MICHIGAN STATE UNIVERSITY | Extension

E-3371 • April 2018

ORGANIC GARLIC PRODUCTION

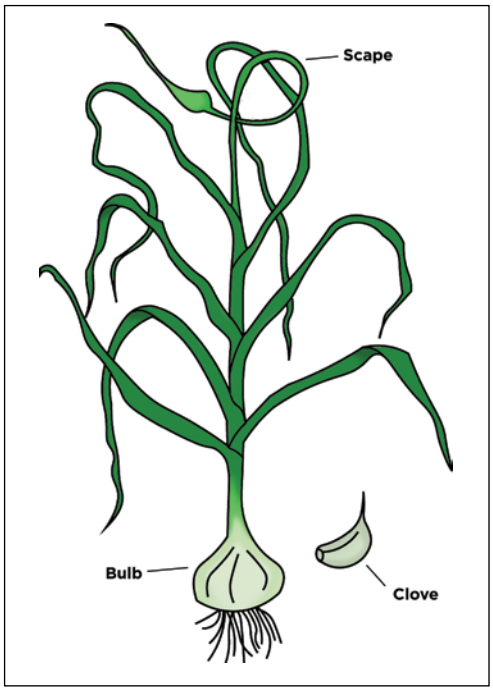
Collin Thompson, Michigan State University Extension Educator

Overview

Garlic (*Allium sativum*) is a member of the *Allium* genus, related to onions, leeks, chives, and shallots. Initially evolving under mild climates, garlic has been bred over thousands of years to be widely adaptable, now performing well in colder regions such as the Midwest.

The garlic plant consists of the bulb, the leafed stalk, and the leafless flower stem called the *scape*. Garlic flowers are sterile and produce small cloves, called *bulbils*, instead of seeds. Garlic bulbs consist of four to twenty separate fleshy sections called *cloves*, each wrapped in a papery skin called the *tunic*.

Collin Thompson, Michigan State University



Typical hardneck garlic plant.

While the entire plant is edible, the most recognizable part of the garlic plant is the bulb. Individual cloves are peeled and eaten raw, dehydrated, or cooked. Growers can harvest immature garlic as *green garlic* and use it in the same way as scallions.

The characteristic heat and pungency of garlic comes from various sulfur compounds produced by the plant. These compounds have been documented to provide various antimicrobial and antifungal effects, leading to a long history of use as both a culinary and medicinal plant in Asian, Middle Eastern, Mediterranean, and South and Central American cultures.

Garlic production in 2016 amounted to 26.5 million tons, with 80% of production in China. The U.S. is the 11th largest producer of garlic worldwide, yielding 167,000 tons in 2016. U.S. per capita consumption of garlic is 2 pounds and continues to steadily increase due to increased affinity for its flavor and continued promotion of its health benefits.

Types of Garlic

Garlic falls into two subspecies – softneck and hardneck.

Softneck varieties (*A. sativum* var. *sativum*) have a flexible stalk that is an extension of the papers that wrap the cloves. These varieties rarely produce a seed stalk and tend to perform better in mild climates, though some varieties have been bred to thrive in cool climates. Softneck varieties are typically more productive than hardneck varieties because the plant's energy is being directed entirely to bulb formation in the absence of a seed stalk. Their flexible necks dry down quickly and can be braided or cut for sale.

Softneck varieties are often believed to have a longer shelf life than hardneck varieties, lasting 6 to 8 months in storage.

Hardneck varieties (*A. sativum* var. *ophioscorodon*) have a stiff stalk that extends from the bottom plate of the garlic bulb to the top of the plant. This stalk produces a scape in early summer, which is a flowering head containing small, genetically identical cloves (bulbils) that can self-sow to produce the next generation. Most growers will remove these scapes to redirect energy underground, allowing for larger bulb formation. Scapes can be cut above the top leaf at emergence and eaten or sold as a garlic substitute. Shelf life is variety dependent, but hardneck varieties tend to have less storage potential when compared to softneck varieties.

Softneck and hardneck garlic can be further divided into different categories, each of which is identified by its clove formation and flavor profile. Numerous categories of garlic exist. A list of the most common follows in Table 1.

Table 1. Common Categories of Garlic

Softneck categories	**Description**
Artichoke	Productive and easy to grow, artichoke varieties are common. They typically consist of an outer row of large cloves with several inner cloves of a smaller size, typically with 12–20 cloves per bulb. The flavor of artichoke garlic can range from spicy to mild. Example varieties – Inchelium Red, Chet's Italian Red, Susanville
Silverskin	Silverskin garlic is some of the longest lasting in storage. Because of this, it is typically the most common to find in the supermarket. Similar to artichoke varieties, silverskin garlic has 12–20 cloves arranged in multiple layers. Also like artichokes, the flavor is wide ranging among varieties. Example varieties – Silver White, California Select, Idaho Silver
Hardneck categories	**Description**
Porcelain	Porcelain garlic is identified by its four large, symmetrical cloves around the central stalk. The cloves can reach impressive sizes, which are a joy to cook with, but lead to fewer plants per pound of seed. Porcelain garlics have great flavor, balancing earthiness with strong heat. Example varieties – Music, German Extra Hardy, Georgian Crystal
Rocambole	Known for their excellent, full-bodied flavor, rocamboles are sought out by chefs and processors. They have 6–11 large, easy-to-peel cloves, though they have a shorter shelf life than other varieties. They can be identified by their scapes, which form a double loop as they develop. Example varieties – Spanish Roja, German Red, Killarney Red
Purple Stripe	Purple stripe garlics earn their name due to their beautifully colored papers that feature purple stripes and splotches that can vary with variety and weather. They feature 8–12 cloves per bulb, with slightly smaller cloves than rocambole varieties. They have a moderate storage life of six months. Example varieties – Chesnok Red, Persian Star, Metechi

Soil Preparation

For garlic to be considered organic, it must be produced in compliance with the U.S. Department of Agriculture (USDA) National Organic Program (NOP) rules and regulations. These guidelines dictate proper soil management, crop rotations, and permissible inputs. Land that will be used for organic production must go through a 3-year transition period, during which no nonorganic inputs are applied. For more information on organic certification, contact your local Extension office or review the USDA NOP standards.

Garlic benefits from well-drained soil with high organic matter and a near neutral pH, but it can survive in a wide range of soil types. Softneck varieties tend to be more forgiving, but all garlic can succumb to root and bulb rot when soil drainage is inadequate.

Using tillage to improve drainage can be an important step in heavy or compacted soils. Alternatively, a cover crop rotation including tillage radishes, buckwheat, and a high-yielding legume improves drainage and soil physical properties while also providing nitrogen credits.

Garlic responds well to increased nitrogen fertilization. Recommended rates are 125–150 pounds per acre of applied nitrogen for good yields without compromising disease resistance. Recommended preplant phosphorus and potassium soil test levels are in the range of 100–150 pounds per acre.

Nitrogen is best applied at planting (75% of total), and in the spring at 6 inches of growth (25% of total). It is best to apply slow-release forms of nitrogen in the fall, but apply quick-release forms in the spring. On soils with high organic matter levels, nitrogen applications can be reduced. Compost can be applied to add fertility and organic matter, though it should be analyzed to better understand what fertility it provides in both soluble and total forms. Animal manures can be used in organic systems, though the NOP guidelines include specific requirements for timing and application of any raw animal-based materials. Currently, NOP regulations require a 120-day period between application of raw manure and harvest for crops whose edible portion comes in contact with the soil, such as garlic.

For an input to be permissible under NOP standards, it cannot contain any unapproved substances. The Organic Materials Review Institute (OMRI) provides a list of approved generic and branded inputs, though the only way to ensure a product is allowed is to confirm with your local certifier. Table 2 on the next page provides an overview of some commonly used fertility sources for organic production.

Growers can plant garlic into bare soil or into plastic film mulch. Black and green IRT (infrared transmitting) plastic film mulches can help retain moisture, reduce weed pressure, and boost soil temperatures in the spring.

Collin Thompson, Michigan State University

Garlic planted into bare soil.

Collin Thompson, Michigan State University

Garlic being planted into black plastic mulch using a simple measuring tool to mark 6-inch spacing.

Table 2. Commonly Used Fertility Sources for Organic Production

Plant-based fertility source	**Description**
Alfalfa meal	Slow-release nitrogen source (3%)
Cottonseed meal	Slow-release nitrogen source (7%). GMO-free meal can be challenging to source, but it is required for organic purposes.
Kelp meal	Low source of NPK. Primarily used for micronutrients, including Fe, Cu, Zn, Mo, Bo, Mn and Co
Peanut meal	Medium release nitrogen source (7-8%)
Soybean meal	Slow-release nitrogen source (7%). GMO-free meal can be challenging to source, but it is required for organic purposes.
Animal-based fertility source	**Description**
Feather meal	Slow-release nitrogen source (13%)
Fish products (meal/emulsion)	Moderate source of nitrogen (4–9%) and phosphorus (1–5%)
Poultry litter	Source of NPK. Slow-release nitrogen, quick release of phosphorus and potassium
Bone meal	Source of phosphorus (12–20%) and calcium (22%)
Mineral fertility source	**Description**
Sulfur	Used to lower pH
Dolomitic lime	Used to raise pH. 25% Ca and 10% Mg
Calcitic lime	Used to raise pH. 38% Ca and no Mg
Gypsum	Calcium sulfate. Adds Ca without adjusting pH
Greensand	Moderate source of potassium (3–7%). Also contains Mg and Fe
Granite dust	Slow-release potassium
Potassium sulfate	Source of potassium (50%) and sulfur
Rock phosphate	Source of phosphorus (3%) and calcium (20%)

Planting

Although sexual propagation is possible, most growers use asexual propagation techniques. To accomplish this, growers use individual cloves as the seed stock, resulting in a genetic clone of the parent. Prior to planting, it is critical to ensure that clean, disease-free seed stock is secured.

Break apart garlic bulbs into individual cloves a few days prior to planting. Ideally, the protective papers surrounding each clove should be kept intact to help prevent rotting when planted. Although cloves without the paper can be planted, plan for a slightly higher risk of loss. Cloves should be graded and selected to achieve optimal head size. Large cloves tend to produce larger plants and harvested bulbs due to greater seed energy reserves and more rapid formation of a larger plant. The number of cloves per pound of seed is highly variable depending on seed size and variety, but a rough guide is provided in Table 3.

Table 3. Average Number of Cloves per Pound of Seed

Garlic variety	Average cloves per pound of seed
Artichoke	65
Silverskin	70
Porcelain	40
Rocambole	60
Purple Stripe	60

Collin Thompson, Michigan State University

Garlic cloves separated and graded before planting.

Garlic is typically planted with 6–12 inches between rows, with individual cloves set 4–8 inches apart in-row. Larger bulbs result from greater spacing, but this will result in fewer plants per acre. Cloves are planted 1–2 inches deep, with the clove oriented with the root growth plate down.

Plant 3 to 5 weeks before a hard freeze settles in, providing enough time for root development in the fall. In Michigan, this is typically in October–November. In areas with limited snowfall, apply 2–4 inches of straw mulch after planting. Growers in high snowfall areas can sometimes use the snowpack as effective mulch, though most growers continue to mulch to minimize risk of freezing planted cloves and to manage or minimize weeds.

Management

Irrigation

To achieve maximum bulb size, soil should be consistently moist throughout the production cycle. An average of 1–2 inches of water per week will allow for uninterrupted growth. Organic matter levels, mulching strategy and soil type will have an impact on frequency and duration of irrigation. Irrigation should be reduced once bulb formation slows to encourage maturation and to prevent disease. Either drip or overhead irrigation systems can be used, though many growers find drip systems to be ideal due to reduced water requirements and the ability to more effectively irrigate through mulches.

Weed Management

Garlic is a poor competitor against weeds, so take proper steps prior to planting to minimize weed pressure. Using stale bedding for 2–4 weeks prior to planting and using clean, weed-seed-free straw mulch can greatly reduce weed pressure. You can remove mulch in the spring to allow for mechanical cultivation, though irrigation needs may increase as a result.

Pests

Few insect pests are of concern in Michigan, though growers should scout the garlic crop regularly to spot emerging issues. Several pest control options are available to organic

Collin Thompson, Michigan State University

Garlic mulched with oat straw after planting.

producers. NOP standards request that growers use cultural or mechanical controls as the first line of defense against pests. This can consist of physical barriers, mechanical removal, balanced plant nutrition, and predatory insect habitat establishment. When necessary, growers can use nonsynthetic chemical treatments, assuming the input is approved for use under the NOP guidelines. Allowed inputs are included in the OMRI list but you should consult with your local certifier prior to using any questionable inputs. Potential pests include:

- **Onion thrips** – These small, sucking insects leave whitish specks on leaves that result from their feeding. Insecticidal soaps can be effective on thrips.

Joe Ogrodnik, Cornell University

Onion thrips.

- **Onion maggots** – These small, white maggots (5 millimeters) bore into garlic stems, causing plants to wilt and die. Remove affected plants immediately. Long rotations (a minimum of 3 years) with other alliums is the most effective control.

John Obermeyer, Purdue Extension Entomology

Onion maggots on garlic.

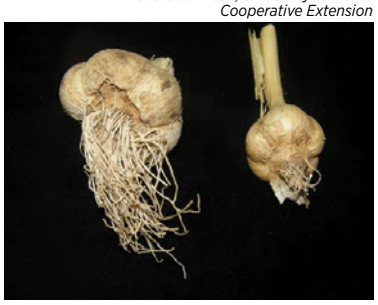
- **Wireworms** – These yellowish brown larvae (1–1.5 inches) feed on roots and bulbs of garlic, leaving holes and imperfections, reducing marketability. Wireworms are commonly found in fields recently converted from sod or pasture, so wait a year to plant into recently transitioned ground to prevent outbreaks.

John Obermeyer, Purdue Extension Entomology

Wireworm.

- **Stem and bulb nematodes** – Infestation of these nematodes causes deformation of garlic leaves and stems, resulting in stunted growth and death. Nematodes survive in plant tissues, so removal of residues and proper rotations with nonhost species can prevent issues.

Steve Johnson, University of Maine Cooperative Extension



Damage to garlic root and basal plate due to bloat nematode.

Diseases

Garlic is a host to several diseases that can be problematic for Midwestern producers. Growers can manage most of these diseases using extended rotation schedules and proper handling techniques. Carefully inspect seed stock to ensure cleanliness. Source seed through reputable growers to avoid the importation of pest and diseases. Some common diseases include:

- **White rot** – This fungal pathogen (*Sclerotium cepivorum*) causes yellowing of leaves and stunted growth and crop loss. Most commonly seen in

springtime in cool climates, white rot can be a devastating disease. It can be controlled using long rotations and pure seed.

Steve Johnson, University of Maine Cooperative Extension

Garlic infected with white rot (*Sclerotium cepivorum*). Infected bulbs show reduced roots and clinging soil.

- **Basal rot** – This fungal pathogen (*Fusarium* spp.) typically affects plants that are already weakened, causing yellowing leaves, stunted growth, decay of roots and reduced storage potential. Rogueing out infected plants and proper rotation techniques are effective controls of *Fusarium*.

Melodie Putnam, Oregon State University Plant Clinic

Fusarium on garlic bulb.

- **Blue mold** – This fungal pathogen (*Penicillium* spp.) can be problematic in both field and storage conditions, causing early mortality of emerging plants. Plants that survive the disease can show a blue-green mold on cloves, which can transmit the disease to the next generation and throughout storage facilities. The best control for this disease is ensuring clean seed stock at planting and destroying infected bulbs.

David Fuller, University of Maine Cooperative Extension

Blue mold (*Penicillium* spp.) on garlic clove.

Harvest/Curing

Garlic is ready for harvest when 40–60% of the leaves have yellowed. Each of the yellow and remaining green leaves corresponds with a paper on the bulb, with more layers of papers corresponding with longer storage life. Late harvests, in which leaves have senesced, yield fewer papers and poor storage life. To confirm, pull sample bulbs and cut in half. If the cloves fill the skins and there are 4–6 papers intact, the garlic is ready for harvest. In Michigan, harvest usually occurs mid-June to mid-July.

You can hand-harvest small plantings of garlic by using a digging fork or spade. Loosen the soil around the plant before pulling it by hand. For larger areas, you can pull an undercutter bar beneath the plants to loosen the soil. Plants are hand-pulled and often placed in windrows to field dry for a few hours to a week. Layering the plants so the leaves cover the bulbs will help prevent sunburn of the bulbs during field curing.

If storage is required, garlic must be cured properly. If moisture is released from a cut stem when squeezed, the garlic is not fully cured. Cure garlic by hanging it in bunches, by forcing air through bulk containers, or by laying it out on racks or on the floor. Optimal curing conditions are 75–90 °F and 60–75% relative humidity. Depending on the curing conditions, the process can take 3 days to 2 weeks. Some growers will power wash garlic postharvest to reduce the amount of dirt on the papers before curing. This can result in cleaner papers and less handling after curing, though care must be taken to avoid damaging bulbs. If adequate layers are present, and the method of marketing benefits from cleaner looking bulbs, remove an outer layer of papers prior to drying and curing. Most growers leave the tops intact while curing, though trimming the tops

Filaree Garlic Farm

Garlic curing in hanging bunches and on elevated racks.

can speed curing and reduce handling after curing. Proper sanitation is important when trimming prior to curing to avoid the introduction of pathogens into cut tissues. Using circulation fans or supplemental heat to speed curing time is especially valuable in areas with high humidity. After the leaves have dried and papers have shrunk to the bulb, trim the garlic tops and roots to the desired length and store in clean boxes or mesh bags at 32–35 °F and 65–75% relative humidity. Store garlic reserved for seed at slightly warmer temperatures, ranging from 40 °F to 50 °F.

Collin Thompson, Michigan State University

Cured, graded, and cleaned garlic ready for shipment.

Heads can be graded for sale and seed selection. U.S. No. 1 garlic requires that bulbs be no less than 1.5 inches in diameter, but depending on the market, garlic can be graded to further specifications. A simple grading tool can allow a grower to select bulbs for varying price points and seed selection.

Collin Thompson, Michigan State University

Simple tool used to grade garlic for sale. Garlic is passed between boards until head diameter is determined.

Further Resources

Bachman, J., & Hinman, T. (2008). *Garlic: Organic production* (No. IP320). Butte, MT: National Center for Appropriate Technology, ATTRA. Retrieved from https://attra.ncat.org/attra-pub/summaries/summary.php?pub=29

Engeland, R. L. (1994). *Growing great garlic: The definitive guide for organic gardeners and small farmers.* Okanogan, WA: Filaree Productions.

Ford, T. G., Bogash, S. M., Orzolek, M. D., Kime, L. F., & Harper, J. K. (2014). *Garlic production* (No. UA435). University Park: The Pennsylvania State University. Retrieved from https://extension.psu.edu/garlic-production

Maynard, D. N., Hochmuth, G. J., & Knott, J. E. (2007). *Knotts handbook for vegetable growers.* Hoboken, NJ: Wiley.