summer garden plants, such as tomatoes, okra, peppers, and eggplants, can be carried over into the fall if they are kept healthy throughout the summer. This requires regular watering, fertilizer, pruning, disease control, and pest control. If these plants are in poor condition, they can be replanted midsummer for a fall harvest. Warm-season crops replanted in midsummer may require extra time to mature as cooler weather and shorter days slow growth.

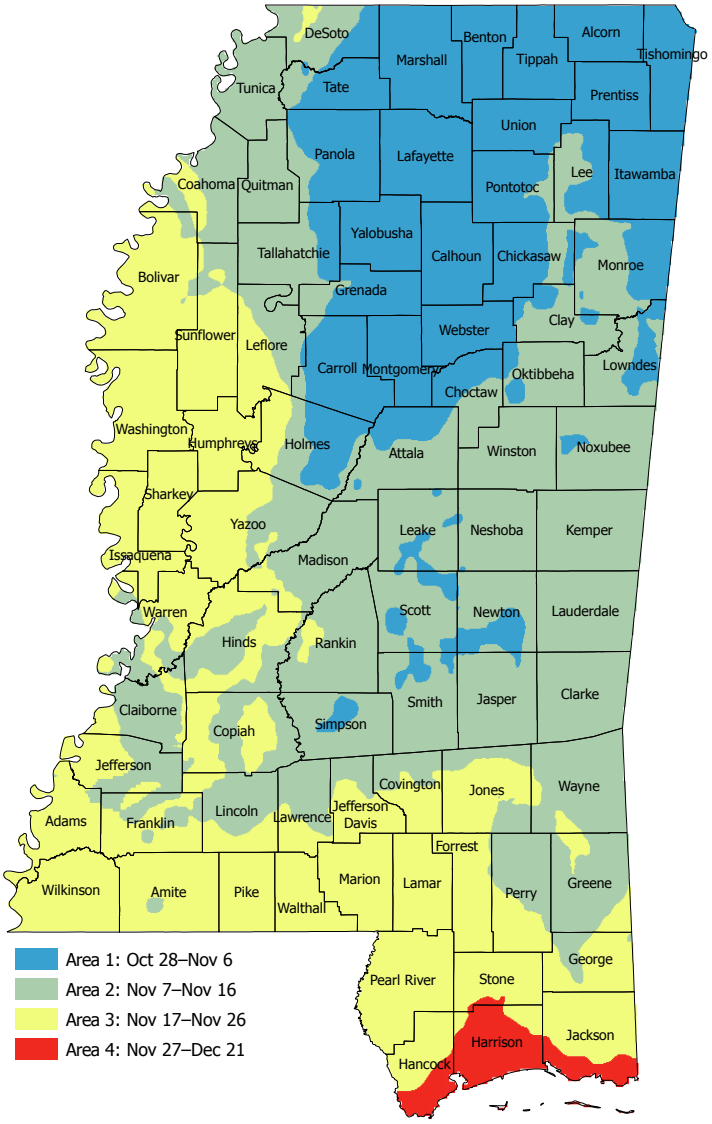


Figure 3. First median freeze dates in fall. Use this map to locate your area for Table 7. Climate data obtained from PRISM Climate Group, Oregon State University; data created for 1991–2023.

Cool-season crops, on the other hand, thrive in fall's cooler temperatures. Many crops, like broccoli, kale, and parsley, can continue producing long into the winter months. However, in particularly harsh winters, some crops may not survive or may show stunted growth until spring warmth returns.

Planting in Summer Heat for a Fall Harvest

The hot, dry weather of late summer can make it challenging for seeds to germinate and survive. To improve germination and seedling survival:

- Water the soil a day or two before planting. Avoid heavy overhead watering immediately after planting, as this can cause the soil surface to pack and crust.
- Cover seeds with a moistened material that will not form a crust, such as a mix of peat moss and vermiculite or composted sawdust and sand. Keep the surface moist during germination and seedling establishment.
- For small-seeded plants like broccoli or cabbage, plant three to five seeds at the recommended spacing, then thin to one plant per location once established. (Note: Thinned seedlings can be successfully transplanted to open locations, but this must be done carefully. Water them well. Extra shade may be necessary to help reduce transplant shock.)
- Monitor the garden daily to ensure the seeds and young plants do not dry out.

Starting vegetable transplants for the fall garden can improve your success. To minimize root disturbance and reduce transplant shock, use individual containers, such as peat pots, small clay or plastic pots, or peat pellets. If the temperatures are extreme during transplant, protecting young plants from the sun for a few days may improve their success rate.

Pests and Diseases in Fall

Pests and diseases can make fall gardening challenging, just as in spring and summer. However, pest pressures shift throughout the year, creating opportunities to grow crops that may struggle in spring. For example, squash vine borers, which can be highly problematic for zucchini in spring, are typically less active in late summer and fall, allowing for a more successful harvest. In some cases, pest pressure can even be worse in the fall. For instance:

- Cabbage loopers and imported cabbage moths are significant problems for crops like cabbage, broccoli, cauliflower, and collards. Use biological sprays to manage these leaf-eating worms.
- Squash bugs can damage fall squash and pumpkins. Regular monitoring and control measures are essential.
- Sweet corn planted in late summer may experience higher insect pressure than spring-planted corn. Therefore, pest management strategies should be adjusted accordingly.

Proper care, such as maintaining plant health through regular watering, fertilization, and pest control, can help minimize the impact of pests and diseases. Remember that fall crops need fresh fertilizer applications, as nutrients added in spring may no longer be available.

Winter Arrival: Extending the Harvest

Monitor weather forecasts closely as frost approaches. While warm-season crops will decline with colder temperatures, some can be protected from light frosts using frost cloth or row covers, allowing them to continue producing for a few extra weeks. When a killing frost is inevitable, harvest tender vegetables like green tomatoes, which can be ripened indoors by wrapping them in paper and storing them in a cool place.

The frost doesn't mean the end of the garden. Many cool-season crops thrive in Mississippi's mild winters and can be harvested well into the cold months. Leafy greens like collards, kale, mustard, and spinach actually improve in flavor after frost, and root crops like carrots, turnips, radishes, and rutabagas can be left in the ground and harvested as needed. Broccoli, cauliflower, and cabbage also tolerate cold temperatures and continue growing through much of the winter.

After the first hard freeze, clean up warm-season crop debris, store stakes and poles, and prepare for early spring plantings like Irish potatoes and English peas. Take a soil test and use the winter months to plan for the next growing season. With the right crop selection and a little protection, Mississippi gardeners can enjoy fresh harvests year-round.

Table 7. Fall planting dates.

Cool-Season Crops	Area 1	Area 2	Area 3	Area 4	Successive Planting/Notes
Alliums					
Garlic (cloves)	Oct 1–Nov 10	Oct 10–Nov 15	Oct 15–Nov 20	Oct 25–Dec 5	Fall planting; spring harvest
Leeks (seed)	Aug 15–Sep 25	Sep 1–Oct 5	Sep 15–Oct 20	Oct 1–Nov 1	Overwinter for late winter/spring harvest
Leeks (plants, 8–10 weeks old)	Sep 1–Oct 10	Sep 15–Oct 20	Sep 20–Nov 1	Oct 1–Nov 10	
Dry bulb onions (seed)	Sep 1–Oct 10	Sep 10–Oct 15	20 Sep–20 Oct	Oct 1–Nov 1	Fall sowing; spring harvest
Green onions (scallions)	Sep 1–Oct 10	Sep 10–Oct 20	Sep 15–Nov 1	Oct 1–Nov 10	2–3 weeks when entire plant is harvested
Shallots (seed)	Sep 15–Oct 10	Oct 1–Oct 15	Oct 10–Nov 1	Oct 15–Nov 10	Fall sowing; spring harvest
Shallots (sets)	Oct 1–Nov 10	Oct 15–Nov 10	Oct 20–Nov 15	Nov 1–Dec 5	Faster than seed; overwinter for spring harvest
Brassicas (Cole Crops)					
Asian greens	Sep 1–Oct 5	Sep 10–Oct 15	Sep 20–Nov 1	Oct 1–Nov 10	2–3 weeks
Bok choy (pak choi, transplants, 4–6 weeks old)	Aug 15–Sep 10	Sep 1–Sep 20	Sep 10–Oct 10	Sep 20–Oct 15	Use heat-tolerant varieties for earlier plantings
Broccoli (plants, 6–8 weeks old)	Aug 15–Sep 15	Sep 1–Sep 20	Sep 10–Oct 1	Sep 20–Oct 10	Use heat-tolerant varieties for earlier plantings
Brussels sprouts (plants, 6–8 weeks old)	Aug 1–Aug 25	Aug 15–Sep 5	Sep 1–Sep 15	Sep 10–Sep 25	Plant early in fall
Cabbage (plants, 6–8 weeks old)	Aug 15–Sep 25	Sep 1–Oct 10	Sep 15–Oct 15	Oct 1–Oct 20	2–3 weeks
Chinese cabbage (plants, 4–6 weeks old)	Aug 1–Sep 5	Aug 15–Sep 20	Sep 1–Oct 5	Sep 15–Oct 15	
Cauliflower (plants, 6–8 weeks old)	Aug 15–Sep 5	Sep 1–Sep 15	Sep 10–1 Oct	Sep 15–Oct 10	Use heat-tolerant varieties for early planting
Collards (plants, 4–6 weeks old or direct sow)	Aug 1–Oct 10	Aug 15–Oct 20	Sep 1–Nov 1	Sep 15–Nov 15	Frost-tolerant; extended harvest possible
Kale (plants, 4–6 weeks old or direct sow)	Aug 1–Oct 10	Aug 15–Oct 20	Sep 1–Nov 1	Sep 15–Nov 15	Frost improves flavor
Kohlrabi (plants 4–6 weeks old or direct sow)	Aug 15–Sep 10	Sep 1–Sep 20	Sep 10–Oct 10	Sep 20–Oct 15	
Mustard greens	Sep 1–Oct 10	Sep 10–Oct 15	Sep 15–Nov 1	Oct 1–Nov 15	Frost improves quality
Leafy Greens					
Arugula	Sep 1–Oct 10	Sep 7–Oct 15	Sep 15–Oct 25	Sep 20–Nov 15	
Head lettuce (plants, 4–6 weeks old)	Aug 15–Sep 20	Sep 1–Oct 1	Sep 10–Oct 15	Sep 20–Nov 1	
Leaf lettuce	Aug 15–Sep 20	Sep 1–Oct 1	Sep 10–Oct 15	Sep 20–Nov 1	
Spinach (plants, 4–6 weeks old or direct sow)	Sep 1–Oct 10	Sep 10–Oct 20	Sep 20–Nov 1	Oct 1–Nov 15	Best germination at soil temps <75°F; frost improves flavor
Swiss chard (plants, 4–6 weeks old or direct sow)	Aug 1–Sep 25	Aug 15–Oct 5	Sep 1–Oct 15	Sep 15–Nov 1	2–3 weeks when entire plant is harvested
Legumes					
English peas (snow/sugar)	Sep 1–Oct 1	Sep 10–Oct 15	Sep 15–Nov 1	Oct 1–Nov 15	Injury at <28°F
Root Vegetables					
Beets	Aug 15–Sep 25	Sep 1–Oct 5	Sep 10–Oct 20	Sep 20–Nov 1	
Carrots	Aug 15–Sep 25	Sep 1–Oct 5	Sep 10–Oct 20	Sep 20–Nov 1	
Parsnips	Aug 1–Aug 25	Aug 15–Sep 5	Sep 1–Sep 20	Sep 15–Oct 10	Fall sowing; spring harvest

Cool-Season Crops	Area 1	Area 2	Area 3	Area 4	Successive Planting/Notes
Irish potatoes (2–4 oz tuber pieces)	Aug 1–Aug 10	Aug 15–Aug 20	Sep 1–Sep 5	Sep 10–Sep 15	
Radishes	Sep 1–Nov 10	Sep 10–Nov 15	Sep 20–Nov 20	Oct 1–Dec 5	1–2 weeks
Rutabagas	Jul 25–Sep 1	Aug 5–Sep 15	Aug 15–Oct 1	Sep 1–Oct 15	Plant early for long growing season; frost often improves flavor
Turnips	Sep 1–Oct 20	Sep 10–Nov 1	Sep 20–Nov 15	Oct 1–Dec 1	Frost improves flavor
Herbs					
Chives (plants, 8–10 weeks old or direct sow)	Sep 1–Oct 5	Sep 10–Oct 20	Sep 15–Nov 1	Oct 1–Nov 10	Overwinter for spring harvest; frost-tolerant
Cilantro	Sep 1–Oct 10	Sep 10–Oct 20	Sep 20–Nov 15	Oct 1–Nov 15	Cut above crown for repeated harvests; coriander can be harvested in the spring
Dill	Sep 1–Oct 10	Sep 10–Oct 20	Sep 20–Nov 15	Oct 1–Nov 15	
Fennel (plants, 6–8 weeks old)	Aug 1–Aug 20	Aug 15–Sep 10	Sep 1–Sep 15	Sep 15–Oct 1	Harvest bulbs before frost
Parsley (plants, 8–10 weeks old)	Sep 1–Sep 20	Sep 15–Oct 5	Oct 1–Oct 15	Oct 15–Nov 1	Biannual; cut above crown for repeated harvest until bolting
Miscellaneous					
Celery (plants, 8–10 weeks old)	Aug 15–Sep 15	Sep 1–Sep 25	Sep 15–Oct 5	Sep 25–Oct 10	
Strawberries (plants, 12–14 weeks old)	Oct 1–Oct 15	Oct 10–Oct 25	Oct 20–Nov 10	Oct 25–Nov 15	June bearing (short-day) recommended

Warm-Season Crops	Area 1	Area 2	Area 3	Area 4	Successive Planting/Notes
Grasses					
Corn (field/popcorn)	Jul 1–Jul 10	Jul 10–Jul 20	Jul 15–Jul 30	Jul 20–Aug 1	Use short-season varieties; plant early to avoid frost
Sweetcorn	Jul 1–Jul 10	Jul 10–Jul 20	Jul 15–Jul 30	Jul 20–Aug 1	Use short-season varieties; heat during tasseling reduces yields
Cucurbits					
Cucumbers	Jul 15–Aug 1	Jul 20–Aug 10	Jul 25–Aug 15	Aug 1–Aug 20	Protect from frost if planted later in the season
Melons (cantaloupe, watermelon, etc.)	Jul 15–Aug 1	Jul 20–Aug 5	Jul 25–Aug 10	Aug 1–Aug 15	Plant early
Pumpkins	Jun 1–Jul 10	Jun 15–Jul 20	Jul 1–Aug 1	Jul 15–Aug 10	Select appropriate maturity dates for Halloween harvest
Summer squash (crookneck, zucchini, etc.)	Jul 15–Aug 1	Jul 20–Aug 10	Jul 25–Aug 15	Aug 1–Aug 20	
Winter squash (butternut, gourds, etc.)	Jun 1–Jul 10	Jun 10–Jul 20	Jul 1–Aug 1	Jul 15–Aug 15	Ensure enough days to harvest for long-season varieties
Seedless watermelons (plants, 3–4 weeks old)	Jul 15–Aug 1	Jul 20–Aug 5	Jul 25–Aug 10	Aug 1–Aug 15	Plant early
Leafy Greens					
Malabar spinach	Jul 15–Aug 1	Jul 20–Aug 10	Jul 25–Aug 15	Aug 1–Aug 20	3–4 weeks
New Zealand spinach	Jul 15–Aug 1	Jul 20–Aug 10	Jul 25–Aug 15	Aug 1–Aug 20	3–4 weeks
Legumes					
Dry/shelling bean	Jul 1–Jul 10	Jul 10–Jul 25	Jul 15–Aug 1	Jul 20–Aug 5	May be better suited for spring; needs warm, dry conditions to cure
Snap bean	Aug 1–Aug 10	Aug 5–Aug 20	Aug 10–Aug 25	Aug 15–Sep 1	2 weeks; choose quick-maturing varieties (50–60 days)

Warm-Season Crops	Area 1	Area 2	Area 3	Area 4	Successive Planting/Notes
Lima/yardlong bean	Aug 1–Aug 10	Aug 1–Aug 20	Aug 10–Aug 25	Aug 15–Sep 1	Heat-loving crop
Edamame (soybean)	Jul 15–Aug 1	Jul 20–Aug 5	Jul 25–Aug 10	Aug 1–Aug 15	Use early-maturing varieties (74–90 days)
Peanuts	Jul 1–Jul 15	Jul 10–Jul 25	Jul 15–Aug 1	Jul 20–Aug 5	Requires 120–140 frost-free days; plant early
Southern peas	Jul 1–Aug 1	Aug 1–Aug 20	Aug 10–Sep 1	Sep 1–Sep 15	Tolerates heat and drought well; productive in late summer
Nightshades					
Eggplant (plants, 6–8 weeks old)	Jul 1–Jul 15	Jul 15–Aug 1	Aug 1–Aug 15	Aug 10–Aug 25	Protect from frost with row covers if planted late
Ground cherries (plants, 6–8 weeks old)	Jul 15–Aug 1	Jul 20–Aug 5	Jul 25–Aug 10	Aug 1–Aug 15	Long growing season required; protect from early frost
Peppers (plants, 6–8 weeks old)	Jul 15–Aug 1	Jul 20–Aug 5	Jul 25–Aug 10	Aug 1–Aug 15	Extend season with row covers or tunnels from frost
Tomatillos (plants, 6–8 weeks old)	Jul 15–Aug 1	Jul 20–Aug 5	Jul 25–Aug 10	Aug 1–Aug 15	
Tomatoes (plants, 6–8 weeks old)	Jul 15–Aug 1	Jul 20–Aug 5	Jul 25–Aug 10	Aug 1–Aug 15	Use determinate or quick-maturing indeterminate varieties for fall planting
Herbs					
Basil (plants, 4–6 weeks old)	Aug 1–Aug 10	Aug 5–Aug 20	Aug 10–Aug 25	Aug 15–Sep 1	Use short-season varieties for late planting
Summer savory (plants, 4–6 weeks old)	Aug 1–Aug 10	Aug 5–Aug 20	Aug 10–Aug 25	Aug 15–Sep 1	
Miscellaneous					
Okra	Jul 1–Jul 15	Jul 10–Jul 25	Jul 15–Aug 1	Jul 20–Aug 10	
Sweet potatoes (plants/slips)	Jul 1–Jul 15	Jul 5–Jul 20	Jul 10–Jul 25	Jul 15–Aug 1	

MAINTENANCE

Watering

During the growing season, crops usually need about 1 inch of water (630 gallons per 1,000 square feet) per week. In midsummer, gardens with sandy soil may need as much as 2 inches of water. Each watering should wet the top 3 to 5 inches of soil.

Mulches that slow soil surface evaporation can reduce the amount of water needed. Soaker hoses and drip irrigation systems wet only the soil in the root zone and can cut the water needed in half.

Adequate soil moisture is crucial for seed germination, uniform growth, and productivity. The most critical periods for adequate moisture are during seed germination, early growth, flower and fruit development, root enlargement of root crops, and immediately following transplanting.

Sprinklers

There are several choices of garden sprinklers, ranging from simple garden hoses with spray nozzles to semi-automatic systems. Portable lawn sprinklers are often well-suited for the garden. When using any sprinkler, adjust the water application rate to match the absorption rate of the soil. Water applied too rapidly runs off, which is wasteful and causes erosion, creates puddles, and may cause soil compaction.

Place a sprinkler where plants do not block the spray. Mounting sprinklers above the crops may be necessary; however, wind may shift the distribution pattern when sprinklers are placed higher above the ground. Place small cans throughout the garden to measure the amount of water applied and show the overlap necessary to achieve an even application.

Since overhead sprinklers wet plant leaves, water early enough in the day to allow time for leaves to dry before night. This helps keep diseases from developing and spreading.

Drip Irrigation

Soaker hoses and perforated plastic hoses (e.g., drip tape) are great tools for watering gardens, especially when placed near the base of plants or beneath mulch. These hoses provide a steady water supply directly to the soil, helping maintain consistent moisture for healthy plant growth. Drip irrigation systems, which deliver water directly to the root zone, are another highly efficient option for conserving water while keeping plants healthy.

Drip irrigation systems are widely available through garden supply websites, local garden centers, and hardware stores. They operate at low pressure and deliver water slowly and precisely to plants. A typical system includes a supply line connected to a garden hose and delivery tubes with emitters placed near the plants. To prevent the emitters from clogging, install a 150-mesh filter at the start of the system. A pressure regulator may also be needed to prevent hoses from bursting due to excessive water pressure.

Irrigate during dry spells, typically three to four times a week, to keep plants healthy and actively growing. Reduce the irrigation schedule or shut off the system when rain returns to avoid overwatering. Monitoring soil moisture and adjusting the schedule based on weather conditions are key to preventing waterlogging or drought stress. Avoid extremes of wet and dry soil to ensure optimal growth.

Additional emitters or spray heads designed for drip systems may be required to provide full irrigation coverage over the root zone, especially in wide-row or raised-bed gardens.

Drip irrigation systems have many advantages:

- Reduce water use by 50 percent or more.
- Deliver water directly to the base of plants, minimizing waste.
- Compatible with plastic mulch use.
- Allow large gardens to be watered all at once.
- Enable access to the garden for harvesting, cultivating, and other garden tasks, even while in operation.
- Keep plant leaves dry, reducing the risk of disease.

The primary disadvantage of a drip system is the high initial cost.

Mulching

Mulch is any material used to cover garden soil. It offers benefits such as weed control, soil temperature regulation, moisture retention, and erosion prevention. It also protects plant roots, improves plant growth, enhances produce quality, and boosts yields. Mulches also reduce soil splashing on the plants, which helps prevent diseases.

There are many types of mulch, so it's important to consider the cost, availability, and characteristics when deciding which one to use.

Mulches are often divided into two general categories: natural and synthetic. Natural mulches come from nature and include organic and inorganic elements like rocks and gravel. Organic mulches are natural mulches made from living materials (e.g., plants and animals). Synthetic mulches are made from plastics, rubber, and landscape glass.

Organic Mulches

Common organic mulches include bark, leaves, grass clippings, straw, hay compost, paper, sawdust, and pine straw. These mulches are typically applied after crops are planted and are large enough that a 2- to 5-inch-deep layer will not smother them. Light and airy mulches, like pine straw and hay, must be 4 to 5 inches deep to be effective. Before applying mulch, ensure the area around the crops is weed-free, as weeds compete for nutrients, space, and water.

Organic mulches should be applied based on crop type and soil temperature needs. For warm-season crops, apply mulch in late spring to early summer, after the soil has warmed sufficiently, as applying too early can slow root growth. In contrast, for cool-season crops like broccoli, cabbage, and English peas, mulches applied in mid-spring help prevent rapid soil warming and drying, extending their growing and harvest windows.

Organic mulches improve soil as they decompose, enhancing water retention, nutrient availability, aeration, and structure while supporting beneficial organisms. However, microorganisms involved in decomposition can temporarily reduce soil nitrogen, especially with materials like sawdust, wood shavings, or corncobs. To prevent nitrogen deficiency, mix nitrogen fertilizer

(e.g., about one-fourth pound of 33-0-0 fertilizer per cubic foot of packed mulch) before mulch is installed or side-dress with nitrogen later if plants exhibit yellowing or slow growth.

Some mulching materials, like pine straw and oak leaves, are acidic and often thought to acidify soil, but this isn't the case. Their acidity breaks down quickly as they decompose. Any pH change is usually less than 0.1 units. In Mississippi, acidification is mainly from rainfall and nutrient leaching. Lime according to a soil test.

Finely ground peat moss makes a poor mulch. It is easily blown around by the wind and repels water when dry. Peat is best mixed with soil to improve organic matter content, moisture-holding capacity, and structure.

Newspapers or cardboard can also be used as mulch. Lay several sheets of newspaper or a single layer of cardboard on the soil and secure the mulch with soil, sticks, rocks, or landscape staples. Alternatively, organic mulches can be used to secure the newspapers or cardboard. Being organic, they can be tilled into the soil or left in place to decompose.

Synthetic Mulches

Plastic mulches are widely used in vegetable gardening to improve crop growth and yield. Unlike organic mulches, they are applied before planting. Plastic mulches help warm the soil, control weeds, conserve moisture, and reduce soilborne diseases by preventing soil splashing on the plants.

Black plastic mulch is the most common choice because it is inexpensive, widely available, and highly effective. It warms the soil, allowing for earlier planting, faster growth, and earlier harvests while protecting fruits and leaves. For durability, use 1.5-mil (0.0015-inch) plastic.

White plastic mulch, in contrast, reflects sunlight and keeps the soil cooler. This makes it ideal for heat-sensitive crops like lettuce and broccoli during warmer months, particularly in Mississippi's hot summers.

Clear plastic mulch warms the soil more rapidly than black plastic but can overheat plants in non-winter months. Therefore, it is not commonly used as a mulch for crops. Instead, it is primarily used for soil solarization to kill weeds, pests, and diseases before planting.

Plastic mulch is suitable for both warm- and cool-season crops, resulting in higher yields than bare soil. For planting, cut small holes in the mulch using a pointed tool, scissors, or a manual bulb planter for widely spaced crops like squash or melons. Plastic mulch is unsuitable for closely spaced crops like carrots or green onions.

For even greater benefits, combine black plastic mulch with plastic row tunnels to create a mini-greenhouse effect. This setup warms the soil, traps heat, and protects plants from frost and wind, enabling earlier planting in spring, extending the growing season in fall, or allowing cool-season crops to thrive through Mississippi's mild winters.

Prepare the soil completely before applying plastic mulch. Remove weeds and debris, break up large clods, and incorporate fertilizer and lime. Rake the soil to create a smooth, level surface, install drip lines for irrigation (if using), and water it thoroughly before laying the plastic if the soil is dry.

A standard garden row typically needs plastic mulch 3 to 4 feet wide. Apply it when there is little or no wind. Bury one end of the plastic and unroll it down the row. Ensure the plastic is straight and tight, touching the soil surface. Bury all edges to prevent wind from getting under the plastic and causing tears.

If you have a small garden less than 4 feet wide, use large sheets of black plastic to cover the whole area rather than individual rows. Be careful when stepping on wet plastic, as it can be slippery.

Soils lose less moisture from evaporation with plastic mulches, so you won't need to irrigate as often. In prolonged dry periods, supplemental water becomes necessary. Because plastic causes rain and overhead irrigation to roll off its surface (instead of soaking into the soil), you will need to irrigate the plants using other methods, such as drip irrigation or hand watering in the holes at the base of each plant. The easiest way to irrigate with plastic mulch is to install a drip irrigation system or lay soaker hoses on the surface of the rows before laying the plastic.

Because plastic mulch protects soil from leaching rain, the soil needs less fertilizer. When additional fertilizer is required, apply it through the planting holes or upside-down "T" slits cut at intervals into the plastic as shown in Figure 4.

Although plastic warms the soil in spring, it can have disadvantages in summer. Excess heat may build up under the plastic, injuring plant roots and reducing yields. Rather than removing the plastic and losing the advantage of weed control, cover the plastic with pine straw, hay, or similar organic mulches to provide shade where the crop foliage does not.

Another technique is spraying black plastic mulch with white latex paint after an early crop to reduce heat buildup under the mulch during the summer. This will make the mulch useful for summer and fall vegetables. The light-colored surface reflects much of the heat while

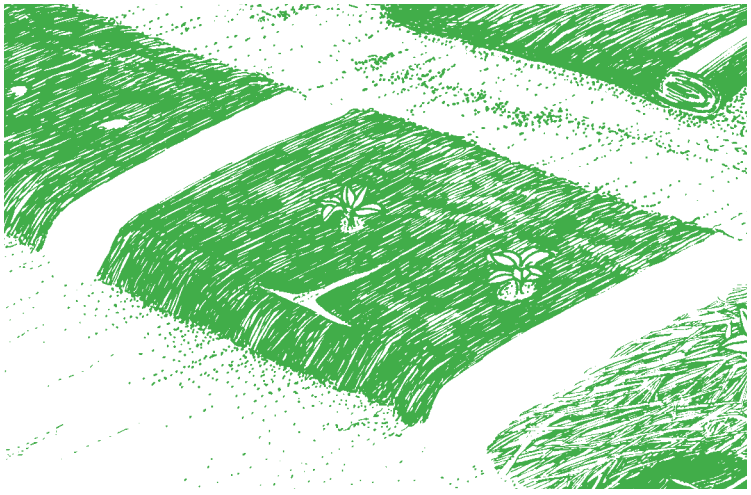


Figure 4. "T" slit for side-dressing.

retaining the other benefits of the mulch. At the end of the season, remove the plastic; it will not decompose in the soil as organic mulches do.

Weed Control

Weeds are a serious garden problem, much more than a "plant out of place." The soil acts as a seed bank, where weed seeds lie dormant until the right temperature, moisture, soil depth, and light are met for germination. Cultivation brings weed seeds to the soil's surface, and a new lawn of weeds will quickly form. Weeds rob vegetable plants of space, sunlight, water, and nutrients. They can also host insects and diseases that could infect nearby vegetable plants.

Controlling weeds can be overwhelming, especially if left unchecked. Some gardeners even abandon their gardens in midsummer because of them. The key to controlling weeds is to act when they are small, before they become out of control.

Common problematic garden weeds include crabgrass, yellow and purple nutsedge, morning glories, chamber bitter, lesser swinecress, bermudagrass, and pigweed.

Proper mulching and cover crops significantly reduce weeds, but additional techniques can be used to combat weeds further. See the Mulching section on page 25 and the Cover Crop Use section on page 8 for additional details. Most weeds can be controlled and kept from becoming serious problems in the garden. Additional methods of control include hand-pulling, cultivation, and applying herbicides.

Hand-Pulling

Hand-pulling weeds is inefficient over large areas but useful near vegetables, where tools or herbicides may cause damage. Effective hand-weeding is a skill that requires practice. A common mistake is gripping the plant too high, tearing off leaves or stems while leaving behind the crown (where the roots and stems meet). Instead, firmly grip the crown and wiggle it forcefully while pulling until the plant releases from the soil. For best results, weed when the soil is moist. Use a trowel, soil knife, or weeding fork for tap-rooted weeds like dandelions. You can hand-weed while thinning crops.

Cultivation

Cultivation is the most widely used method of garden weed control. It is not a one-time chore—with each rain, irrigation, and stirring of the soil, weed seedlings emerge.

Various hand and power tools are used for cultivation, but the hoe and garden tiller are the most common. A sharpened hoe blade is one of the most economical and efficient tools for removing weeds. You can scrape the blade along the soil surface to cut the emerging seedlings off from their roots while leaving the soil undisturbed. No new weed seeds are brought to the surface, and the severed weeds dry in the sun and die.

If the weeds are left to grow too large, hoeing becomes much harder and will disturb the soil. Careful, shallow hoeing can remove weeds close to vegetable plants, especially if the vegetable plants are much larger than the weeds, but hand-pulling is best for weeds growing right next to vegetable plants.

Use a garden tiller to weed areas farther from the vegetable plants, such as walkways and between rows. This is especially effective on hot days when the disturbed weeds will dry out quickly. Cultivation kills small weeds faster than larger weeds, so do it frequently enough to prevent weed seedlings from becoming established. Cultivation for weeding should also be shallow to avoid disturbing or injuring vegetable plant roots.

Remove perennial weeds, such as bermudagrass, from the soil following cultivation to prevent them from re-establishing in the garden.

Herbicides

Commercial vegetable growers have a wide choice of chemical weed killers (herbicides) to prevent or control weed problems. Gardeners, however, have fewer choices.

Read and follow all safety precautions on the herbicide label to prevent injury to yourself and your vegetables. When used correctly, herbicides can be applied to vegetable gardens without harming the vegetables, but applying them incorrectly can be disastrous.

Preemergence herbicides are applied to the soil before planting vegetables and before weeds emerge. Some can be applied immediately after the vegetable seeds or plants are planted but before the weed seeds germi-

nate. Postemergence herbicides are applied after weeds emerge from the soil.

Herbicides used in the garden may be granules, wettable powders, or liquids. The equipment needed for an application depends on the formulation. For liquids and wettable powders, use a pump-up pressure sprayer. Since most garden sprayers have a cone-type nozzle, attach a 50-mesh screen and an 8003 E or equivalent fan nozzle to the sprayer.

Chemical herbicides used in the vegetable garden can be washed from the sprayer, but some herbicides used for lawn care cannot. Therefore, it is wise to keep two sprayers: one for lawn herbicides and the other for garden herbicides. When spraying herbicides approved for application over the tops of vegetable plants, do not use a sprayer that has been used with lawn herbicides.

Before using an herbicide in your garden, check the product's label for the recommended application rate, application method, and vegetables for which the herbicide has been approved. Never use a product not labeled for the vegetables you spray around, and do not exceed the recommended rate.

Trifluralin is a preemergence herbicide used to control many annual grasses and some small-seeded broadleaf weeds. It is helpful to group trifluralin-labeled vegetables in one area of the garden. To obtain good weed control, broadcast the recommended amount of granules or the liquid formulation (granules are easier for most gardeners to use). Cultivate the soil to eliminate clods, then mix the herbicide into the top 2 inches of soil. Two very shallow cultivations ensure thorough incorporation. Trifluralin is labeled for use before planting seeds of several vegetables and before setting transplants of others. Read the package label for a list of approved vegetables. Several brand names are available.

Sethoxydim is a postemergence herbicide that selectively controls grass weeds in several vegetables. It should be applied to most grasses before they reach 8 inches high. One application controls most annual grasses, but several applications may be required to control perennial grasses like bermudagrass. Before application, mix a crop oil concentrate in the spray solution. Read the label for specific instructions and approved vegetable crops. Several brand names are available.

Glyphosate is a nonselective, postemergence herbicide that targets grasses and broadleaf weeds. Some formulations are approved for limited use in the vegetable garden. Most applications are for eliminating existing weed problems before vegetable seedlings emerge and before vegetable plants are in the garden. Read the label for specific application instructions and limitations.

Pruning and Staking

Support should be provided to crops to keep their leaves, stems, and fruit off the ground. This reduces losses from fruit rot when the fruit touches the soil and from sunburn when the fruit is not shaded by foliage. Supported plants are easier to spray or dust for insect and disease control and easier to harvest than those sprawling on the ground.

Three popular methods of supporting plants are staking, caging, and trellising. Some crops should be pruned to optimize growth. For example, supported tomato plants are pruned (suckered) to reduce the number of branches.

Plant type also determines the amount of pruning. Tomato varieties are divided into two general groups based on their growth pattern: determinant and indeterminant.

Determinate, or self-topping, varieties have short- to medium-length vines. Plants are heavily branched. Rather than continuously producing leaves and flower clusters, every branch ends with a flower cluster. Determinate varieties tend to mature earlier and produce most of their fruit over a short, concentrated period. These plants are staked or caged but are not adapted to trellising. Some determinate varieties are Celebrity, Mountain Pride, and Rutgers. Determinate varieties are not heavily pruned, regardless of the support system, because most fruit is produced on the branches.

Indeterminate varieties continue to grow and produce leaves and flower clusters until disease, insects, cold, or lack of water and fertilizer kill the plants. Indeterminate varieties are Better Boy, Floradel, and Big Beef. Indeterminate varieties are heavily pruned when trellised, moderately pruned when staked, and lightly pruned when caged.

Pruning removes small shoots where each leaf joins the stem. Properly pruned plants produce larger and earlier fruit than non-pruned plants of the same variety. Remove shoots when they are less than 4 inches long to avoid injuring the plant. The larger the sucker before removal, the larger the resulting wound and the more wasted plant energy that went into the sucker. Remove a sucker by grasping it between your thumb and second finger and bending it to the side until it breaks. This is best done early, when plants are crisp and not wilted from the day's sun and heat. Do not cut suckers with a knife because this can spread virus diseases.

Staking

Staking requires wooden or metal stakes 5 to 6 feet long for indeterminate varieties and 3 to 4 feet long for determinate varieties. Wooden stakes should be at least 1 inch in diameter. Metal stakes can be smaller and have the advantage of lasting many years. Do not use chemi-

cally treated wood. Sections of concrete reinforcing rods (rebar) make excellent tomato stakes.

Space plants 18 to 24 inches apart in the row and drive a stake next to each plant or every other plant. Place the stake 3 to 4 inches from the base of the plant on the side, away from the first bloom cluster, to prevent trapping the fruit between the plant and the stake.

There are many ways to prune and tie tomato plants. Limit staked indeterminate plants to two or three fruit-producing branches. A common method is to keep the main stem, the strong sucker just below the first flower cluster, and one additional sucker lower on the plant. Remove all other suckers and continue removing new ones that form on the selected branches as the plant grows. Tie individual branches to the stake with twine, looping it loosely around the plant. Never tie just below a fruit cluster, as the weight may pull the branch down and cause it to break. Continue pruning and tying regularly to support growth.

The Florida weave is an alternative system to support staked tomato plants in a row. Using a polypropylene cord (because it doesn't stretch), tie the cord to the first stake about 6 to 10 inches above the ground. Run the cord to the second stake and wrap it around the stake once at the same level. Be sure to keep the cord tight. Repeat this process, going on to the third, fourth, and remaining stakes until you reach the end of the row. Return with the cord on the opposite side of the stakes, wrapping it around each stake. Plants are held in the space between the cords on opposite sides of the stakes. Repeat this process as plants grow so the branches are always held between the cord. Three to five runs down the row should be enough for the season. Remember to keep pruning plants as they grow to reduce the amount of plant material that must be supported.

When staking determinate varieties, prune only once to remove the first suckers.

Caging

Tomato plants supported by cages made from concrete reinforcing wire require considerably less work than staked or trellised tomatoes because there is no tying and only limited pruning. A 5-foot length of 10-gauge reinforcing wire with 6-inch openings makes a cage about 18 inches in diameter. For indeterminate varieties, cages should be at least 5 feet high, while shorter cages are best for determinate varieties. Remove the bottom horizontal wire sections using heavy bolt cutters, leaving the wire legs to stick into the ground.

Set your tomato plants 3 feet apart in the row and place a cage over each plant. Push the legs into the ground to anchor the cage. Protect early plants from cold and wind by wrapping the bottom 18 inches of each cage with clear plastic. In combination with caging and a clear plastic wrap, black plastic mulch promotes early blooming.

Caged plants are generally pruned to four or five main fruiting branches. As plants grow, keep turning the ends of the branches back into the cages. Caged plants may not produce ripe tomatoes as early as staked or trellised plants, but they produce more tomatoes that are less likely to crack or sunburn.

Trellising

Trellising is only for indeterminate varieties. Set plants about 1 foot apart in the row and prune to just the main stem or occasionally to the main stem and one strong sucker (the sucker originating just below the first bloom cluster). Remove all other suckers as they develop.

Construct a trellis by driving support posts in the ground approximately 20 feet apart. The tops of the posts should be about 6 feet above the soil surface. Stretch a heavy wire or a piece of barbed wire between the tops of the posts and attach a length of heavy twine to the wire above each plant. The barbed wire prevents the twine from slipping as the top wire sags under the weight of the plants. Secure the twine to the base of each plant or a bottom wire if

one is used. As the plants grow, wrap them around the twine for support, or use plastic clips designed for greenhouse tomatoes. When trellising two stems per plant, use a separate cord for each stem.

Trellising produces ripe fruit earlier than other methods of support. Because of the small amount of protective foliage, each plant produces fewer but larger tomatoes that are more susceptible to sunburn.

Tomato plants loaded with fruit are heavy. Anchor the posts to keep them from collapsing.

POLLINATION

Pollination is the process by which pollen is transferred from the anthers (male parts) of a flower to the pistil (female part); this causes the edible fruits and seeds we harvest in the garden to form. However, pollination is generally unimportant for leafy vegetables, like spinach, greens, cabbage, and root crops, such as carrots, radishes, and beets, unless gardeners are interested in collecting their seeds.

Crops rely on pollination through wind and insects, and through self-pollination. Wind-pollinated crops, like corn, depend on pollen falling from the tassels to the silks of the ears. Planting corn in blocks rather than single rows improves pollen distribution. High temperatures and drought can reduce pollen viability and silk receptivity, leading to poor ear development. In contrast, insect-pollinated crops, such as squash, pumpkins, melons, and cucumbers, require insects to transfer pollen between male and female flowers. Some cucumber and summer squash varieties are parthenocarpic, meaning they can produce fruit without pollination, making them well-suited for use with insect covers.

Self-pollinating crops, including beans, peas, and tomatoes, transfer pollen within the same flower without wind or insects. These plants are highly efficient at pollination, but environmental stressors, such as excessive heat, shade, or insufficient moisture, can reduce pollen viability, leading to misshapen or poorly developed fruit, or aborted flowers. Bees may still visit self-pollinated crops to collect nectar and pollen. To protect these essential pollinators, gardeners should use the least toxic insecticides and apply them late in the day when bees are less active.

Cross-pollination is only a concern for gardeners interested in saving seeds because it changes the genetics of the seeds, resulting in plants that may not grow "true to type." For example, if you grow a sweet orange pumpkin near an ornamental gourd and save the seeds from the pumpkin, the plants grown from those seeds may produce fruit with undesirable traits, such as a mix of the two—small, bitter, or oddly shaped pumpkins. This is why isolation is necessary for seed-saving gardeners who want to preserve the specific characteristics of their crop varieties.

A common misconception is that growing different varieties of squash, pumpkins, or gourds close together will affect the fruit produced that season; this is not true. Corn is an exception because the part we eat is the seed. Cross-pollination between different types of corn (e.g., sweet corn, field corn, popcorn) or between genetic classes (e.g., supersweet sh2, sugary-enhanced se, and standard sugary su) can reduce kernel quality, sweetness, and texture. To prevent this, isolate different corn types by at least 250 feet, or stagger planting dates by at least 14 days so tassel and silk emergence do not overlap.

PEST AND DISEASE MANAGEMENT

Insect Identification and Control

Vegetable gardens often have many crops, each vulnerable to insect pests. Controlling these pests is essential for success.

Insect pests damage vegetables in various ways. Tomato fruitworms, cowpea curculios, stink bugs, and pickleworms feed directly on fruit, while pests like tobacco hornworms, which feed primarily on the leaves, or aphids, which suck sap from the plant, cause indirect damage by reducing the carbohydrates plants use for fruit production. Thrips and bean leaf beetles spread diseases, and pests like corn earworms and cowpea curculios also contaminate food.

Although many insect and mite pests can affect home vegetable gardens, they rarely appear all at once, so you likely won't need to spend the summer applying insecticides to succeed. Effective pest management involves nonchemical methods, many of which are passive and require relatively little effort. Practices that promote healthy, productive crops often naturally help control pests.

Sometimes, insect pest populations reach damaging levels, requiring treatment with insecticides. Apply them only to the affected crops. Treating the entire garden can be counterproductive, as it kills beneficial insects (Figure 5), allowing pests to thrive. However, depending on the season or planting location, some crops may require repeated treatments during periods of high pest pressure.

For example, yellow squash planted from midsummer to fall often suffers from squash bugs, though squash vine borers are typically less of a concern later in the season. Southern peas grown in the same spot year after year are prone to cowpea curculios without timely insecticide treatments. Similarly, fall tomatoes commonly face stink

Beneficial Insects

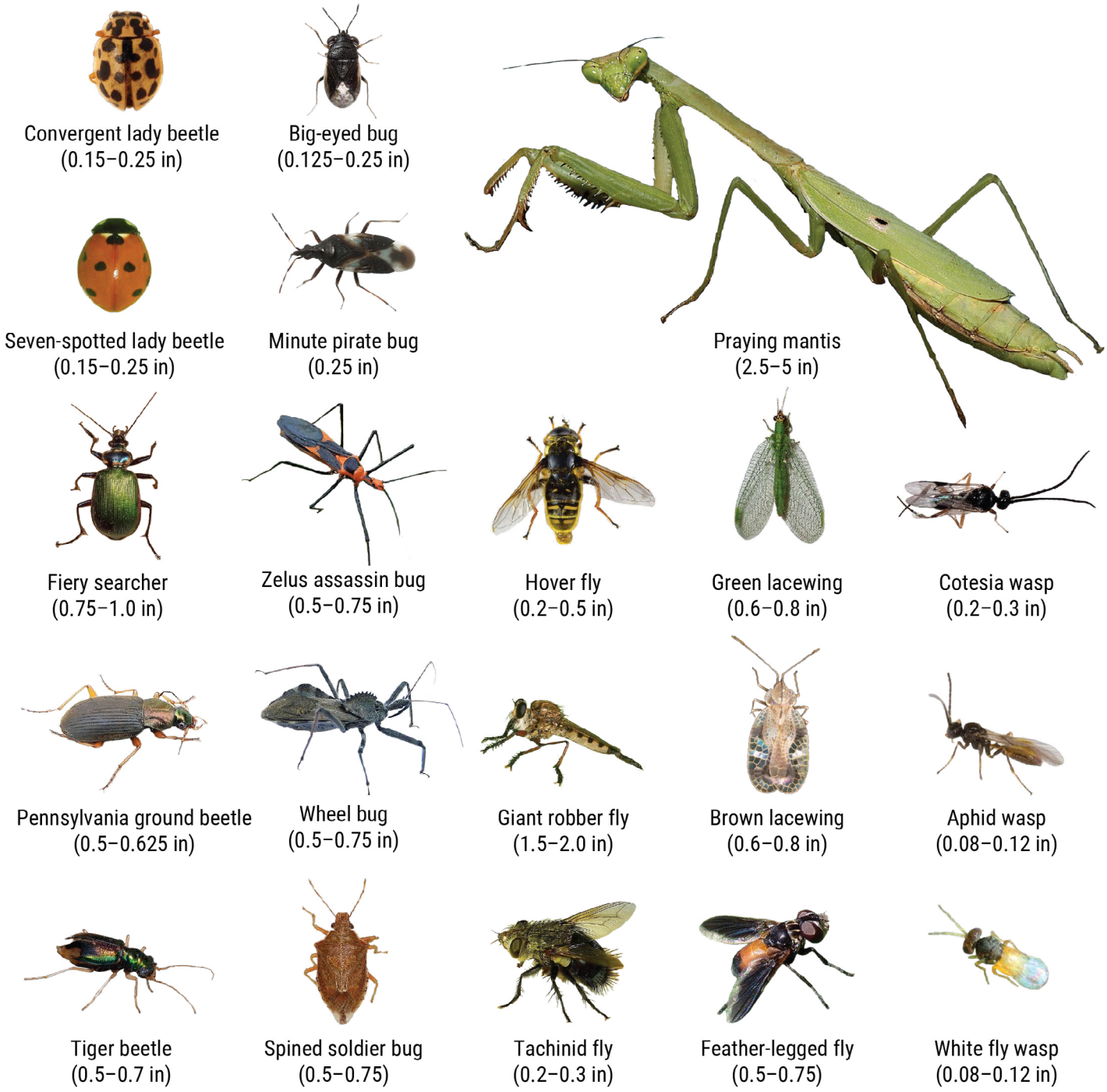


Figure 5. Beneficial insects. *Photo credits on back cover.*

bugs and tomato fruitworms. Experienced gardeners learn to anticipate these pests and take appropriate action.

Common Garden Insect Pests

Insects can damage plants by chewing foliage, boring into stems or roots, sucking sap, or attacking fruit. The type of damage depends on the insect's mouthparts, which fall into two main categories: chewing or sucking.

The following sections provide an overview of common insect pests in each group. For more detailed insect management and control information, see MSU Extension Publication 2347 *Insect Pests of the Home Vegetable Garden*.

Sucking Insects

Insects with sucking mouthparts inject saliva into plants and extract sap. The damage from their feeding may affect individual leaves and stems or, in the case of seedlings, the entire plant. Sucking insects can also deform

fruits, like peas and beans, before the pod hardens. The following paragraphs highlight common garden pests with sucking mouthparts (Figure 6).

Aphids, or **plant lice**, are small, soft-bodied insects that vary in color, including green, pink, black, and yellow. They feed on sap from leaves or stems, causing curled leaves and yellowing in many garden crops. During feeding, they also can inject poisonous saliva or transmit disease-causing organisms. They often occur in large numbers on crops like cabbage, tomatoes, mustard, and peas. Aphids also secrete a sticky substance called "honeydew," which promotes the growth of black sooty mold fungi. While sooty mold does not invade the plant, heavy build-up is unsightly and can interfere with photosynthesis.

Harlequin cabbage bugs overwinter as adults in protected areas, such as old cabbage stalks or clumps of grass. These insects are black with brilliant red or yellow markings. They feed by sucking sap from plants, like cabbage, collards, mustard, and turnips, often causing wilting and plant death.

Stink bugs, which can be either brown or green, are large, shield-shaped insects that emit an unpleasant odor when handled or crushed. They feed on developing bean and pea seeds by piercing the pods and sucking the sap. This can scar the seed and may prevent proper development. Puncture sites on pods appear as small, pimple-like marks. In tomatoes and peppers, they cause fruit to develop unsightly yellow marks.

Thrips are tiny insects, rarely more than one-sixteenth of an inch long, with straw-colored bodies and fringed wings. They damage plant leaves and flower buds by puncturing plant cells with their single, icepick-like mouthpart and feeding on the sap. This feeding causes leaves to curl and become silvery, especially on infested onion shoots. To check for thrips, gently slap the plant's leaves or flowers onto a flat, white surface, like a piece of paper. If present, the insects will be visible as they move across the white background.

Whiteflies are small, white insects typically found on the undersides of leaves. When infested plants are disturbed, the insects flutter away. Both adults and immatures feed by piercing the tissue and removing sap. They can occur in large numbers on crops like eggplant and tomatoes. Early detection is critical for controlling this pest.

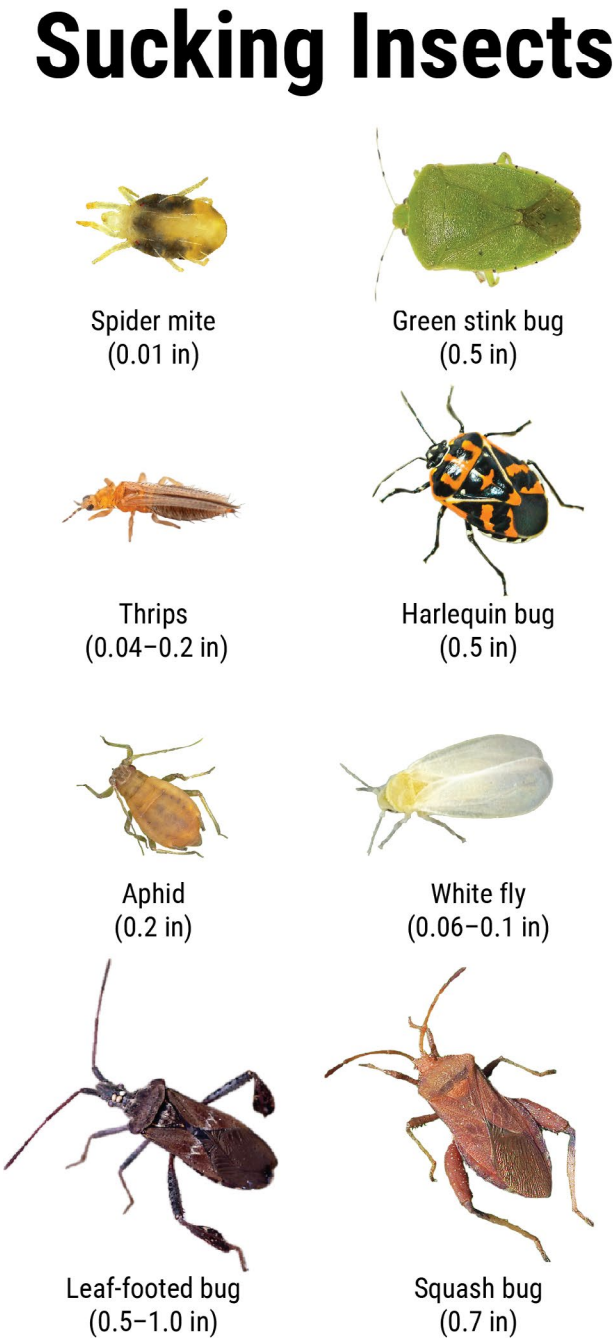


Figure 6. Sucking insects. *Photo credits on back cover.*

Chewing Insects

Insects with chewing mouthparts cause damage by cutting holes in leaves and fruit or boring into stems and fruit. Below are examples of common garden pests with chewing mouthparts (Figure 7).

Ants are attracted to the garden for many reasons. Some feed on honeydew secreted by aphids, others consume decaying fruit, and some hunt other insects. While ants are usually considered minor pests, fire ants can inflict painful stings. To control ants, manage aphids, harvest ripe fruit promptly, and use fire ant baits labeled for use around the garden perimeter (not inside of it).

Bean leaf beetles overwinter as adults near garden sites and feed on young beans and southern peas as they emerge. These beetles vary in color and markings, typically appearing reddish or yellowish with a black band around the edge of their wings. Some may have three or four black spots on their back, while others are solid tan, red, or pink. Adults often feed on the undersides of leaves and drop to the ground when disturbed. They create small holes in leaves. When treating bean leaf beetles,

Chewing Insects

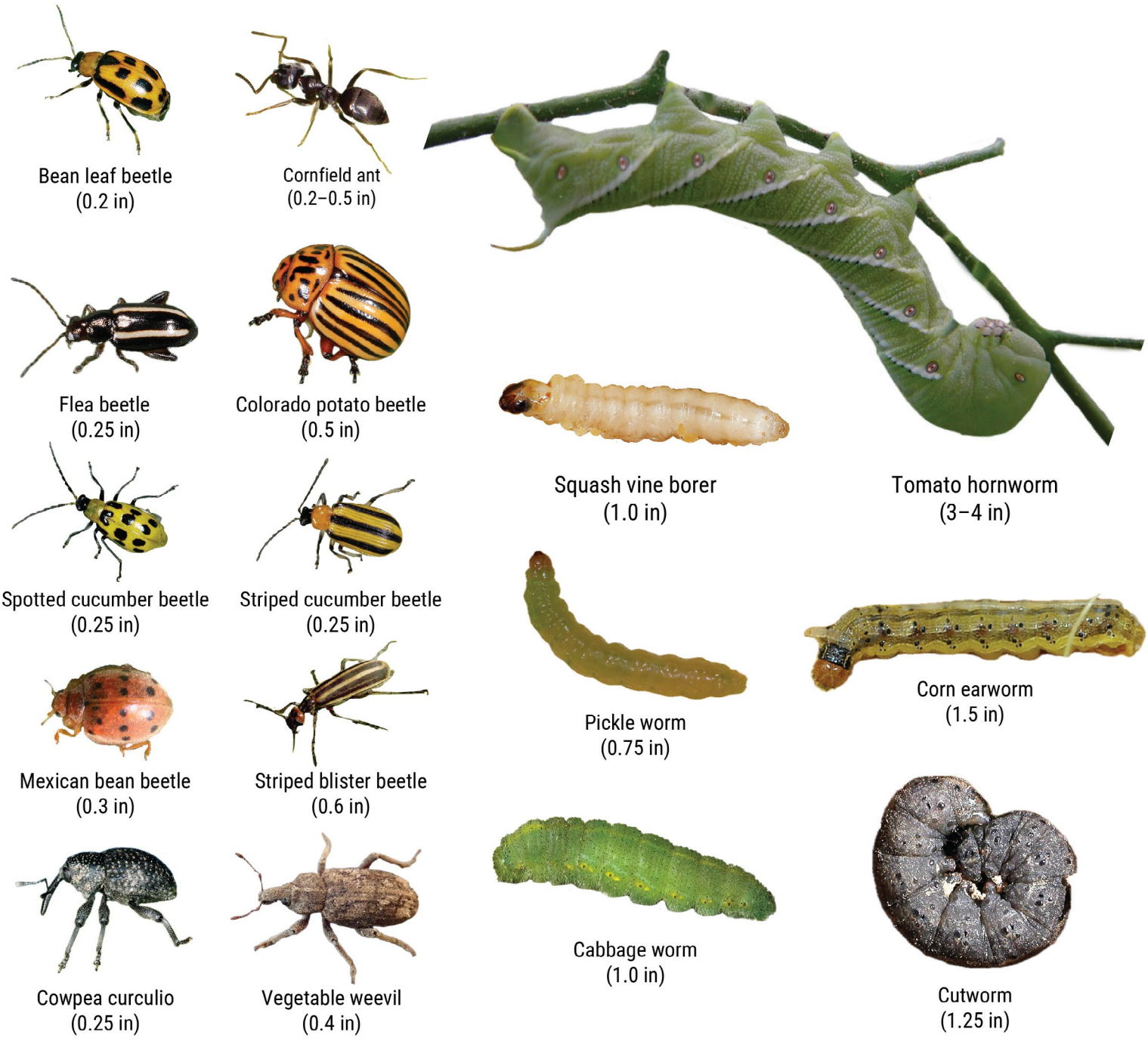


Figure 7. Chewing insects. *Photo credits on back cover.*

ensure that insecticide is applied to the upper and lower leaf surfaces.

Blister beetles are slender and about three-fourths of an inch long. They can be gray, black, or striped. They feed on the foliage of most garden crops, especially tomatoes.

Cabbageworms, or **cabbage loopers**, are pale green caterpillars with light stripes down their backs. Imported cabbageworms are velvety green. They create ragged holes on the undersides of leaves and bore into the heads of cabbage, collards, and related plants.

Corn earworms are green, pinkish, or brown caterpillars with light stripes along their sides and backs. They grow up to 2 inches long before pupating and attack corn as it grows. In pre-tasseled corn, they feed in the whorl, damaging emerging leaves. Later, the adult moths lay eggs on new silks, and young larvae burrow into the ear, feeding on kernels near the tip. Many gardeners forgo control

measures and discard the damaged portion of infested ears. However, this insect will also attack tomatoes; heavy infestations can cause crop damage.

To control earworms in corn, spray into the whorl at the first sign of damage. To prevent ear damage, apply insecticide when silks first appear, repeating applications every 3 to 4 days until the silks dry. Treat the ear area of the stalk thoroughly, and to protect bees, spray in the early morning or late afternoon, avoiding the tassel.

Cowpea curculio adults are small, dark gray, and rarely seen. Their larvae—white, legless grubs—cause the most damage by feeding on developing seeds in bean and pea pods, making them unusable. Apply a foliar spray when small pods first appear, and repeat three applications every 5 days.

Cutworm moths are dull-colored and active at night. Their larvae are gray, brown, or black with stripes or spots. They feed at night, cutting young plants at the soil line, and hide during the day. To control cutworms, protect transplants with aluminum foil or wax paper collars and use insecticides like permethrin.

Fall armyworm moths are dull-colored, night-flying insects that appear in early June. Their larvae vary in color from light tan or green to nearly black, with yellowish lines down their sides. The larvae feed primarily on corn but sometimes on peas, tomatoes, and beans. They infest the whorls of corn and can be found 1 to 2 inches deep in the whorl, making them challenging to control. To manage infestations, spray insecticides directly into the whorls.

Flea beetles are small, with enlarged hind legs that allow them to jump vigorously when disturbed. They create tiny, round, or irregular holes in leaves, giving them a "peppered" appearance. These pests attack crops such as cabbage, eggplant, peppers, potatoes, spinach, sweet potatoes, tomatoes, and turnips.

Mexican bean beetles are short and yellow to coppery-brown, with 16 black spots on their backs. They feed on the undersides of legumes, creating a lacy or skeletonized appearance.

Pickleworms and **melonworms** are similar in appearance but vary in their feeding behavior. Pickleworms bore into the fruit, often through the underside, causing the interior to sour. They may also tunnel in vines. Melonworms, on the other hand, primarily feed on foliage and rarely enter vines. Both worms grow to about three-fourths of an inch long and are white to green. They are more likely to cause problems on late-planted crops. Start control measures when young caterpillars appear near blooms.

Seed maggots are small, white to dirty-white larvae of flies. They attack seeds, which weakens or kills the embryo inside. These pests are most problematic in wet, cool springs and soils high in organic matter—delay planting in such conditions to avoid infestations.

Serpentine leaf miners are small flies whose larvae feed between the upper and lower leaf surfaces, creating slender, white, winding trails. They severely damage crops such as beans, cucumbers, peas, squash, and tomatoes.

Squash vine borers are wasp-like moths with metallic, olive-brown front wings and transparent hind wings. Their abdomens are ringed with red, black, and copper. Eggs are laid on leaves or stems, and larvae bore into plants from these locations, causing vines to wilt. Once inside, insecticides cannot reach the larvae. Infestations are common on pumpkins and squash. Weekly insecticide applications are often required. These should be applied in the late afternoon to protect bees.

Cucumber beetles, striped or spotted, damage crops such as cucumbers, melons, squash, and, to a lesser extent, beans and peas. The larvae of the spotted cucumber beetle (SCB), known as the southern corn rootworm, also damage corn seedlings. Apply foliar sprays of carbaryl or other recommended insecticides to control adults.

Tobacco hornworms are large, green caterpillars with diagonal white stripes along their sides and a prominent tail horn. They feed heavily on the foliage and occasionally the fruit of tomatoes, eggplants, peppers, and related plants.

Slugs are not insects. However, they feed on young foliage and low-lying fruit, like strawberries, leaving silver trails of dried mucus behind. They rest in moist, shaded areas during the day and feed at night. To control slugs, use metaldehyde or iron phosphate baits according to the label directions, taking care not to contaminate edible plant parts. Trapping can also be effective: Place wet burlap bags in the garden in the evening and destroy slugs found underneath the next morning.

Insecticides for the Home Vegetable Garden

This section provides general information about commonly used garden insecticides. See Table 8 on page 38 for specific pest/insecticide recommendations.

Use insecticides safely! Before using any insecticide, read the label carefully and follow all directions regarding personal protective equipment and mixing and applying the product. The label is the law, and the directions it specifies are designed for the safety of the applicator, the environment, and those using the area. Handle insecticides with the respect they deserve. They are poisons, and excessive exposure can result in acute and/or chronic health problems.

Be sure the insecticide is labeled for use on the vegetable being treated. Few insecticides are labeled for use on every garden crop. Before applying an insecticide, read the label and verify that the product is labeled for use on that crop.

Observe and follow the pre-harvest interval, or PHI. This refers to the time between applying an insecticide and harvesting the crop. PHIs vary by insecticide and crop. For example, the PHI for carbaryl (Sevin) is 3 days on tomatoes, 7 days on Irish potatoes, and 14 days on turnips. Failure to follow PHIs can lead to harmful insecticide levels in your food.

Common Insecticides

Insecticides marked with an asterisk (*) are suitable for organic gardens.

Malathion is a standard insecticide for home vegetable gardens. It controls various pests, including aphids, bugs, and certain beetles, and is labeled for use on most vegetables.

Bt kurstaki* (*Bacillus thuringiensis kurstaki*) is a bacterium that produces toxins that are effective against certain caterpillars, such as loopers and diamondback moths, without affecting other insects. Thuricide is a common brand name for this product, which works well on leaf-feeding caterpillars.

Spinosad* is a microbial insecticide effective against caterpillars, thrips, leaf miners, and Colorado potato beetles. Common brands include Green Light Spinosad Lawn and Garden Spray and Fertilome Bore, Bagworm, Leafminer, and Tent Caterpillar Spray.

Insecticidal soaps*, made from potassium salts of fatty acids, disrupt the cell membranes of pests they contact. They are most effective against soft-bodied pests like aphids, mites, and thrips. Safer Insecticidal Soap is a widely available brand. These products are labeled for most vegetables and have a short PHI.

Neem oil* is a botanical insecticide that targets aphids, mites, and whiteflies. It is labeled for use on most vegetables and is sold under several brand names (Monterey 70% Neem Oil is one example). Thorough coverage is necessary for pest control.

Azadirachtin*, derived from neem tree seeds, is different from neem oil and has a zero-day PHI. Gardeners often use brands like Azatrol. It is effective against many pests, especially soft-bodied insects like aphids and whiteflies.

Pyrethrin* (or pyrethrum) is a botanical insecticide that rapidly kills many pests but has limited residual activity, meaning insects may recover. It is often combined with piperonyl butoxide (PBO) to enhance its effectiveness, though PBO is not organic. Pyrethrin is labeled for use on most vegetables and has a short PHI.

Acetamiprid is especially effective against whiteflies and aphids but controls many other pests. Ortho Max Flower, Fruit, and Vegetable Insect Killer is one common brand name. This product is sold as a ready-to-use spray and a concentrate.

Pyrethroids are synthetic insecticides modeled after pyrethrin and are highly effective at low doses against various pests. Several pyrethroids are labeled for home vegetable gardens:

- **Permethrin:** Targets beetles, bugs, and caterpillars, but not white flies or spider mites. It also has a shorter PHI than most pyrethroids. Common brands include Bonide Eight Insect Control Concentrate, Hi-Yield Garden, Pet, and Livestock Insect Control, and Martin's Vegetables Plus.
- **Bifenthrin:** Useful for controlling pests on labeled crops, though not all vegetables are included. It is less likely to trigger outbreaks of spider mites and aphids. Ortho Bug B Gon Insect Killer for Lawns and Gardens is a common brand.
- **Lambda-cyhalothrin:** A pyrethroid that targets various insects but is labeled for use in only a few vegetables. Spectracide Triazicide Insect Killer for Lawns and Landscapes is the most common brand.
- **Zetamethrin (zeta-cypermethrin):** Sold as GardenTech Sevin Insect Killer; however, it does not contain carbaryl and should not be mistaken for older formulations of "Sevin." Zetamethrin is labeled for use on most vegetables with a 1-day PHI and is effective on most insect pests (but check the label for exceptions). Some crops have significantly longer PHIs, and like other pyrethroids, it does not control some pests, such as aphids, whiteflies, spider mites, and certain caterpillar pests.

Table 8. Insecticides for home vegetable gardens.

Crop	Pest	Insecticide (PHI)*
Beans	aphid	acetamiprid (7), azadirachtin (0), malathion (1), insecticidal soap (1), neem oil (NA)
	spider mite	insecticidal soap (1), neem oil (NA)
	bean leaf beetle cucumber beetl Mexican bean beetle	bifenthrin (3), carbaryl (3), malathion (3), bifenthrin (3), zetamethrin (1)
	cowpea curculio	carbaryl (3), bifenthrin (3), zetamethrin (1)
	corn earworm lima bean pod borer other caterpillars	bifenthrin (3), spinosad (3), zetamethrin (1)
	leaf miner	spinosad (3)
	stink bug plant bug	malathion (3), carbaryl (3), pyrethrin (0), bifenthrin (3), zetamethrin (1)
Broccoli, Cauliflower	aphid	acetamiprid (7), malathion (broccoli–3; cauliflower–7), insecticidal soap (1), neem oil (NA)
	looper diamondback moth other caterpillars	Bt kurstaki (0), spinosad (1)
	harlequin bug stink bug	carbaryl (3), cyhalothrin (1), malathion (broccoli–3; cauliflower–7), bifenthrin (7), permethrin (1), zetamethrin (1)
Brussels sprouts	aphid	acetamiprid (7), malathion (7), insecticidal soap (1), neem oil (NA)
	looper diamondback moth other caterpillars	Bt kurstaki (0), spinosad (1)
	harlequin bug stink bug	carbaryl (3), cyhalothrin (1), malathion (7), permethrin (1), zetamethrin (1)

Crop	Pest	Insecticide (PHI)*
Cabbage	aphid thrips	acetamiprid (7), malathion (broccoli–3; cauliflower–7), insecticidal soap (1), neem oil (NA)
	looper diamondback moth cabbageworm	Bt kurstaki (0), spinosad (1)
	harlequin bug stink bug	carbaryl (3), cyhalothrin (1), malathion (7), bifenthrin (3), permethrin (1), zetamethrin (1)
Collards	aphid	azadirachtin (0), malathion (7), insecticidal soap (1), neem oil (NA), acetamiprid (7)
	looper diamondback moth	Bt kurstaki (0), spinosad (1)
	harlequin bug stink bug	malathion (7), carbaryl (14), permethrin (1), zetamethrin (1)
Corn	cutworm	bifenthrin (1), carbaryl (2), permethrin (1), zetamethrin (1)
	chinch bug stink bug	bifenthrin (1), carbaryl (2), malathion (5), permethrin (1), zetamethrin (1)
	corn earworm fall armyworm European corn borer	bifenthrin (1), carbaryl (2), malathion (5), permethrin (1), pyrethrins (0), spinosad (1), zetamethrin (1)
Eggplant	flea beetle	bifenthrin (7), carbaryl (3), malathion (3), permethrin (3)
	Colorado potato beetle tortoise beetle	bifenthrin (7), carbaryl (3), permethrin (3), spinosad (1), zetamethrin (1)
Lettuce	aphid	azadirachtin (0), malathion (head lettuce–7; leaf lettuce–14), insecticidal soap (1), neem oil (NA)
	caterpillar	Bt kurstaki (0), spinosad (1)

Crop	Pest	Insecticide (PHI)*
Melons	thrips	bifenthrin (3), permethrin (1), spinosad (3), zetamethrin (1)
	cucumber beetle flea beetle	bifenthrin (3), carbaryl (3), malathion (1), permethrin (1), zetamethrin (1)
	leafminer	spinosad (3)
	looper	spinosad (3), Bt kurstaki (0)
	pickleworm melonworm	bifenthrin (3), permethrin (1), spinosad (3), carbaryl (3), zetamethrin (1)
	whitefly	azadirachtin (0), insecticidal soap (1), neem oil (NA)
	spider mite	insecticidal soap (1), neem oil (NA)
Mustard	aphid	malathion (7), insecticidal soap (1), neem oil (NA)
	looper diamondback moth	Bt kurstaki (0), spinosad (1)
	vegetable weevil yellow-margined leaf beetle	malathion (7), carbaryl (14), zetamethrin (1)
Okra	aphid	acetamiprid (7), azadirachtin (0), insecticidal soap (1), neem oil (NA), malathion (1)
	stink bug leaf-footed bug	bifenthrin (7), malathion (1), pyrethrins (0), zetamethrin (1)
	corn earworm	bifenthrin (7), spinosad (1), zetamethrin (1)
	looper other caterpillars	Bt kurstaki (0), spinosad (1)
Onions	onion thrips	malathion (3), cyhalothrin (14), insecticidal soap (1), zetamethrin (1)
Peas, English (sweet peas, snow peas)	aphid	acetamiprid (7), azadirachtin (0), malathion (3), insecticidal soap (1), neem oil (NA)
	thrips	malathion (3), spinosad (3)
	caterpillar	spinosad (3), Bt kurstaki (0)
	leaf miner	spinosad (3)

Crop	Pest	Insecticide (PHI)*
Southern peas (cowpeas, field peas, black-eyed peas, crowder peas)	aphid	acetamiprid (7), azadirachtin (0), malathion (3), insecticidal soap (1), neem oil (NA)
	spider mite	insecticidal soap (1), neem oil (NA)
	bean leaf beetle cucumber beetle Mexican bean beetle	carbaryl (3), malathion (3), bifenthrin (3), zetamethrin (1)
	cowpea curculio	carbaryl (3), bifenthrin (3), zetamethrin (1)
	corn earworm lima bean pod borer other caterpillars	spinosad (3), bifenthrin (3), zetamethrin (1)
	stink bug plant bug	malathion (3), carbaryl (3), pyrethrin (0), bifenthrin (3), zetamethrin (1)
Peppers	aphid	azadirachtin (0), acetamiprid (7), insecticidal soap (1), neem oil (NA), malathion (3)
	leafminer	spinosad (1)
	flea beetle	bifenthrin (7), carbaryl (0), permethrin (3), zetamethrin (1)
	European corn borer	permethrin (3), spinosad (1)
	thrips	malathion (3), permethrin (3), spinosad (1), zetamethrin (1)
	spider mite	insecticidal soap (1), neem oil (NA)
	pepper weevil	malathion (3), permethrin (3)
Potatoes	Colorado potato beetle	acetamiprid (7), spinosad (7), carbaryl (7), permethrin (7), zetamethrin (1)
	blister beetle flea beetle	carbaryl (7), permethrin (7), zetamethrin (1)
	potato tuberworm	spinosad (7), permethrin (7)
	leaf miner	spinosad (7)
Spinach	aphid	azadirachtin (0), malathion (7), insecticidal soap (1), neem oil (NA)
	leafminer	spinosad (1)
	looper other caterpillars	Bt kurstaki (0), spinosad (1)

Crop	Pest	Insecticide (PHI)*
Squash, Pumpkins	squash bug	acetamiprid (0), bifenthrin (3), carbaryl (3), malathion (squash–1; pumpkins–3), permethrin (1), pyrethrins (0), zetamethrin (1)
	squash vine borer	acetamiprid (0), bifenthrin (3), permethrin (1), zetamethrin (1)
	pickleworm	bifenthrin (3), carbaryl (3), permethrin (1), zetamethrin (1)
	cucumber beetle	bifenthrin (3), carbaryl (3), malathion (squash–1; pumpkins–3), permethrin (1), zetamethrin (1)
	spider mite	insecticidal soap (1), neem oil (NA)
Sweet potatoes	armyworm looper	spinosad (7), zetamethrin (1)
	flea beetle cucumber beetle tortoise beetle	carbaryl (7), permethrin (7), zetamethrin (1)
	sweet potato weevil	carbaryl (7) Stored sweet potatoes may be treated with phosmet (Imidan dust) according to label.
Tomatoes	tomato fruitworm tobacco hornworm	bifenthrin (1), carbaryl (3), cyhalothrin (5), malathion (1), permethrin (1), pyrethrins (0), spinosad (1), zetamethrin (1)
	looper	Bt kurstaki (0), spinosad (1)
	stink bug leaf-footed bug	bifenthrin (1), carbaryl (3), cyhalothrin (5), malathion (1), permethrin (1), pyrethrins (0), zetamethrin (1)
	spider mite	insecticidal soap (1), neem oil (NA)
	thrips	bifenthrin (1), carbaryl (3), cyhalothrin (5), malathion (1), permethrin (1), pyrethrins (0), spinosad (1), zetamethrin (1)
	whitefly	azadirachtin (0), acetamiprid (7), insecticidal soap (1), neem oil (NA), insecticidal oil (see label)
	leafminer	spinosad (1)
	aphid	azadirachtin (0), acetamiprid (7), insecticidal soap (1), neem oil (NA), malathion (1)
Turnips	aphid	azadirachtin (0), malathion (7), insecticidal soap (1), neem oil (NA)
	vegetable weevil yellow-margined leaf beetle	malathion (7), carbaryl (14), spinosad (1), zetamethrin (1)
	flea beetle	
	looper diamondback moth	Bt kurstaki (0), spinosad (1)

*The numbers in parentheses indicate the pre-harvest interval (PHI) or the number of days that must elapse between treatment and harvest. Always verify the PHIs on the insecticide label being used.

Applying Insecticides in Home Vegetable Gardens

Several methods are available for applying insecticides to your home garden. Dusts, ready-to-use sprays, and liquid sprays are three of the most common methods.

Dusts

Dust formulations, such as 5 percent Sevin Dust and 0.25 percent permethrin, can be applied using shaker cans or hand-powered dusters. However, dusts are generally less effective than sprays and often produce uneven coverage. Many also find dusts unsightly.

Ready-to-Use Sprays

Several insecticides are sold as ready-to-use (RTU) sprays labeled for use in the home garden. The active ingredients in these sprays are permethrin, carbaryl, cyhalothrin, cyfluthrin, and neem oil. The products come in hand-pump spray bottles that have already been diluted to their final-use strength. RTU treatments are very convenient

for applying spot treatments to individual plants. However, they are too costly to use on a large scale.

Single-Nozzle Hand-Pump Sprayers

Single-nozzle hand-pump sprayers are the most common insecticide application method for home gardeners. They come in sizes ranging from 1 quart to 5 gallons, with 1 gallon being the most common size. They can apply liquid concentrate, wettable powder, or wettable granule insecticides according to label directions. Here is an example of the directions that might appear on the label of a liquid concentrate: "Mix 1 tablespoon per gallon of water and spray to runoff, taking care to direct spray to undersides of leaves."

Hand-pump sprayers are powered by pumping air into the headspace over the insecticide mixture. When the spray valve is opened, compressed air forces the insecticide spray through the nozzle. Most hand sprayers have a nozzle that can adjust the coarseness or fineness of the spray droplets. Be sure to rinse the sprayer thoroughly after each use.

To avoid crop injury, it is strongly recommended that insecticides not be applied with a sprayer previously used for herbicides. It is best to dedicate one sprayer specifically for herbicide use and another for insecticides and fungicides. Label each sprayer clearly.

Caution!

- Be sure to read and follow all label directions.
- Note and observe the pre-harvest interval (PHI).
- Store insecticides in a safe, secure place where children cannot reach them.
- If you spill insecticide on your body, wash it off immediately with soapy water. Also, wash all exposed skin after dusting or spraying.
- Wash all food before preparing or eating.

Noninsecticidal Insect Management Methods

For every insect pest, many predators and parasites feed on that pest and help keep its population in check. Without these naturally occurring predators and parasites, our gardens would be overrun with insect pests. As a gardener, you should recognize the importance of this natural control and avoid disrupting it when possible.

Without question, naturally occurring biological control is the single most important method of controlling insect pests. Insecticide treatments are disruptive to beneficial insects and pests; therefore, you should avoid unnecessary insecticide treatments. Destroying naturally occurring beneficial insects can cause pest populations to increase. However, do not let a fear of disrupting natural control keep you from making insecticide applications when needed. In the southern garden, there will be times when pest populations escape natural control and reach damaging levels. Prompt, judicious use of insecticides can control pest populations and help prevent crop damage.

When selecting insecticide treatments, remember that some insecticides are more disruptive of natural control than others. For example, Bt products control only caterpillar pests and are harmless to most beneficial insects, while broad-spectrum insecticides like permethrin are more disruptive. Still, there are times when you will need to use one of the broad-spectrum treatments to obtain control of a particular pest or pest complex.

Many cultural control practices can make plants more or less vulnerable to insect attack and/or injury. Healthy, vigorous plants are generally more resistant and more tolerant to damage by insect pests. Consequently, practices that promote good growth and plant health also help with insect management.

Because many species of insect pests complete several generations per growing season, with populations increasing substantially each generation, early-planted crops often experience lower insect pressure than late-planted crops. This is especially important with crops like sweet corn, summer squash, and tomatoes.

Many insect pests also reproduce on weeds and vegetable plants left in the garden after harvest. So good sanitation practices, including weed control and prompt removal of plants that have ceased to produce, will help reduce insect populations.

Some vegetable varieties are less vulnerable to insect damage than other varieties of the same vegetable, so variety selection can also be an important insect management consideration. These are just a few general examples of how cultural control practices can influence insect populations.

"Hand-picking and foot-stomping" is one type of mechanical control that home gardeners can use successfully. In small plantings, you can manage pests by removing individual insects or egg masses. Flicking beetles into soapy water or washing aphids from plant terminals with a strong spray from a garden hose are other effective techniques.

You might also use floating row covers, which prevent insects from attacking or depositing eggs on young plants. Wax paper or aluminum foil collars can protect young transplants from cutworm attacks.

Reflective mulches are another useful mechanical control for certain pests. They are especially effective in preventing thrips from attacking young tomato and pepper

plants and spreading virus diseases, particularly the tomato-spotted wilt virus.

Using plastic mulches instead of organic mulches helps reduce populations of certain pests because the plastic mulch provides less favorable shelter for pests like crickets and slugs. Commercially available pheromone traps or sticky traps can also help you control or monitor certain pest species.

Vegetable Diseases

Garden vegetables can be attacked by a wide range of fungi, bacteria, viruses, and nematodes. No single management measure can prevent or treat all diseases, but following some general practices can go a long way in keeping your garden healthy:

- Choose varieties recommended for Mississippi that have resistance to common diseases (see MSU Extension Publication 3744 *Variety Recommendations for Mississippi Vegetable Gardens*).
- Use healthy, disease-free transplants.
- Buy seeds from reputable sources, and avoid saving seeds from plants that were diseased the previous season.
- Use fungicide-treated seed when available.
- Plant seeds/transplants when weather conditions are optimal for germination and plant growth.
- Plant in an area that drains well and receives adequate sunlight and airflow.
- Practice crop rotation.
- Stake, trellis, or cage plants.
- Use mulch to reduce soil splashing onto the plants.
- Water early in the day and avoid overhead irrigation.
- Avoid handling plants when wet.
- Clean and disinfect tools, equipment, and support structures between uses.
- Avoid moving infested soil to non-infested sites.
- Remove diseased leaves or plants promptly.
- Remove weeds and volunteer plants.
- Use approved fungicides or biological treatments as labeled (see Table 9).
- Remove and destroy or bury crop debris.

Table 9. Fungicides for disease management.

Crop	Active Ingredients Labeled for Crop
Beans*	chlorothalonil, copper, myclobutanil, phosphorus acid, sulfur
Beets	copper
Broccoli	chlorothalonil, copper, phosphorus acid, sulfur
Brussels sprouts	chlorothalonil, copper, phosphorus acid, sulfur
Cabbage	chlorothalonil, copper, phosphorus acid, sulfur
Carrots	chlorothalonil, copper, phosphorus acid
Cauliflower	chlorothalonil, copper, phosphorus acid, sulfur
Celery	chlorothalonil, copper, phosphorus acid
Corn*	chlorothalonil, copper, mancozeb
Cucumbers	chlorothalonil, copper, mancozeb, myclobutanil, phosphorus acid
Eggplant	copper, phosphorus acid
Greens* (collard, mustard, and/or turnip)	copper, phosphorus acid
Kale	copper, phosphorus acid
Lettuce	copper, phosphorus acid
Melons	chlorothalonil, copper, mancozeb, myclobutanil, phosphorus acid
Okra	phosphorus acid
Onions*	chlorothalonil, copper, mancozeb, phosphorus acid, sulfur
Peas	copper, phosphorus acid, sulfur
Peppers	copper, phosphorus acid
Potatoes	chlorothalonil, copper, mancozeb, phosphorus acid
Pumpkins	chlorothalonil, copper, myclobutanil, phosphorus acid
Radishes	phosphorus acid
Spinach	copper, phosphorus acid
Squash*	chlorothalonil, copper, mancozeb, myclobutanil, phosphorus acid
Sweet potatoes	phosphorus acid
Tomatoes	chlorothalonil, copper, mancozeb, phosphorus acid

*The label is the law. Always read it to ensure the fungicide is allowed for your crop and harvest stage (e.g., green versus bulb onions), and to check the pre-harvest interval (PHI).

If you suspect a disease is affecting your plants, the first step is to identify it correctly. The sooner a disease is recognized, the better chance you have of controlling it. Many leaf spots, blights, and mildews can be managed within the same season if caught early. Other disease problems may not be treatable this season, but can be prevented next year with the right steps.

Some vegetable diseases are easy to recognize, but others may require helps. Don't hesitate to contact your county Extension agent or a plant disease specialist. The best samples come from plants that are still showing symptoms but are not completely dead. Once dead, it's usually too late to diagnose the problem accurately.

The following section includes descriptions of common vegetable diseases in Mississippi, along with symptoms, signs (visible evidence of the disease-causing pathogen), and recommended management measures. If you cannot identify a disease from the descriptions provided, reach out to your county Extension office for assistance.

For an accurate diagnosis, you can submit samples to the MSU Extension Plant Diagnostic Lab (405 Garrard Rd. East, Mailstop 9612, Mississippi State, MS 39762 for FedEx/UPS or P.O. Box 9612 for USPS). Instructions for correctly submitting samples are available in MSU Extension Publication M1562 *How to Collect and Package Plant Disease Specimens for Diagnosis*. Be sure to include the *Plant Disease Sample Submission Form* (F1139). You'll find current forms, fees, and submission instructions at extension.msstate.edu/lab.

Additional information on vegetable diseases and nematodes can be found at your county Extension office and online at extension.msstate.edu.

Diseases take their toll in Mississippi gardens every year, but with some planning and the right practices, you can keep losses to a minimum.

Specific Diseases and Management Measures

Damping-off can affect the seeds and seedlings of many vegetables, especially when planted in soil that contains the disease-causing pathogens. Seeds may fail to germinate, or seedlings may be attacked before or after emergence. Roots and stems of infected seedlings may begin to rot, and seedlings may collapse and eventually die. Manage damping-off by using fungicide-treated seeds, planting in well-drained areas when soil temperatures have increased, avoiding the excessive application of nitrate forms of nitrogen fertilizers, and rotating the location of the vegetables (see Table 2 on page 6 for rotation recommendations). It is also a good idea to inspect the roots of purchased transplants before planting them in your garden. Discard transplants with brown or sloughing roots. For additional details on damping-off, see MSU Extension Publication 3747 *Damping-off in Vegetables*.

Root rot is severe on green beans, lima beans, and southern peas. The disease first appears as reddish or reddish-brown areas on stems and roots. As the disease advances, discolored areas expand until the entire root and lower stem are affected. Aboveground symptoms include stunting, yellowing, drooping of leaves, failure to produce normal pods, and plant death.

These management practices reduce losses from root rot:

- Use high-quality, fungicide-treated seeds.
- During cultivation, do not throw soil onto plant stems.
- Plant in a 4- or 5-year rotation with other vegetables.
- Plant in well-prepared soils with a pH of about 6.5 that have been fertilized based on soil test results and treated for nematodes, if recommended.
- Plant seeds 1 inch deep only when the weather is favorable and the soil is warm. Use raised beds to prevent "drowning" and reduce the risk of rot.

Buckeye rot commonly occurs on tomatoes during periods of warm, wet weather. The pathogens that cause this disease are present in the soil and can infect fruits when they contact infested soil. This often occurs when soil is splashed onto low-hanging fruit during rains or overhead watering. Tomato fruits with buckeye rot develop a brown, oily-looking lesion that usually displays alternating light and dark rings. This lesion can enlarge to cover much of the fruit. Buckeye rot is often confused with blossom-end rot, but blossom-end rot lesions are usually black and sunken and do not contain rings. The pathogens that cause buckeye rot in tomatoes can also cause a similar disease, called Phytophthora blight, in eggplants and peppers.

Symptoms of buckeye rot on tomato fruits.
Credit: D. Ferrin, LSU AgCenter, Bugwood.org

Buckeye rot and Phytophthora blight can be reduced using these management practices:

- Plant in well-drained soils.
- Remove and discard infected fruits.
- Rotate out of solanaceous crops.
- Stake or cage plants.
- Use mulch.

Early blight is a common and major disease of tomatoes in Mississippi. Symptoms first appear on lower, older leaves as circular, brown lesions surrounded by a yellow halo. Lesions often contain rings. As the disease progresses, leaves turn yellow, wither, and drop. Frequently, only the upper half of the plant has green leaves, and in severe cases, the plant becomes completely defoliated.

Early blight also occurs on plant stems and sometimes on fruit. On seedlings, the disease may girdle the stem and give the appearance of damping-off.

Reduce losses to early blight by allowing for good air circulation and sunlight in plant canopies, reducing the amount of time that leaves remain wet (avoid overhead irrigation or apply water when leaves can dry quickly), planting in a location that did not have early blight the previous year, using mulch, removing and destroying diseased plant debris after harvest, and applying fungicides.

Applications of approved fungicides, such as chlorothalonil or mancozeb, at the appropriate times can effectively manage early blight. Be sure to check the product label as the pre-harvest interval (PHI) depends on the fungicide or product.

Symptoms of early blight on a tomato leaflet. Credit: R. A. Melanson, MSU Extension, Bugwood.org

Begin fungicide applications when plants are 8 to 10 inches tall and continue at 7-day intervals through the growing season. Applications of these fungicides also help manage some other leaf, stem, and fruit diseases of tomatoes.

Southern blight affects most garden vegetables. The fungus that causes southern blight attacks plant parts (roots, stems, leaves, or fruit) that are in contact with or just under the soil surface.

The first noticeable symptom of this disease in tomatoes and some other vegetables is usually an advancing yellowing and wilting of the foliage. During warm, moist weather, white fungal growth may develop on stems near the soil surface, plant parts in contact with the soil, and organic debris in the soil. Later, round, light tan to brown structures called sclerotia may develop. As the disease advances, several plants next to one another may become infected and eventually die.

White fungal growth of southern blight on tomato stem. Light tan and brown sclerotia are visible on the lower part of the stem beneath the fungal growth. Credit: R. A. Melanson, MSU Extension, Bugwood.org

Southern blight is difficult to manage, but losses can be reduced with these practices:

- Plow 6 inches deep in the fall to bury plant debris and sclerotia.
- Avoid throwing soil on plants when cultivating.

- When a few scattered plants are affected, remove them from the garden along with the soil 6 inches deep and 6 inches from the stem.
- Manage other foliar diseases as well as weeds; dead leaves on the ground and weed hosts may trigger pathogen growth.
- Wrap transplant stems with aluminum foil and plant so that the foil extends 2 inches below and above the soil line.

Fusarium wilt is a fungal disease that infects watermelons, cabbages, tomatoes, sweet potatoes, beans, and peas.

Lower leaves often turn yellow on one side of the plant only. Discoloration of the vascular tissue that originates from the roots is often visible when stems are split lengthwise. Infected plants are usually stunted and wilted.

The best way to manage Fusarium wilt is by planting resistant varieties.

Vascular discoloration (symptom) in a tomato stem with Fusarium wilt. Credit: Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

Bacterial wilt in tomatoes is a common disease in Mississippi. When temperatures increase in the summer, tomato plants infected with the bacterial pathogen suddenly wilt and do not recover. Wilting is the first symptom observed with this disease. A brown lesion may also be present at the base of the tomato stem. Discoloration of the vascular tissues may be observed in a cut stem. Bacterial streaming from a cut tomato stem suspended in a clear container of water is common and is often used as a quick field test to determine the presence of a vascular bacterial infection.

Bacterial streaming (sign) from the stem of a tomato plant with bacterial wilt. Credit: R. A. Melanson, MSU Extension, Bugwood.org

Management of this disease is difficult once the pathogen becomes established in the soil. Management practices to reduce the occurrence of this disease include using disease-free planting material, practicing crop rotation, removing and destroying infected plants, and practicing good sanitation.

Peppers may also be affected by the same pathogen that causes bacterial wilt in tomatoes.

Bacterial wilt in cucumbers is a destructive disease caused by a bacterium that overwinters in adult striped and spotted cucumber beetles. It is different from the bacterial wilt that affects tomatoes and peppers. As these beetles feed on young plants in the spring, bacteria are introduced into the vascular system, where they multiply rapidly and produce a sticky material that stops water movement through the plant. As a result, leaves on an infected runner wilt rapidly. Within a short time, all runners may become permanently wilted. Plants can die within a week or two after initial symptoms appear. Yellowing is not normally associated with this disease.

A sign of bacterial wilt is a thick, white, sticky substance that oozes from the cut stem of a wilted vine. If you press your fingertip against the cut surface of a stem several minutes after cutting it and then slowly remove it, the bacterial ooze frequently remains attached and strings out in thin threads.

Since bacterial wilt-resistant cucumber varieties are not commonly available, the best management method is to keep cucumber beetle populations in check.

Anthracnose is a common disease of beans, including lima beans. Symptoms of this disease appear on pods as small, brick-red blotches. These blotches may spread over

Symptoms of anthracnose on common bean.
Credit: E. Bush, Virginia Tech, Bugwood.org

the entire surface of the pods. Later, the diseased areas become brownish to grayish and may have many tiny black specks, which are fruiting bodies of the fungus. Occasionally, diseased pods fall from the plant.

Brick-red streaking may occur along the veins on the underside of leaves and young stems. Reddish spots occur on the lower leaf surface and enlarge and become noticeable on the upper leaf surface. Occasionally, leaves are killed and fall from the plant. Severely diseased plants are yellow and stunted.

Reduce damage from anthracnose by following these practices:

- Use only certified disease-free, western-grown seed.
- Practice crop rotation so beans are not planted in the same location more than once in 3 years.
- Avoid planting beans in the fall in an area of the garden where anthracnose was a problem the previous spring.
- Apply approved fungicides according to label directions.

Mosaic diseases are caused by viruses that commonly infect beans, sweet corn, squash, melons, cucumbers, peas, peppers, and tomatoes. Symptoms include misshapen leaves with light and dark green areas; fruit with green specks, yellow and green mottles, or bumps; distorted fruit; and stunted plants.

Management of virus diseases is difficult. You can reduce the chance of mosaic diseases in these ways:

- Plant resistant varieties when available.
- Manage insect vectors.
- Remove weeds.
- Remove infected/diseased plants as they appear.
- Purchase certified transplants or buy western-grown seed.
- Do not use tobacco products when handling plants.

Phenoxy herbicides, such as 2,4-D, can cause damage resembling mosaic disease symptoms. Leaves and stems of plants damaged by phenoxy herbicides are typically twisted, deformed, curled, leathery, and excessively long and narrow.

Spotted wilt is a virus disease spread by several species of thrips. It can severely damage tomatoes and peppers, sometimes killing plants or drastically reducing fruit production. Fruits from diseased plants are generally small and distorted and often develop ring spots.

Initial symptoms appear as a thickening of veins on younger foliage. Younger foliage generally exhibits pronounced downward curling. Internodes become shortened, and immature fruit does not ripen. Dark purple streaks can occur on leaves, stems, and fruits. Other symptoms may include blighting and blackening of young shoots. On individual leaflets, small, dark, circular spots may appear. Heavily diseased leaves may turn dark and wither.

Symptoms of tomato spotted wilt on tomato fruits.
Credit: W. M. Brown, Jr., Bugwood.org

Try these management practices to reduce losses to tomato spotted wilt:

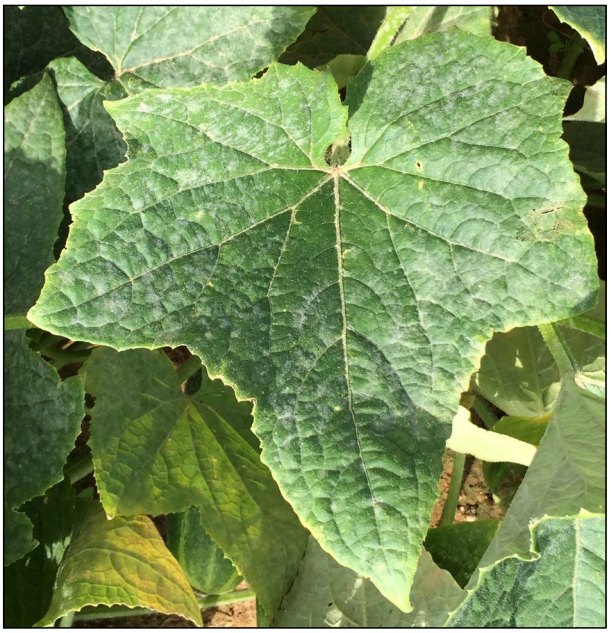
- Use resistant varieties.
- Remove and destroy diseased plants.
- Keep weed populations down in and around gardens to reduce the movement of virus-carrying thrips from weeds to garden plants.
- Suppress thrips by applying approved insecticides.

Further suppress thrips with reflective mulch around tomatoes and other susceptible vegetables. Conventional black plastic may be painted with aluminum-colored paint. Oil-based paints adhere to plastic surfaces and are easy to apply. This technique works best when mulch is

laid at planting and combined with other recommended management methods.

Powdery mildews are caused by fungal pathogens and are commonly visible as a white, powdery growth (sign) on cucumbers, squash, melons, beans, and English pea leaves. Unlike other diseases that often develop during frequent rainfall, powdery mildews can develop during dry periods.

Manage powdery mildew by growing resistant varieties (cucurbits) and applying approved fungicides.



Signs of powdery mildew on a cucumber leaf. Credit: R. A. Melanson, MSU Extension, Bugwood.org

Downy mildews are caused by fungal-like organisms that are commonly called water molds. These diseases can occur on various crops, including cucurbit and cruciferous crops, lettuce, and basil. Symptoms vary depending on the host that is affected, but in most cases, visible pathogen growth that has a downy appearance can be observed on affected leaves when environmental conditions are favorable. Downy mildews commonly develop in cool, moist conditions.

Pathogen growth (sign) on the underside of a cucurbit leaf with downy mildew. Credit: R. A. Melanson, Bugwood.org

Management of downy mildew will depend on the crop in question, but using resistant varieties, when available, and approved fungicides can help reduce this disease's occurrence.

Black rot is a bacterial disease that affects cruciferous crops such as cabbage, collards, mustard, cauliflower, Brussels sprouts, kohlrabi, rutabagas, turnips, kale, and rape. It may affect plants at any growth stage but is usually most prominent close to maturity. On older plants, yellow, wedge-shaped areas appear at leaf margins and expand toward the center. Blackened veins are apparent in affected areas. Vascular tissue within the stem may also become discolored.

Symptoms of black rot on cabbage. Credit: G. Holmes, Strawberry Center, Cal Poly San Luis Obispo, Bugwood.org

Black rot also causes head dwarfing, and soft rot frequently develops on affected heads.

Practices important for managing black rot include:

- Using disease-free seeds that have been hot-water treated.
- Purchasing transplants that have been certified as disease-free.
- Practicing crop rotation so that at least 2, preferably 3, years elapse between cruciferous crops.

Rusts are fungal diseases that commonly appear on beans and sweet corn as reddish-brown spots on leaves. They can be managed using approved fungicides according to label directions.

Leaf spot diseases are often caused by fungi or bacteria and commonly occur on many vegetables. They appear on leaves and sometimes stems as distinct, dark-colored or tan spots one-sixteenth to 1 inch in diameter. Reg-

ularly applying approved fungicides generally provides acceptable management of fungal leaf spots. Applying approved copper fungicides can help manage bacterial and fungal leaf spots.

Fruit rots are caused by bacteria and fungi that infect fruit, leading to soft, slimy decay with an offensive odor. You can reduce the occurrence of fruit rot by staking plants, mulching, avoiding mechanical injury to fruits, managing insects, following a regular fungicide application program, and harvesting mature fruit from the garden.

Nematode diseases are caused by slender, microscopic, worm-like animals that feed on plant roots, stems, and leaves. Because they are invisible to the naked eye, their presence often goes unnoticed until plants begin to appear weak, stunted, or slow-growing. Nematodes rarely kill plants outright, but they can significantly reduce the quality and yield of many vegetables, including beans, beets, carrots, cucumbers, lima beans, okra, peas, squash, tomatoes, and watermelons.

Nematode damage to roots reduces the plant's ability to absorb water and nutrients. Aboveground symptoms include general stunting, yellowing, poor vigor, and overall decline. Belowground, the most common sign is root galling, especially from root-knot nematodes. However, other nematode species can also cause serious damage. Less obvious symptoms include stubby or overly branched roots, the loss of fine feeder roots, or small lesions on root surfaces.

Galls on an okra root caused by root-knot nematodes. Credit: R. A. Melanson, MSU Extension, Bugwood.org

The best time to determine if you have a nematode problem is during the fall when nematodes are most active. The presence of root-knot nematodes can be determined during the growing season if you observe galled roots on plants.

You can have your soil tested for nematodes by sending a soil sample to the MSU Extension Plant Diagnostic Lab. A completed *Nematode Sample Submission Form* (F448) should accompany the samples. Additional information, including tips for sample collection and current fees for nematode analysis, is available on the Extension Plant Diagnostic Lab webpage (extension.msstate.edu/lab).

Various management practices can help reduce nematode populations:

- Plant resistant varieties.
- Plant nematode-free transplants.
- Practice crop rotation.
- Incorporate fallow periods.
- Practice good sanitation.
- Remove weeds.
- Plant marigolds.
- Implement solarization.
- Apply approved chemical treatments.

For additional details on managing nematodes in the home garden, see MSU Extension Publication 483 *Nematode Control in the Home Garden*.

HARVESTING

Gardening itself is a lot of fun, but the harvest is what gardeners work toward. Harvesting at the right time is essential for obtaining quality produce. If you pick vegetables too early or too late, they will not have optimal textures or flavors.

The ideal time to harvest is when crops have had enough time to mature. *Days to maturity* is the number of days from the date a crop is directly sown or transplanted to when it is ready to harvest. Varieties of the same crop can vary in their days to maturity. Fortunately, this information is provided on seed packets and catalogs.

Average days to maturity by crop are provided in Tables 1 and 10. Cool-season vegetables mature more rapidly as the weather warms in late spring; warm-season vegetables mature more slowly as the weather cools in the fall. Early varieties mature more rapidly than mid- and late-season varieties. Use the number of days as a guide and consider

the weather, the variety description (early, midseason, or late), and the appearance of the vegetables.

Keep these points in mind when harvesting vegetables:

- Harvest at the right stage of maturity. Picking too early reduces quality and flavor.
- Many crops can be harvested multiple times. Leafy greens, green onions, and most herbs will continue growing if you remove only the outer leaves or cut above the roots. Some fruiting vegetables also keep producing if only the ripe parts are picked.
- Pick frequently from plants that produce continuously. Okra, summer squash, beans, and cucumbers should be harvested every 1 to 2 days to keep them producing and prevent overripening.
- Harvest when foliage is dry. Walking through wet plants can spread diseases.
- Avoid harvesting from wilted plants. Vegetables picked from wilted plants may be limp and lower in quality. Harvesting also increases water loss, putting additional stress on the plant.
- Handle plants carefully to prevent damage. Avoid stepping on vines or breaking stems, as injuries create entry points for disease. When harvesting, gently remove produce—cut crops like eggplants, watermelons, and tough okra stems with a knife rather than pulling.
- Move harvested vegetables to the shade immediately and keep them cool.
- Use freshly harvested vegetables as soon as possible for the best flavor and texture.

In addition to knowing how to harvest crops, understanding average bushel weights can help home gardeners estimate yields, plan for storage, and compare their harvests to market standards. This is especially useful for those who can, freeze, or preserve food, as it helps determine how much produce is needed for recipes and how much space is required for storage. While bushels are a traditional unit of measure, they remain a practical tool for managing large harvests efficiently and reducing waste. See Table 11 for crop-specific information.

Table 10. Days to maturity and harvesting guidelines.

Crop	Days to Maturity	Harvest Tips
Asparagus	2 years	Cut or snap spears when they are 6–8 inches tall and before leaf bracts at the tips begin to open. Leave 20–50% of spears to grow for next year's crop.
Beans, snap	50 (bush), 65 (pole)	Best when pods are crisp and snap easily but when tips are still pliable.
Beans, lima	65 (bush), 80 (pole)	Pick when pods are well-filled but still bright green and fresh. The end of the pod should feel spongy when squeezed.
Beans, shell	70	Harvest when beans are very evident in pods but before pods begin to dry—similar to lima beans and southern peas.
Beans, dried	90	Harvest when pods are dry but before they shatter. Cut the entire plant and dry or pick the pods. Once completely dry, shell and store in the freezer.
Beets	50–65	Pull when medium-sized (1.25–2 inches in diameter). Leafy tops can be cooked as greens.
Broccoli	55–75 (from transplants)	Heads should be compact with tight buds. Yellow flowers indicate overmaturity.
Brussels sprouts	90 (from transplants)	Cut sprouts from stalk when they are 1–2 inches in diameter and firm. Lower sprouts develop first. Remove the leaf when cutting the sprout.
Cabbage	65–80 (from transplants)	Cut when the head is firm and before splitting.
Carrots	60–75	Harvest according to desired size and weather. Sugar content is higher in mature roots, but younger ones are more tender.
Cauliflower	65 (from transplants)	Cut when the head is firm and smooth. Should not be "ricey" in appearance. Pure white color results from blanching; creamy color is fine.
Chinese cabbage	45–65	Cut entire plant at ground level when the head is fairly compact or at the desired size.
Collards	55	Harvest as soon as leaves are large enough to pick. Large, old leaves are tough and fibrous.
Sweet corn	65–80	Harvest when silks turn dark and begin to shrivel (17–21 days after silking). Kernels should be bright, plump, and milky. Super sweets may appear watery.

Crop	Days to Maturity	Harvest Tips
Cucumbers, pickling	55	Pick when ≤2 inches long for pickles and 4–6 inches for dills. Frequent harvest is necessary.
Cucumbers, slicing	60	Harvest when 6–8 inches long and before ends soften or turn yellow.
Cucumbers, burpless and European	60	Harvest when 8–10 inches long and 1–1.5 inches in diameter.
Eggplant	65–80 (from transplants)	Ready when fruit is half-grown, before color dulls.
Endive, escarole	70–85	Cut plants at ground level when large enough to eat.
Gourds, small decorative	-	Cut from vine with stem attached when rind is hard, before frost.
Gourds, dipper and birdhouse	-	Cut from vine with stem attached when they begin to dry. Frost does not injure mature gourds.
Gourds, luffa	-	Cut from vine when skin turns yellow or after drying. For eating, harvest when small (≤4 inches long) and tender.
Horseradish	-	Dig roots in late fall after frost. In well-drained soil, roots can be left in the ground until needed.
Jerusalem artichoke	-	Dig tubers all winter after cold kills the tops.
Kale	55	Cut entire plant or larger leaves while still tender. Cold weather improves flavor.
Kohlrabi	55	Harvest when swollen stem is baseball-sized. Large, old kohlrabi is woody and tasteless.
Lettuce, leaf	45–50	Ready when leaves are large enough to harvest.
Lettuce, head	45–60	Harvest leaves as needed before heads form or as soon as heads are firm.
Melons, muskmelons	42–46 (from pollination), 70–85 (from seed)	Ready when blossom end gives to pressure and melon slips easily from stem. Netting should be coarse and prominent.
Melons, honeydew	85–110 (from planting)	Harvest when greenish rind turns golden; does not slip from vine.
Melons, watermelons	42–45 (from pollination), 90 (from transplants)	Ready when the ground spot turns from white to creamy-yellow.
Mustard	45	Ready as soon as leaves are large enough to harvest; old leaves are tough.
Okra	4–6 (from pollination), 50–60 (from transplants)	Pick when pods are 2–4 inches long.
Onions, green	50–60	Harvest when 0.25–0.5 inch in diameter and tops are 12–16 inches tall. Cut near ground level for repeated harvests.
Onions, bulb	90–110	Dig when tops have yellowed and fallen over.
Parsley	70– 90	Harvest when leaves are large enough to pick.
Peanuts	110	Dig when tops are yellowing and inner hulls are brown. Dig entire plant.
Peas, English	50– 65	Best when pods are bright green and well filled. Raw peas should be sweet.
Peas, snap	65	Best when pods are green and crisp and peas have filled pods.
Peas, southern	65	Pick purple hull varieties when pods are ≤50% purple. Pick tan pod types when pods show a hint of yellow. Peas should be green when shelled.
Peppers	75 (from transplants)	Pick green bell peppers when shiny green and firm. Harvest colored peppers when fully colored.
Potatoes, Irish	75–90	Harvest when large enough for early potatoes. Harvest main crop after vines have yellowed.
Potatoes, sweet	90– 120	Harvest when roots have reached usable size, before frost or when soil cools below 50°F.

Crop	Days to Maturity	Harvest Tips
Pumpkins	85– 110	Harvest when fully colored, heavy, and rind is hard.
Radishes	28	Pull as soon as large enough.
Radishes, winter	50	Harvest before ground freezes.
Rhubarb	-	Pull leaf stalks when leaves are fully grown. Discard the leaf blade and eat the stalk only.
Rutabagas	70– 90	Dig anytime they are large enough. Dry, woody if soil moisture is insufficient.
Spinach	35– 45	Use before leaves get old and tough.
Spinach, New Zealand	-	Pick the terminal 3–4 inches of shoots when plants are large enough.
Squash, summer	40– 55 (from planting)	Harvest when medium-sized, with good color and rind easily dented with a fingernail.
Squash, winter (storage)	90	Harvest when color is good and rind is very hard.
Swiss chard	50	Harvest as soon as leaves are large enough.
Tomatoes	70 (from transplants), 45 (from pollination)	Harvest when fully colored. Size is not an indicator of maturity.
Turnips, greens	-	Harvest when leaves are large enough to pick.
Turnips, roots	40– 60	Best when medium-sized and firm.
Watermelons	-	See Melons.

Table 11. Average bushel weights.

Crop	Weight per Bushel* (lb)
Beans, lima (unshelled)	32
Beans, snap	30
Cabbage (sack)	50
Cucumbers	47–55
Eggplant	33
Greens	23–24
Okra	30
Peanuts (green)	35–45
Peas, English	28–30
Peas, southern	25
Peppers, bell	25
Potatoes, Irish	60
Potatoes, sweet	55
Spinach	20–25
Squash, summer	42

*A bushel measures approximately 1.25 cubic feet in volume, but its weight varies by crop.

Storing Vegetables

In addition to canning, freezing, and drying fresh vegetables, you can store many for later use. The length of successful storage depends on the vegetable and the storage conditions. Moisture loss is the major factor that reduces quality during storage. Reducing the temperature slows this loss and delays the growth of bacteria and fungi that cause vegetables to spoil.

Some vegetables, such as winter squash, onions, Irish potatoes, and pumpkins, lose moisture slowly, while others, such as leafy greens, lose moisture rapidly. Place vegetables in a plastic bag or container before refrigerating to prevent wilting or softening. This applies to lettuce, mustard greens, spinach, collards, turnip greens, Chinese cabbage, beets, carrots, radishes, snap beans, shelled lima beans, cucumbers, broccoli, cauliflower, kohlrabi, and green onions. Turnip roots lose moisture rapidly and have a strong odor, so be sure to bag them.

For short-term refrigerated storage, wash vegetables to remove insects, soil, and spray residue before refrigerating. Some vegetables can be stored for several weeks or longer without refrigeration under proper conditions.

Beets, carrots, turnips, rutabagas—When grown in the fall, leave them in the garden until needed. Pull the soil up over the roots or cover them with straw. Store harvested roots in plastic bags or moist sand in a cool location, like your refrigerator.

Cabbage—Harvest mature heads before a hard freeze. Trim loose outer leaves and store heads in the refrigerator or a cool, humid place like a root cellar. For short-term storage, leave roots attached and place in a ventilated cold frame or insulated outdoor bin.

Onions—After bulbs are harvested and dried, trim tops, leaving about a half-inch. Most southern onions do not store well, but for best storage, keep dry bulbs in a cool, well-ventilated place. If the temperature is too warm, the tops will sprout. If the humidity is too high, the roots will begin to swell and develop.

Irish potatoes—Spring-grown Irish potatoes are difficult to store. Cure potatoes in a warm place for several days to heal cuts and bruises. Do not wash potatoes unless they are very dirty from harvesting in wet soil. Store dry potatoes in boxes in a closet in an air-conditioned house. If the house is on a conventional foundation, store potatoes under the house. Be sure to shut out all light to prevent greening.

Irish potatoes grown in the fall are easier to store than spring-grown potatoes. Harvest when the soil is dry, and don't expose the potatoes to the sun. Cure in a warm, moist place for about a week to heal cuts and bruises; then place potatoes in a cool, dark place. Make sure they don't freeze. Fall-grown potatoes can be successfully stored for several months.

Sweet potatoes—Sweet potatoes are very sensitive to cold soils and cold storage. Potatoes chilled in the soil or in storage will not last very long. Dig potatoes before soil temperatures drop to 55°F. Cure potatoes for 7 to 10 days in a warm, moist place—80 to 85°F and 90 percent relative humidity. Curing helps heal all cuts and bruises that occurred during harvest. Store cured potatoes at 55°F and high humidity to prevent shrinkage. Storing at warmer temperatures encourages sprouting.

Pumpkins, winter squash—Harvest these vegetables as they mature because they do not store well in the garden. They will be ready to harvest in July and August if planted in April or May. If left exposed to the sun and wet weather, they rot. Cure in a warm, dry place for 10 to 14 days to harden rinds and improve flavor. After curing, store in a cool, fairly dry place. Small quantities can be stored in an air-conditioned home. Do not stack these vegetables in storage or expose them to temperatures below 50°F. If the humidity is too high, molds and rots will develop. Properly cured varieties like butternut and Hubbard often store for 3 to 6 months, with flavor peaking weeks after harvest.

Tomatoes—Ripe tomatoes store best at a temperature around 60°F. At refrigerator temperatures, the quality rapidly deteriorates. Mature green tomatoes (those that have reached full size and are turning white before coloring) will ripen if picked before frost injures them. Wrap tomatoes in paper and store them in a cool place. Check them regularly to remove any ripening or spoiled tomatoes. You can have garden tomatoes in December and even later if you strip the vines of fruit before a freeze and handle them as described.

Dried beans and peas—The greatest danger in storing dried beans and peas is insect infestation. Pick dry pods and thoroughly dry them in a warm, well-ventilated place before shelling. Kill insects by heating dry, shelled beans and peas in a 180°F oven for 15 minutes. Store these treated beans and peas in plastic bags or containers with tight-fitting lids. If freezer space is available, you can store dried peas and beans in the freezer without prior heating.

HERB GARDENING

Herbs are used for flavoring, scents, teas, and medicinal purposes. Many herbs used in flavoring foods and teas (culinary herbs) can be grown in Mississippi gardens. Almost all fresh herbs provide a stronger and more nuanced flavor to food than their dried counterparts (with some exceptions). Most herbs should be grown in full sun, but a few prefer or tolerate light shade. They prefer a well-drained soil of medium fertility with a pH of 6.0 to 7.0 and benefit from an organic mulch in the summer.

Herbs can be categorized into annuals that are planted every year, biennials that are usually planted in the fall and flower the following year, hardy perennials that survive the winter and come back year after year, and tender perennials that may survive a mild winter but often need to be treated as annuals or protected from freezing temperatures. Like vegetables, they can also be divided into warm- and cool-season crops. See Table 12 for crop-specific information.

As with vegetables, plant what you will use. Many herbs can be easily started from seeds; however, some are only propagated through cuttings. Herb plants and seeds are available at nurseries, garden centers, hardware stores, grocery stores, and online.

Because herbs are used in very small amounts, just a few plants of each type may be enough. If you want a large quantity of a particular herb, such as sweet basil, for making pesto, plant the herb in the vegetable garden. Otherwise, prepare a small area set aside for herbs so that you can enjoy them for their appearance and fragrance. Locating herbs near your house is also a good idea so you can harvest them easily and quickly while cooking.

Herbs typically do not have pest problems. When planting herbs in the vegetable garden, protect them from pesticides used on vegetables.

Most herbs transplant readily from starts into the garden, but there are exceptions. Cilantro, borage, and dill are best planted by seed. Scatter seeds directly in the garden or start them in containers.

The flavors and scents of herbs come from the oils stored in their tissues. However, excessive fertilization, overwatering, or too much shade can reduce the oil content, weakening the flavor. For many herbs, oil levels peak just before they flower, making this the ideal time to harvest for maximum flavor and aroma.

Table 12. Herb planting tips and uses.

Herb	Classification	Uses	Planting Notes
Anise	Cool-season annual	Culinary (licorice-flavored seeds/leaves); medicinal	Plant early spring or fall; avoid summer heat; slow-growing
Basil	Warm-season annual	Culinary (leaves); sweet basil for Italian, Thai for Asian dishes	Plant after frost; grows easily from seed; frost-sensitive
Bay	Tender perennial	Culinary (leaves); dried bay has milder flavor than fresh	Hardy in southern Mississippi; plant in spring; best in containers; overwinter indoors in colder areas
Bergamot	Perennial	Tea (minty leaves); attracts bees and hummingbirds	Plant in well-drained soil; tolerates heat; start from crown division or seeds
Borage	Warm-season annual/biennial	Culinary (cucumber-flavored leaves/flowers); ornamental; attracts bees	Direct sow in spring or fall; self-seeds; tolerates light frost; grows unruly
Burnet, salad	Perennial	Culinary (cucumber-flavored leaves); salads	Prefers partial shade in hot summers; grow from seeds or division
Catnip	Perennial	Tea (leaves); attracts cats; medicinal	Thrives in well-drained soil; spreads easily; tolerates summer heat
Chamomile, German	Cool-season annual	Tea (flowers); medicinal	Plant early spring or fall; tolerates light frost; prefers full sun
Chives	Perennial (short-lived)	Culinary (onion-flavored leaves); ornamental (purple flowers)	Prefers partial shade in hot summers; plant in spring; divide clumps every few years
Chives, garlic	Perennial	Culinary (mild garlic-flavored leaves); ornamental (white flowers)	Thrives in Mississippi; self-seeds prolifically; flat leaves distinguish from regular chives
Coriander (cilantro)	Cool-season annual	Culinary (cilantro leaves, coriander seeds); Mexican/Asian dishes	Plant early spring or fall; choose slow-to-bolt varieties; fall-sown crops will yield heavily in spring
Costmary	Perennial	Tea (mint-scented leaves); medicinal	Tolerates partial shade; grow from seeds or division
Dill	Cool-season annual	Culinary (leaves/seeds); pickling; medicinal	Plant early spring for leaves and flower heads; plant in fall for leaves; direct sow
Epazote	Warm-season annual	Culinary (leaves/seeds); Mexican cuisine; medicinal	Plant in spring; prefers full sun; frost-sensitive
Fenugreek	Cool-season annual	Culinary (leaves/seeds); Indian/Middle Eastern cuisine; medicinal	Plant early spring or fall; legumes improve soil nitrogen
Garlic	Perennial (grown annually)	Culinary (bulbs); medicinal	Plant cloves in October; harvest in May to June; prefers well-drained soil
Geraniums, scented	Tender perennial	Ornamental (various scented leaves); tea (leaves); potpourri	Grow in containers; propagate by cuttings; frost-sensitive; overwinter indoors
Galangal	Tender perennial	Culinary (roots); Thai cuisine	Plant in spring; harvest in fall; needs 9–10 months to mature; frost-sensitive
Ginger	Tender perennial	Culinary (roots); medicinal	Plant in spring; harvest in fall; needs 8–10 months to mature; frost-sensitive
Hyssop, anise	Perennial	Tea (licorice-flavored leaves); attracts bees	Plant in well-drained soil; propagate by seeds or division
Lavender	Perennial (short-lived)	Ornamental; essential oils; culinary (flowers in French cuisine)	Needs well-drained soil; struggles in humidity; plant in full sun; may decline after 2–3 years

Herb	Classification	Uses	Planting Notes
Lemon balm	Perennial (short-lived)	Tea (lemon-scented leaves); medicinal	Can become invasive; self-seeds heavily; tolerates partial shade; declines after 2–3 years
Lemongrass	Tender perennial	Culinary (lemon-flavored leaves); Asian cuisine; ornamental grass	Plant in spring; frost-sensitive; hardy in southern Mississippi; sharp-edged leaves
Marjoram, sweet	Tender perennial (annual)	Culinary (leaves); milder flavor than oregano	Treat as annual; plant in spring; prefers well-drained soil; struggles in humidity
Mint	Perennial	Culinary (leaves); spearmint for savory, peppermint for desserts	Invasive; plant in containers; prefers moist soil and partial shade; keep cut for tender growth
Oregano	Perennial	Culinary (leaves); Greek for robust flavor, Italian for mild flavor	Plant in well-drained soil; prefers full sun; dried leaves have stronger flavor
Oregano, Mexican	Tender perennial	Culinary (leaves); similar to oregano but unrelated	Hardy in southern Mississippi; needs well-drained soil; plant in full sun
Parsley	Biennial (annual)	Culinary (leaves); Italian flat-leaf for cooking, curly milder for garnish	Plant early spring or fall; tolerates light frost; fall-planted parsley overwinters in Mississippi
Rosemary	Perennial	Culinary (leaves); medicinal; ornamental (upright/creeping forms)	Thrives in well-drained soil; hardy and long-lived in Mississippi; evergreen shrub
Sage	Perennial (short-lived)	Culinary (leaves); medicinal	Struggles with humidity and wet soil; plant in well-drained soil; partial shade may help
Sage, pineapple	Tender perennial	Tea (pineapple-scented leaves); ornamental (red flowers)	Plant in spring; frost-sensitive; prefers full sun
Savory, summer	Warm-season annual	Culinary (leaves); milder flavor than winter savory	Plant in spring after frost; prefers full sun
Savory, winter	Perennial (short-lived)	Culinary (leaves); stronger, spicier flavor than summer savory	Plant in well-drained soil; tolerates cool weather; may become woody after 2–3 years
Tarragon, French	Perennial (short-lived)	Culinary (leaves); licorice flavor; French cuisine	Struggles in humid summers; grow in containers; prefers partial shade in hot weather
Tarragon, winter	Tender perennial	Culinary (leaves); Mexican cuisine; ornamental (orange flowers)	Plant in spring; frost-sensitive; prefers full sun
Tarragon, Russian	Perennial	Culinary (leaves); milder, grassy flavor	Hardy in Mississippi; tolerates heat and humidity better than French tarragon; full sun, well-drained soil
Thyme	Perennial (short-lived)	Culinary (leaves); medicinal	Struggles with humidity; plant in well-drained soil; prefers full sun; may decline after 2–3 years; English thyme is most common for cooking
Thyme, lemon	Perennial (short-lived)	Culinary (lemon-scented leaves); ornamental	Low-growing; plant in sunny areas; may decline after 2–3 years
Turmeric	Tender perennial	Culinary (roots); medicinal	Plant in spring; harvest in fall; needs 9–10 months to mature; frost-sensitive
Verbena, lemon	Tender perennial	Tea (lemon-flavored leaves); medicinal	Grow in containers; overwinter indoors; prefers full sun

ORGANIC GARDENING

Interest in organic gardening—avoiding synthetic fertilizers, pesticides, and genetically modified plants—is increasing. Organic gardening in Mississippi can be particularly challenging with the severe insect and disease pressures on vegetable plants.

Organic Nutrient Management

Organic matter, such as compost or fresh organic materials, is the most beneficial soil input for organic (and conventional) gardeners. Each type of organic material varies in nutrient content. See Table 13 for specific details. Blend straw, dry leaves, sawdust, wood chips, and paper with high-nitrogen materials like grass clippings, manure, or blood meal to prevent nitrogen deficiencies in vegetable plants. See the Composting section on page 9 for more details.

Soils with a low pH (acidic) can be corrected using limestone, ground oyster shells, wood ashes, or dolomitic limestone. Adding organic matter benefits soils with a high pH (alkaline).

Animal manures are the most widely used organic fertilizers. Unfortunately, their nutrients vary by source, age, degree of decomposition, water content, and the amount and kind of litter used. For more information on organic fertilizers, see MSU Extension Publication 2036 *Organic Vegetable IPM Guide*.

Most organic materials do not contain nutrients in proportions that match plant requirements, so supplementation is necessary to correct these imbalances. For example, well-leached animal manure has an estimated fertilizer value of 1-1-1, or 20 pounds each of nitrogen (N), available phosphate (P_2O_5), and available potash (K_2O) per ton of manure. While organic materials like manure are relatively low in nutrient content, they release nutrients more slowly than inorganic fertilizers. This gradual release helps prevent nutrient leaching but may be insufficient when plants require nutrients immediately.

Plants used as green manures and cover crops can also provide nutrients. For example, hairy vetch or crimson clover can fix up to 100 pounds of nitrogen per acre when allowed to grow over the winter. Southern peas grown during the summer can provide nitrogen for fall vegetables. Mow and plow green manure crops into the soil at least 4 weeks before planting the next crop. For details on selecting, planting, and managing cover crops, see the Cover Crop Use section on page 8.

Organic Pest and Disease Management

Currently, organic pesticides for controlling diseases and insects are limited. A few insecticides are available, including *Bacillus thuringiensis* (Bt), spinosad, and pyrethrums, but disease control is difficult. Neem oil, bicarbonate, and copper- and sulfur-based fungicides provide some protection against diseases, but the best results for disease management come from selecting resistant varieties and planting them at the proper time and spacing. For these reasons, organic gardening is easier on a small scale.

To increase chances for success, organic gardeners should follow these practices:

- Plant disease- and nematode-resistant varieties.
- Use mustard, solarization, and organic products like Clandosan 618 to control plant-parasitic nematodes (see MSU Extension Publication 483 *Nematode Control in the Home Garden*).

Table 13. Nutrient content of organic materials.

Material	N (%)	P_2O_5 (%)	K_2O (%)	Availability	Notes
Alfalfa meal	2–3	0.5	2.5	Medium	Contains natural growth stimulants.
Blood meal	12	1.5	0.5	Medium-rapid	High-nitrogen; fast-acting.
Bone meal	1	15	0	Slow-medium	Good for root crops and flowering plants.
Chicken manure (composted)	1.5–4	1–2	0.5–1	Medium	Composting reduces potency, preventing plant damage.
Compost	Up to 3	1	1	Slow	Nutrient content varies; improves soil health.
Cottonseed meal	6	3	1.5	Slow-medium	May lower pH; look for organic-certified.
Cow manure (composted)	0.5–1	0.4–0.8	0.5–1	Medium	Improves soil texture.
Feather meal	12–15	0	0	Slow	Long-lasting nitrogen source.
Fish emulsion	5	2	2	Rapid	Liquid fertilizer; good for foliar feeding.
Kelp meal	1–2	0.5–2	2–5	Medium	Adds micronutrients and growth hormones.
Rock phosphate	0	20–30	0	Very slow	Long-term phosphorus source; slow release.
Wood ashes	0	1–2	3–7	Rapid	Raises pH; avoid in alkaline soils.
Worm castings	1–2	1–2	0.5–1	Slow	Excellent for soil biology and structure.

- Plant seeds from disease-free plants.
- Plant only healthy vegetable transplants.
- Place an aluminum collar around plant stems at ground level to prevent cutworm damage.
- Incorporate plant residues and animal manures early to allow sufficient time to decompose before planting.
- Use mulches to control weeds and keep soil from splashing onto the plants and fruit.
- Use aluminum foil or reflective plastic mulches to repel aphids and thrips that injure plants and transmit viruses.
- Plant as early in the spring as temperature allows to avoid some insect problems.
- Keep the garden free of weeds that may harbor diseases and insects.
- Hand-pick insects.
- Water earlier in the day so the plants are dry by nightfall.
- Remove diseased plants and plant parts from the garden.
- Control insects using biological controls and natural products.
- Practice crop rotation and consider relocating the garden after several years of cultivation.
- Encourage natural insect predators. Trap slugs under boards and moist burlap laid on the ground, or use beer traps.
- Stay out of the garden when the plants are wet to prevent the spread of diseases.
- Avoid using tobacco products while working in or before entering the garden.
- Mix different vegetables or vegetable varieties in a row to eliminate monocultures and the chance for a disease to spread rapidly.

Figures 5–7 photo credits: Bean leaf beetle, Colorado potato beetle, cowpea curculio, flea beetle, pickle worm, spotted cucumber beetle, squash vine borer, striped cucumber beetle, giant robber fly, praying mantis, tiger beetle—Blake Layton; cabbage worm, white fly, aphid wasp, brown lacewing, white fly wasp—David Cappaert, Bugwood.org; corn earworm—Chris Daves; cornfield ant—Alain Hogue, Bugguide.net; cutworm—Scott Stewart; Mexican bean beetle—Whitney Cranshaw, Colorado State University, Bugwood.org; striped blister beetle—Clemson University, USDA Cooperative Extension Slide Series, Bugwood.org; tomato hornworm—Gerald Holmes, Strawberry Center, Cal Poly San Luis Obispo, Bugwood.org; vegetable weevil—Steve Morris, Bugguide.net; aphid, spider mite—Joe MacGown; green stink bug, Pennsylvania ground beetle, wheel bug—Jim Eckert, Bugguide.net; harlequin bug—Scott Nelson, Bugguide.net; leaf-footed bug—Joseph Berger, Bugwood.org; squash bug—Seth Ausubel, Bugguide.net; thrips—Eric P. Shultz, Bugguide.net; big-eyed bug—John Rosenfeld, Bugguide.net; convergent lady beetle—USDA Agricultural Research Service; cotesia wasp—Adobe Stock Image by Víctor; feather-legged fly, Zelus assassin bug—Dvori Feldman, Bugguide.net; fiery searcher—Jon Rapp; green lacewing—Lynn and Gene Monroe, Granite Ridge Nature Institute, Bugguide.net; hover fly—Gary Griswold, Bugguide.net; minute pirate bug—Stephen Luk, Bugguide.net; seven spotted lady beetle—Mary C. Legg, Bugwood.org; spined soldier bug—Rebekah D. Wallace, University of Georgia, Bugwood.org; tachinid fly—Joe Culin, Clemson University, Bugwood.org

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