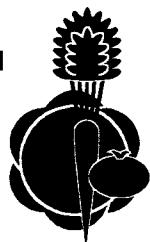


VEGETABLE RESEARCH
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Vegetable Production
Series



ARTICHOKE PRODUCTION IN CALIFORNIA

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PRODUCTION AREAS AND SEASONS

The major California production areas for artichokes (the globe artichoke, *Cynara scolymus*) are the central coast (Monterey, Santa Cruz, and San Mateo Counties) and Southern California (Orange, Imperial, and San Diego Counties). Monterey County produces about 70 percent of the crop.

In the central coast, artichokes are grown year-round as perennials. Fields that have lost their vigor are generally replanted from June through September. Plants are cut back from mid-April to mid-June for fall, winter, and spring harvests; they are cut back in late August or September for summer harvests. In Southern California, artichokes are grown as annuals. Seed are planted from April to June for transplanting from June through early August, and the crop is harvested from October to early April. Some growers in the deserts direct-seed fields from late August through September for harvest from January to April. Transplants can be used for earlier production.

ARTICHOKE ACREAGE AND VALUE

Year	Acreage	Average yield (tons/acre)	Gross value/acre
1995	8,300	2.85	\$4,132
1994	8,500	6.50	\$7,244
1993	8,300	5.50	\$5,513

Source: California Agricultural Statistics 1995 (Sacramento: California Department of Food and Agriculture, 1996).

CLIMATIC REQUIREMENTS

Artichokes are a cool-season crop that grows best in 75°F (24°C) days and 55°F (13°C) nights. The temperature range for a good crop is 85°F (29°C) and 45°F (7°C). Year-round production is possible in climates that fall within the temperature range. Hot, dry, windy conditions create woody, bitter, less compact buds (the edible part) with bracts that curve outward (recurved). Freezing damages bud bracts, causing blistering of the outer bud tissue and a whitish appearance. Freezing injury is superficial and does not affect eating quality but makes discolored buds more difficult to market. Mature plants usually survive heavy frosts but yield may be reduced.

VARIETIES AND PLANTING TECHNIQUES

Varieties. The vegetatively propagated variety Green Globe currently accounts for nearly 90 percent of artichoke production in California. Seeded artichoke varieties include Imperial Star, Emerald, and Green Globe Improved. Some growers plant their own selections.

Annual planting. Direct seeding is the most popular method of stand establishment in the Southern California deserts. Growers use precision planters to drop 2 to 3 seed at an in-row spacing of 2 to 3 feet (60–90 cm). Bed widths vary from 60 to 80 inches (1.5–2 m). Narrower beds and close spacing increases the number of buds but reduces bud size. Poor seed germination in some cultivars or seed lots may necessitate planting more seed at closer spacings and thinning the excess plants to produce a uniform final stand.

Nonuniform seed germination and a long growing season favor the use of transplants in coastal Southern California. Transplants are planted on drip-irrigated beds that are 72 to 80 inches (1.8–2 m) wide in a single row with an in-row spacing of 24 inches (60 cm). Plants are placed about 6 inches (15 cm) from the drip tape to avoid pinching off the tape as they grow. Very close spacing of artichokes makes harvesting difficult, reduces bud size, leads to lodging, and does not increase yield.

For transplant production, approximately 10,000 artichoke seed per pound is sown in flats. The number of seed that germinate in the first 10 days after the initial irrigation can range from under 40 percent to over 95 percent, depending on the cultivar and seed quality. Although seed performance in a greenhouse can be enhanced by treating the seed with a fungicide, there are currently no fungicides registered in California for seed treatment. Treating seed with hot water at 135° to 138°F (57° to 59°C) has given good results. Experiments are underway to retest the hot water method on several artichoke seed lots before this practice is recommended for commercial use.

Perennial planting. Artichokes grown as perennials are propagated by division of the crown. Rooted sections of crowns (“stumps”) selected from commercial fields are

planted by hand in trenches 4 to 6 inches (10–15 cm) deep with 4 to 8 feet (1.2–2.4 m) in-row spacing and 8 to 10 feet (2.4–3 m) between rows. The plants are usually laid out in a grid system to make weeding and other operations easier. Growers generally replant a field every 5 to 10 years, because after years of regrowth, the rooting area becomes crowded and the plants tend to lose vigor. The cropping cycle for annual artichokes is begun when plants are cut back: from mid-April to mid-June for fall, winter, and spring harvests or in late August or September for summer harvests. The plants are cut 2 to 3 inches (5–7.5 cm) below the soil surface to stimulate new shoot development.

SOILS

Artichokes are deep-rooted plants that can be grown on a wide range of soils but produce best on deep, fertile, well-drained soils. Lighter soils that have excessive drainage and poor moisture-holding potential should be avoided. Artichokes are moderately salt tolerant. Research has shown yield reductions starting at 5 to 6 dS/m (ECe in mmho/cm @ 25°C).

IRRIGATION

Artichokes require frequent irrigation during the growing period. Too little soil moisture, particularly when buds are forming, results in poor-quality, loose buds. Drip irrigation is used for most commercial plantings in coastal Southern California. Sprinkler and furrow irrigation are used in the southern deserts. On the central coast, irrigation begins about 1 month after plants are cut off to begin the new production cycle. About 4 inches (10 cm) of water is applied by sprinklers during the dry months. Tensiometers should be used to monitor soil moisture and schedule irrigations. Because artichokes are susceptible to root rot, excessive irrigation should be avoided; drainage ditches between the rows are usually necessary during the rainy season. On heavy clay soils it is advisable to dig a ditch at the lower end of the furrows to drain off excess water.

FERTILIZATION AND PLANT GROWTH REGULATION

Artichokes require less fertilizer than most other vegetable crops to produce top yields. For maximum yields in most circumstances, growers apply 100 to 200 pounds per acre (112–224 kg/ha) of nitrogen (N); 50 to 100 pounds per acre (56–112 kg/ha) of P₂O₅; and 30 to 100 pounds per acre (34–112 kg/ha) of K₂O. In drip-irrigated fields, 30 to 50 pounds per acre (34–56 kg/ha) of N and half of the P₂O₅ and K₂O are banded in two bands 2 to 4 inches (5–10 cm) apart and about 6 inches (15 cm) below the transplant line. The remaining fertilizer is applied in equal weekly applications throughout the season.

Excessive fertilizer not only wastes money and pollutes groundwater but also reduces yield and quality. Fertilizer applications should be based on preplant soil analysis and tissue samples taken during the growing season.

The plant growth regulator gibberellic acid (GA₃ or GA₄₊₇), when applied properly, can increase earliness and uniformity of bud development without significant damage to plant development or reduction of yield. Gibberellic acid treatments in annual production can produce a first harvest 8 weeks earlier than with untreated plants. Misapplication of gibberellic acid can reduce plant vigor, increase susceptibility to black tip and spider mite damage, cause early buds to be more conical than normal, and lead to brittle leaves. Negative impacts are especially apparent when gibberellic acid is applied too early in the season, at very high rates, or when excessive heat is experienced during or immediately after application.

For annual production, growth regulator treatments should consist of 2 to 3 foliar sprays of gibberellic acid at 2-week intervals. A common spray rate is 20 ppm at 30 gallons per acre (a total of no more than 6.6 grams of gibberellic acid per acre). The foliage near the growing point should be wetted to the point of liquid runoff when possible. Treatments should start 5 to 7 weeks after transplanting, when the plants average 18 to 25 inches (45–63 cm) in diameter. Bud production over an extended season may be achieved by treating four separate blocks or sections with applications starting 5 weeks after transplanting in the first block; 6 weeks after transplanting in the second block; 7 weeks after transplanting in the third block; and no treatment in the fourth block. Treatments applied 10 or more weeks after transplanting generally do not promote earliness and uniformity for commercial production.

For perennial production, gibberellic acid treatments are sprayed on the field 6 weeks before the expected first harvest (September to January) at a rate of 10 grams of active ingredient per 100 gallons of water per acre (936 l/ha).

INTEGRATED PEST MANAGEMENT

Detailed information about IPM for artichokes is available by contacting the UC IPM World Wide Web site at <http://www.ipm.ucdavis.edu> (see *UC IPM Pest Management Guidelines*, DANR Communication Services Publication 3339). Herbicides, insecticides, and fungicides should always be used in compliance with label instructions.

Weed management. Growers use mechanical cultivation and herbicides to control weeds. Perennial artichokes are often planted on a grid system that allows mechanical cultivation in two directions; hand weeding in this grid system is required only around the individual artichoke plants. In fields with closer spacing, mechanical cultivation is only possible in one direction. Growers who prefer

to limit herbicide use and minimize hand hoeing should plant on the traditional grid system.

Insect identification and control. The artichoke plume moth (*Platyptilia carduidactyla*) is the most devastating pest of artichokes. The insect lays eggs on the undersides of the fuzzy leaves or on the stem below the buds. The larvae bore into the buds, stem, and foliage, damaging the bracts and receptacle and distorting and stunting young buds. The insects reproduce throughout the year, particularly where there is continuous production. Losses of 25 to 50 percent of all harvestable buds are not unusual in the central coast, even with stringent pest management programs. Artichoke plume moth has been found in the Orange County production area but has not been a problem in the desert production areas. Control depends on strict sanitation practices, including removing infested artichokes found by harvesters and immediately incorporating plant debris into the soil after plant cut-back. Integrated pest management techniques combine sanitation, appropriate cultural methods, female sex pheromone mating disruption, biological control agents, and mass trapping with the reduced use of pesticides.

Aphids, including the bean aphid (*Aphis fabae*) and green peach aphid (*Myzus persicae*), can be a problem at certain times of the year. In addition to affecting growth, the green peach or bean aphid may cause sooty mold on the buds. Cribate weevil (*Otiorhynchus cribricollis*) larvae feed on the roots while adults feed on the foliage and buds. Caterpillars, including the salt marsh caterpillar (*Estigmene acrea*), and cutworms (*Peridroma saucia* and others), feed on artichoke foliage and buds. Caterpillars are a particular problem in transplanted annual production, where they can destroy the growth point of developing seedlings. The bacteria *Bacillus thuringiensis* (BT) is also used to help control caterpillars in annual artichokes.

Garden and greenhouse slugs (*Deroceras agreste* and *Milax gagete*) and brown garden snails (*Helix aspersa*) eat jagged holes in leaves and stems and rasp off the outer surfaces of artichoke buds, blackening the surface and lowering quality. Serious infestations of two-spotted spider mites (*Tetranychus bimaculatus*) can cause serious loss of plant vigor and yield. Larvae of the chrysanthemum leafminer (*Phytomyza syngenesiae*) damage and kill tissue by feeding (mining) within the leaves.

Field mice (*Microtus* spp.) and gophers (*Thomomys bottae*) cause considerable economic damage in artichoke fields. These rodents feed on the fleshy roots, young shoots, and developing buds of the plants. Trapping and pesticide baits are used to control these pests.

Disease identification and management. Powdery mildew (*Leveillula taurica*) and *Ramularia* leaf spot (*Ramularia cynarae*) can cause serious economic losses in artichokes. The pathogens attack bracts and foliage and can lead to premature leaf senescence and leaf drop.

Damaged buds are unmarketable.

Botrytis rot (*Botrytis cinerea*) is common during rainy weather and prolonged periods of moderate temperatures and high humidity. The fungus usually invades tissue damaged by frost, insects, or improper handling. A gray or brown fungal growth develops on the affected plant parts. Millions of spores quickly develop and are spread by the wind. Postharvest control of *Botrytis* requires appropriate handling, removal of infected heads before packing, and proper cooling during storage and shipment. No practical method for controlling *Botrytis* in the field has been developed.

Curly dwarf is a viral disease that severely stunts and eventually kills infected plants. Symptoms include curling leaves, plant dwarfing, and reduced bud production. Buds may become misshaped and remain small. Curly dwarf is insect-transmitted but the specific vector is not known. The virus survives on milkthistle (*Silybum marianum*) and artichoke plants. The only known control measures are to use noninfected planting stock and immediately remove infected plants.

Bacterial crown rot (*Erwinia chrysanthemi*) causes stunting of artichoke plants and wilting during hot weather. In advanced stages, the plants may collapse. The crown and root tissues become soft, rotted, and turn black or brown. The disease is thought to be spread by harvesting tools. The only known control is to use clean propagation material and avoid spreading the disease during harvesting and propagation. So far the disease has been confined to the coasts of California.

Black tip is thought to be a physiological disorder that usually damages only the exposed bracts of small axillary buds. The tips of the affected bracts turn dark brown or almost black, dry, and leathery. Although the edible portion of the bud is not affected, the bud is rendered unmarketable. In annual seeded production, black tip appears most frequently during sunny, warm, windy conditions that increase the growth rate and put plants under moisture stress. The exact cause of the disorder is not known.

HARVESTING AND HANDLING

Although artichokes can be harvested year-round, 70 percent of California's harvest occurs between March and mid-May. The highest yields are from fields in fall, winter, and spring production. As the weather warms in mid-spring, the buds become more fibrous and lose flavor. Perennial fields managed for summer production are harvested from June until plants are cut off in the fall.

Artichokes are generally hand-harvested once or twice a week, depending on the weather. Fields may be harvested for 1 to 3 months. During cold winter weather, perennial fields may go 2 weeks or more between harvests. Perennial artichokes are commonly harvested 30 or more times during the season. Fields in annual seeded

production have a shorter, more concentrated production period that reduces harvesting costs.

Artichokes should be harvested when the buds have achieved maximum size, but before the bracts begin to spread open or the internal pappas (grasslike central portion of the bud) grows up above the top edges of the cup-shaped receptacle. The terminal or primary bud is harvested first. Secondary and tertiary buds are harvested as they reach maximum size. The bracts of some seeded artichoke varieties do not spread open with increasing maturity as readily as the perennial Green Globe. This makes it more difficult to know when to harvest a particular bud. Subtle differences in the color and appearance of the buds as they mature are the only outward clues as to when to harvest. Buds of these seeded varieties do not increase in size if left on the plant past their optimal harvest time. Overmature buds have an internal pappas, turn purple inside, become bitter and woody, and have less edible, fleshy tissue. Cutting a few buds in half, from the stem to the tip of the bud, to observe the level of maturity in relation to the bud's external color and appearance can help a grower decide when to harvest.

Artichokes are cut by hand with 3 to 4 inches (7.5–10 cm) of stem remaining with the bud. Crews select and cut harvestable buds as they walk down the rows. Harvested buds are placed in canvas artichoke bags that are held open by a metal backpack frame or in canvas citrus-harvesting bags that are hung over the shoulder. Workers empty the bags at the end of the rows into pallet-sized wooden bins for subsequent shed packing, into smaller boxes, or onto sorting tables used for field packing.

In perennial fields, old bearing stalks are often removed after the artichokes have been harvested to encourage the development of new shoots. Harvesters use a hand axe or stalk knife to chop out the stalk just below the ground. Stalks are removed at 3- to 4-week intervals throughout the year, depending on the growth of new bud-bearing stalks. This “stumping” process is generally thought to increase total yield and extends the productive life of the field.

POSTHARVEST HANDLING

Annual artichokes are inspected in the field for insect or mechanical damage, disease, or cosmetic defect. Unmarketable buds are removed. Marketable buds are sorted by size and quality and packed in fiberboard cartons. Bud size classifications represent the number of

buds packed in a standard carton: size 18 buds (18 buds per carton, or “18s”) buds are larger than 4.5 inches (11.3 cm) in diameter; 24s are 4.0 to 4.5 inches (10–11.3 cm); 36s are 3.5 to 4.0 inches (8.8–10 cm); 48s are 3.0 to 3.5 inches (7.5–8.8 cm); 60s are 2.75 to 3.0 inches (6.9–7.5 cm). Large or small loose buds, measuring 1.0 to 2.75 inches (2.5–6.9 cm), are jumble-packed with an average of 100 large buds or 175 small buds per carton. The fresh market prefers 24s and 36s; some retailers prefer 36s and 48s since artichokes are usually priced by the bud rather than by the pound. Field-packed artichokes are usually cooled by forced air. Although yields of 800 or more cartons per acre are considered good, the harvest period and total yield depend on market conditions. Individual cartons must weigh at least 22 pounds (9.9 kg) each.

Perennial artichokes are transported to packing sheds or processing plants in pallet-sized wooden bins and dumped into cold water for precooling and to prevent mechanical injury. After precooling, buds are inspected for insect or mechanical damage, disease, or cosmetic defect. Unmarketable buds are removed. Marketable buds are graded by size and quality and packed in waxed fiberboard cartons. Bud size classifications are the same as for annual production. Although yields of 600 or more cartons per acre are consistently achieved, the harvest period and total yield depend on market conditions.

Artichokes should be held at or near 32°F (0°C) at 90 to 95 percent relative humidity during storage and shipping to help maintain quality, retard *Botrytis* rot, and prevent desiccation for up to one month. Artichokes are shipped to markets in refrigerated rail cars and trucks. Top icing of rail-car shipments is common in perennial production.

MARKETING

Artichoke prices drop in March as perennial production increases. Smaller buds become very difficult to sell during times of low prices and high supply and are often processed into marinated artichoke hearts. During the winter, when the supply is low, smaller buds can be sold profitably. Larger buds with cosmetic defects are processed into crowns. Over 99 percent of commercial artichoke production in the United States is in California. In 1995, California exported approximately 4.2 million pounds of artichokes to Canada, Japan, Mexico, and Europe. A limited market has started for fresh, trimmed artichoke hearts, mostly for the upscale restaurant trade.

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