CROP PROFILE FOR ARTICHOKES IN CALIFORNIA

Prepared 2025

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GENERAL PRODUCTION INFORMATION

- California produces 100% of all commercially grown artichokes in the United States (NASS a).
- Commercial artichoke acreage in California was 4,300 acres in calendar year 2023 (CASS, 2023)
- Artichoke production in California totaled 41,700 tons in calendar year 2021 (cdfa.gov)
- Total value of the California artichoke crop was $57,477,000 in calendar year 2021 (cdfa.gov)
- Production costs range from $5,500 - $14,500/acre for annual transplanted artichokes dependent upon the extent of pest control required in calendar year 2000 (UC Cooperative Extension)
- Approximately 95% of harvested artichokes in calendar year 2021 are sold to the fresh market; the remaining 5% are processed as crowns or as frozen, quartered artichokes (cdfa.gov)

Production Regions

The northern tip of the Central Coastal Region of California is the location of 84% of the state's artichoke acreage. In the past the majority of these plantings were of the Green Globe perennial variety but during the last ten years this cropping has transitioned to predominantly the transplanted annual crop.

PERENNIAL ARTICHOKES

Central Coast Region

The California commercial artichoke industry began in the late nineteenth century in San Mateo County with the vegetatively propagated perennial variety, *Green Globe*. The growing region for this "traditional" variety expanded southward to include Santa Cruz County and the Northern Salinas Valley region of Monterey County. The epicenter of perennial artichoke production within this region was the town of Castroville, near Monterey Bay (CAAB). *Green Globe* grows best in well-drained heavy clay loam soil coupled with a cool, moist coastal climate, which is characteristic of this relatively small segment of the California coast.

The typical perennial row spacing is 9 ft to 10 ft, with plant spacing within rows set at 54 in. Another perennial growing option is 80 in row spacing with spacing within the rows set at 36 in. Most acreage is irrigated by overhead sprinklers, but some is irrigated through drip emitters and tape. During October, deep ditches are cut through the fields to drain winter rains from the plant rows. In April, these ditches are filled-in through cultivation which aerates the soil, reduces weed population, and opens planting rows for additional agronomic activities.

If the initial planting takes place in the spring, a first-year crop can be harvested in late fall. Subsequent harvest intervals for most of the perennial acreage is controlled by the timing of "cut-back" or "stumping". This is the practice of cutting back the artichoke plants at ground level at the conclusion of each production season. During cut-back, the above-ground part of the plant is shredded and incorporated into the soil. For approximately 75% of the perennial artichoke acreage, this operation occurs in May, and precipitates a September - May harvest interval, or a "winter "crop. Approximately 15% - 20% of the acreage is cut-back in August or September, for a late spring or summer harvest period (Bari, 1998).

A small percentage of the perennial fields are not cut-back at all, and are maintained by pruning only the dead stalks from plants that allows year-round harvesting. These fields usually need to be cleared and replanted after four years due to build up of pest populations.

Yield per season from a perennially field is typically 400 up to 800 cartons/acre.

From 1988 to 2023 the acres of perennial artichokes has declined from 7,632 acres to approximately 200 acres with the perennial artichoke market share being replaced by the annual artichoke varieties. The reasons for this decline are related to the return on investment of the cost inputs involved with the perennial artichoke crop and the year-round availability of annual artichokes. The economic negatives related to the perennial artichoke production include cost of land, labor, water, pest management, lower yield per acre, and lack of year-round market availability. The pest management cost increase is due to a perennial crop being grown on the same acres for years without rotating. This results in artichoke pests such as weeds, rodents, soil pathogens, mollusks, foliar disease and insects becoming endemic.

ANNUAL ARTICHOKES

Central Coast Region

Annual artichokes are established by seed in greenhouses and then transplanted into the field. Bed widths are 80 inches, single row planting with 26 to 30 inch in-row spacing. The majority of annual artichokes are drip irrigated. Annual artichokes are a year round crop in the Central Coast Region. The planting period is October to June with a planned extended harvest period of May through December. After final harvest the annual artichokes are chopped with a flail type mower and tilled back into the soil. Annual artichokes are rotated with other row crops such as lettuce or brassicas which aids in the prevention of pathogens or pests that specific to artichokes being concentrated in those fields. Growing costs for annual artichokes being less than perennial artichokes are the result of a shorter growing period of 5 - 6 months, the use of drip irrigation, and crop rotation. The seeded varieties have allowed for the geographical expansion of the Central Coast region artichoke crop from being concentrated in the Castroville area to further down the Salinas Valley. During the 2022 - 2023 growing season there were 3070 acres of annual artichokes grown in Monterey County and 150 acres of annual artichokes grown in Santa Cruz County (CAAB). Green Queen and Madrigal are the most common varieties of annual artichokes being planted.

South Eastern Desert Region

There are approximately 1035 acres of artichokes planted in the Inland Desert counties of Riverside and Imperial (CAAB). The soil ranges from sandy clay to clay loam. The planting period is August through September, with harvest beginning as early as December in Riverside County. Hot weather, which tends to degrade the quality of the bud, effectively ends the desert artichoke harvest season with mid-April.

The desert artichoke beds are planted with 80 inch spacing with transplants spaced 30 inches in row. Due to the hot environmental conditions in August and September, overhead sprinklers are utilized to cool transplants and the surrounding soil. When the weather cools, overhead sprinkling is discontinued and drip irrigation is used.

Various types of melons are compatible with artichokes in rotational program. Watermelon, honeydew, and cantaloupe all share a common planting period, irrigation method, and row or bed spacing with artichokes. The crop rotation patterns vary among these crops; artichokes may be planted in alternate years, or there may be multiple years before their reintroduction into a particular field.

South Coast Region

There are approximately 585 acres of artichokes planted along the southern coasts of Santa Barbara and Ventura counties (CAAB). The soil in that area is loamy sand and silica clay loam. Typical bed spacing is 80 inches with single line with single line artichoke plant spacing of 30 inches to 36 inches. The planting period for this region is spread out from June to September with a harvest season of March through May. After final harvest the artichoke fields are rotated with other row crops such as lettuce or brassicas. Crop rotation is utilized as an integrated pest management process to prevent concentration of artichoke pests and pathogens in the soil.

Insect Pests

Artichoke Plume Moth**,** Platyptila carduidactyla

The artichoke plume moth (APM) is the most serious pest confronting artichoke growers. This insect is present in the majority of the of the artichokes grown in northern Monterey County, Santa Cruz County, and parts of the South Coastal acreage. All stages of the pest are present in the fields year-round, although the yield level drops somewhat during the period November - March. Economic damage occurs when APM larvae feed on the floral buds, rendering them unmarketable. If untreated, yield losses could react 70%. The pest is monitored with pheromone traps and light traps to assess adult moth population levels, and with inspection of fields for worm infestation in the artichoke buds and shoots.

Chemical Control:

Esfenvalerate

Trade Name & Formulation: Asana XL, plus generic formulations, 0.66 emulsifiable concentrate

Application Timing Rate & Frequency: Applied after shoot development, and continuing through harvest. Total number of applications ranges from 4 to 8 per season

Typical Application Rate and Method: Typical rate ranges from 0.036 to 0.56 lb./ai depending on pest pressure. These rates correspond to the upper limits of label indicated dosage. Tractor mounted spray booms are the preferred application method, but fields not accessible after rainfall or with excessive plant growth will necessitate aerial applications.

REI & PHI: 12 hours restricted entry interval, 1 day pre-harvest interval

100% of the Monterey Bay region artichokes are treated with this compound. It is considered by growers to be the key insecticide in their program to control APM, and is the pest control chemical with the greatest number of applications and the most aggregate number of treated artichoke acreage in the Monterey Bay region.

Esfenvalerate is effective against the adult and larval stages. Normally, it is tank-mixed with (Dimilin) for two or three applications between shoot emergence and bud formation then applied either alone or tank - mixed with permethrin or pyrethroids for the remainder of the season. Tank mixed sprays during the harvest season need to be carefully scheduled in accordance with labeled PHIs

Diflubenzuron

Trade name & Formulation: Dimilin, 25 WP
Application Timing & Frequency: Soon after bud formation, 2 applications
Typical Application Rate & Method: 0.125 lb. ai/ac (low end of label dosage) usually applied by ground spray; occasionally by air.
REI & PHI: 12 hours restricted entry, 1 day pre-harvest interval
Dimilin is an insect growth regulator that is moderately effective against eggs and exposed larvae, but does not kill adult APM.
Most artichoke acreage is treated with diflubenzuron. It ranks fourth to esfenvalerate and spinetoram in number of applications and aggregate of artichokes treated.

Spinetoram

Trade Name & Formulation: Radiant, SC
Application Timing & Frequency: Applied after shoot development, and continuing through harvest. Total number of applications ranges from 2 to 4 per season.
Typical Application Rate & Method: 0.0469 lb. ai/ac, (low end of label dosage). Dosage will be dependent on pest pressure. Tractor mounted spray booms are the preferred application method, but fields not accessible to tractor sprayers after rainfall or with excessive plant growth will necessitate aerial application.
REI & PHI: 12-hour restricted entry, 2-day pre-harvest interval

A majority of California artichoke acreage is treated with this compound. It is considered by artichoke growers as a key insecticide in their IPM program to control APM. It is the sixth most utilized material for both volume and aggregate acres by artichoke growers.

Spinetoram is effective against the adult and larval stages. Normal tank mixed with permethrin or pyrethroids for one or two applications. Tank mixed sprays during the harvest season need to be carefully scheduled in accordance with labeled PHIs.

Methoxyfenozide

Trade Name & Formulation: Entrepid, 2F
Application Timing & Frequency: Soon after bud formation, 2 to 4 applications
Typical Application Rate & Method: 0.12 lb ai/ac, (higher end of label dosage) usually applied by ground spray, occasionally applied by air.
REI & PHI: 12 hours restricted entry, 4-day pre-harvest interval

Methoxyfenozide is effective against the egg and larval stages. Normal tank mixed with spinetoram or esfenvalerate for first two applications between shoot emergence and bud formation. Methoxyfenozide does not kill adult APM

Alternative Chemical Controls:

Chlorantraniliprole (Coragen) effective on APM larvae. Possible rotation for esfenvalerate or spinetoram

Permethrin (Ambush, Pounce, various generic) has moderate control for APM larvae and adults. Rotational materials that can be used late in crop production cycle due to short pre-harvest interval.

Bifenthrin (Brigade WSB) moderate control on APM larvae. Rotational material with 5-day pre-harvest interval.

Pyrethroid (Mustang Max EC) moderate control on APM larvae. Control on lygus bug. Rotational material with 5-day pre-harvest interval.

Biological Controls:

Bacillus thuringiensis products are not effective against APM when used alone, but experimental evidence suggests that APM control may be achieved by using *Bacillus thuringiensis* in combination with esfenvalerate.

Pheromone rope may provide additional control of APM through mating disruption when used with insecticides, although it is not considered to be a cost-effective approach

Azadirachitin (Margosan-O) neem oil, a botanical material, kills APM larvae. It however is not effective against adult APM and is more costly than conventional materials

Parasitic wasps are natural enemies of APM, but are not currently effective at keeping APM populations below the economic threshold. It has been speculated that predator populations have diminished over the years as the result of pesticide use.

Trichogramma thalense is an egg parasite that may offer some APM control, but has not yet been developed for commercial use in artichokes

Root cuttings for propagation may be dipped in beneficial nematode (*Steinernema carpocapsae)* to help suppress APM infestation at planting. At present, the nematode suspension is not available in sufficient quantity for large scale commercial use.

Cultural Control:

The most important cultural control in artichoke production has been the transition from perennial artichokes to the transplanted seeded varieties. This has reduced pest pressure by rotating the crop to other row crops annually reducing the buildup of endemic pest populations. Ranches that are not mono cropped with large acreages of perennial artichokes have reduced pest habitat.

Artichoke Aphid

Artichoke aphid has become less of a pest problem as a result of the transition from perennial to annual artichoke production. The peak period for this pest with the perennial artichoke crop was during the warm summer months.

Some of the crop damage is due to feeding injury, but the main deleterious effect of aphid infestation is related to a sugary secretion that the insect deposits on artichoke plants. Called "honeydew" this substance sticks to the plant, and serves as a host for mold. When this sooty mold forms, it interferes with the photosynthetic process and retards plant development, leading to undersized poorly formed buds. If the mold forms on the buds themselves, it can turn them black. In addition to feeding and honeydew related damage, the presence of dead aphids in the buds at harvest may make the product unmarketable.

Fields are monitored by scouting and sampling the artichoke leaves. Treatment is recommended if the infestation reaches three aphids/leaflet.

Chemical Control:

Spirotetramat

Trade Name & Format: Movento

Application Timing and Frequency: Applied at early bud stage, slow acting. One to two applications per crop. Tank mixed with esfenvalerate or spinetoram

Typical Application Rate & Method: Apply at 0.13 lb ai/acre for a moderate rate. Usually applied with a ground rig.

REI & PHI: 24-hour restricted entry interval; 3-day pre-harvest interval

Movento has a low use rate on artichokes due to the low population rate of artichoke aphid

Alternative Chemical Controls:

Bifenthrin (Brigade WSB) moderate control on artichoke aphid. Rotational material with 5-day pre-harvest interval

Pyrethroid (Mustang Max EC) moderate control on artichoke aphid. Control on lygus bug. Rotational material with 5-day pre-harvest interval.

Imidacloprid(Admire pro)

Good aphid control. Slow mode of action needs to be applied early after bud and shoot formation

Biological Control:

Predaceous beetles native to the area may mitigate aphid infestation, but they have been ineffective at holding aphid population levels below the economic threshold. It is possible that repeated usage of esfenvalerate (Asana) for control of the primary pest, APM, has had the effect of diminishing the population of beneficial parasites and predators. It is doubtful that the introduction of additional beetle populations into the fields that are heavily sprayed for APM would result sufficient survivorship of the beneficials to provide effective control of aphid.

Cribrate Weevil, Brachyrhncus cibricolli

Because adult weevils are unable to fly, the primary mode of introduction of this pest into an artichoke field is through root cuttings infested with eggs or weevil grubs during replanting. With the artichoke growers transitioning to the seeded transplant program and away from the perennial artichokes which entailed planting root cuttings, "crown", into the bed Cribrate Weevils are no

longer a major pest. It was estimated that Cribrate Weevils were present in 99% of the Monterey Bay region perennial acreage

Damage to the artichoke plant is caused by both the larval and adult stages. The larvae ("weevil grub") infest the root zone and stunt the growth of the plant, causing a drop in marketable yield at harvest. The adults feed on the buds and leaves; if the infestation level is severe, they can strip leaves down to petioles. The peak period for adult feeding is mid-June through September which makes the summer artichoke crop particularly vulnerable to yield loss from bud damage.

Chemical Control:

Bifenthrin

Trade Name & Formulation: Brigade WSB, Brigade 2EC
Application Timing & Frequency: July or August, one application
Typical Application Rate & Method: 0.1 lb. ai/acre. Ground rig application with lowered spray boom. Must use closed system.
REI & PHI: 12-hour restricted entry, 5-day pre-harvest interval

Diflubenzuron

Trade name & Formulation: Dimilin, 25 WP
Application Timing & Frequency: Soon after bud formation, 2 applications
Typical Application Rate & Method: 0.125 lb ai/ac (low end of label dosage) usually applied by ground spray; occasionally by air.
REI & PHI: 12 hours restricted entry, 1 day pre-harvest interval

Alternative Chemical Controls:

Spinetoram (Radiant) or zeta-cypermethrin (Mustang-Max) can be applied as a soil application in a single band

Biological Controls:

Soil applications of various species of entomophatic nematodes (*e.g. Steinernema carpocapse)* which parasitize weevil grub have been tested experimentally. Results indicate that delivery of the nematode suspension at sufficient depth to provide effective control is problematic.

Cultural Controls:

The proven cultural control for Cribrate Weevil has been the transition from perennial

artichoke production to the annual varieties. The annual artichoke plugs produced in the greenhouse are not a host for the Cribrate Weevil grub.

Beet Armyworm, Spodoptera exigua

Beet armyworm migrates into artichoke fields from adjacent row-crop fields during the summer months. By October and November, larvae will have begun to bore into the artichoke bud, or to feed on external petals. Population levels of this insect are sporadic from year to year. During seasons of light infestation, the crop is not threatened, but larval feeding during periods of heavy infestation can cause losses in fall production of 3% to 5%.

Chemical Control:

Esfenvalerate

Trade Name & Formulation: Asana XL, plus generic formulations, 0.66 emulsifiable concentrate

Application Timing Rate & Frequency: Applied after shoot development, and continuing through harvest. Total number of applications ranges from 4 to 8 per season

Typical Application Rate and Method: Typical rate ranges from 0.036 to 0.56 lb/ai depending on pest pressure. These rates correspond to the upper limits of label indicated dosage. Tractor mounted spray booms are the preferred application method, but fields not accessible after rainfall or with excessive plant growth will necessitate aerial applications.

REI & PHI: 12 hours restricted entry interval, 1 day pre-harvest interval

Spinetoram

Trade Name & Formulation: Radiant, SC

Application Timing & Frequency: Applied after shoot development, and continuing through harvest. Total number of applications ranges from 2 to 4 per season.

Typical Application Rate & Method: 0.0469 lb ai/ac, (low end of label dosage). Dosage will be dependent on pest pressure. Tractor mounted spray booms are the preferred application method, but fields not accessible to tractor sprayers after rainfall or with excessive plant growth will necessitate aerial application.

REI & PHI: 12 hour restricted entry, 2 day pre-harvest interval

Alternative Chemical Controls:

Zeta-cypermethrin (Mustang-Maxx) has been proven to be efficacious against beet army worm. All of listed chemical controls can be applied either by a ground rig or by aerial application

Biological Controls:

Bacillus thuringiensis

Trade Name & Formulation: Agree Soluble Pouch, Javlin 6.4 WG

Application Timing and Frequency: Applied one- or two-times during fall season depending on observed army worm infestation

Typical Application Rate & Method: Applied by air and ground at 0.21 lb ai/acre

REI & PHI: 12-hour re-entry and pre-harvest intervals

Alternative Cultural Controls:

There are no known cultural control programs for management of this pest

Black Bean Aphid, *Aphis fabae*

Green Peach Aphid, *Myzus persicae*

Black Bean aphid has been reported as the dominant pest species in the Southern Coastal fields, where infestation levels peak in July and August. Nearly 100% of the southern coastal acreage is populated by this pest, although infestation levels vary from year to year. Damage from black bean aphid occurs in the form of retarded plant growth due to feeding injury, which leads to undersized or poorly formed buds.

Green peach aphid is a minor pest on Central Coast Region artichokes. Populations of this pest tend to peak in spring and fall, but seldom reach treatment levels. It is possible that pest control programs targeted towards the major pests APM and artichoke aphid have the residual effect of controlling green peach aphid as well.

In the desert, all fields have some aphid present at all times, with infestations peaking in the winter. However, populations have only recently progressed to levels that require treatment, principally just before and during harvest.

Green peach aphid has less effect on plant growth than the southern coastal black bean aphid, but the presence of dead aphids of either species in artichoke buds at harvest may render the product unmarketable. The extent of potential "marketable" yield loss due to untreated aphid infestation depends heavily on consumer demand at the time of harvest.

Growers or Pest Control Advisors monitor aphid pressure by walking the fields. Infestations are also reported by harvest crews or qualified assurance personnel.

Chemical Control:

Thiaomethoxam

Trade Name & Formulation: Actara

Application Timing & Frequency: Apply one to two applications per crop **according** to observed pest pressure

Typical Application Rate & Method: Applied at 0.47 lb per ai/ acre per **application**. Two applications per crop usually with a ground rig

REI & PHI: 12-hour restricted entry; 4-day pre-harvest interval

Actara is usually tank mixed with tank mixed with esfenvalerate or spinetoram

Spirotetramat

Trade Name & Format: Movento

Application Timing and Frequency: Applied at early bud stage, slow acting. One to two applications per crop. Tank mixed with esfenvalerate or spinetoram

Typical Application Rate & Method: Apply at 0.13 lb ai/acre for a moderate rate. Usually applied with a ground rig.

REI & PHI: 24-hour restricted entry interval; 3-day pre-harvest interval

Alternative Chemical Controls:
Bifenthrin (Brigade WSB, Brigade 2EC) tank mixed with esfenvalerate or spinetoram.

Imidacloprid (Admire Pro) tank mixed with esfenvalerate or spinetoram and applied with a ground rig.

Neem Oil (Trilogy) Thorough coverage is important; apply in a minimum of 75-gal water/ acre.

Biological Controls:
Desert growers are concerned with possible mite flare ups that can be induced by some insecticides, because there is no proven miticide for use on desert artichokes. Fortunately, aphid populations in the desert are light enough to be controlled with lady bug and lacewing. These aphid predators are applied to artichoke fields in December, providing biological control of green peach aphid without stimulating the mite population. Strong winds and greater usage of insecticides inhibits adoption of this practice on coastal artichokes.

Cultural Controls:
There are no known cultural controls for management of these pests.

Cutworm, *Peridroma saucia*

Cabbage Looper, *Trichoplusia ni*

Worms are a sporadic problem for the coastal artichoke growers. In various years the Central Coast fields have had moderate to heavy populations of cabbage looper. Further south, again not a consistent annual infestation, cutworms can be observed in high concentrations. In other production seasons worms are not a problem in either area.

Cabbage loopers are a serious early season pest for inland desert growers. They feed on the young, developing plant, causing loss of stand. Untreated, stand losses due to worm damage in the desert approach 100%. With conventional pest control, treating 100% of the desert acreage, the stand loss is reduced to less than 10%.

Chemical Control:

Spinetoram

Trade Name & Formulation: Radiant, SC
Application Timing & Frequency: Applied after shoot development, and continuing through harvest. Total number of applications ranges from 2 to 4 per season.
Typical Application Rate & Method: 0.0469 lb ai/ac, (low end of label dosage). Dosage will be dependent on pest pressure. Tractor mounted spray booms are the preferred application method, but fields not accessible to tractor sprayers after rainfall or excessive plant growth will necessitate aerial application.
REI & PHI: 12-hour restricted entry, 2-day pre-harvest interval

On the southern coast and in the desert, it is sprayed in rotation with esfenvalerate which is more efficacious against cabbage looper.

Esfenvalerate

Trade Name & Formulation: Asana XL, plus generic formulations, 0.66 emulsifiable concentrate Application Timing Rate & Frequency: Applied after shoot development, continuing through harvest. Total number of applications ranges from 4 to 8 per season

Typical Application Rate and Method: Typical rate ranges from 0.036 to 0.56 lb/ai depending on pest pressure. These rates correspond to the upper limits of label indicated dosage. Esfenvalerate is often mixed with *Bacillus thuringiensis*. On the southern coast it is sprayed in rotation with spinetoram.

REI & PHI: 12 hours restricted entry interval, 1 day pre-harvest interval

Alternative Chemical Controls:

Chlorantraniliprole (Coragen) effective on cabbage looper and cutworm larvae. Possible rotation for esfenvalerate and spinetoram.

Permethrin (Ambush, Pounce, various generic) has moderate control for larvae and adults. Rotational materials that can be used late in crop production cycle due to short pre-harvest interval

Bifenthrin (Brigade WSB) moderate control on cabbage looper and cutworm larvae. Rotational material with 5 day pre-harvest interval.

Biological Controls:

***Bacillus* thuringiensis**

Trade Name & Formulation: Agree Soluble Pouch, Javlin 6.4 WG

Application Timing and Frequency: Applied one or two-times during fall season depending on observed army worm infestation

Typical Application Rate & Method: Applied by air and ground at 0.21 lb ai/acre. Often tank mixed with esfenvalerate and spinetoram.

Cultural Controls:

There are no known cultural control programs for management of these

Lygus Bug, *Lygus hesperus*

Lygus bugs are pests of artichokes grown in the south coastal region during the late spring and early summer season. In the Central Coast growing region lygus bug peak activity is during the mid-summer to fall production periods. Lygus bugs have been a serious infestation issue periodically in the south coast region

Lygus adults are greenish or brownish in color with reddish- brown wing markings. They are about 0.25 inch long, oval with a flattened body with a small yellow triangle on the back. The immature lygus bug is pale green and looks similar to an aphid.

Lygus nymphs and adults with piercing-sucking mouth parts feed on the very young leaves that are in the fond stage. Lygus inject a toxin into the artichoke plant that causes injury and death of leaf tissue around the feeding wound causing brown, dry spotting on the leaves as they mature. Feeding at the base of the immature bud causes it to turn partially or completely black making it unmarketable.

Chemical Control:

Zeta-Cypermethrin

Trade Name & Formulation: Mustang Maxx
Application Timing & Frequency: Winter season for desert, spring to early summer for southern coast, early summer to fall for Central Coastal region.
Typical Application Rate & Method: Do not apply more than 0.2 lb ai/acre. Do not make applications less than 14 days apart. Ground rigs are the preferred method application when possible.
REI & PHI: 12-hour restricted entry: 5-day pre-harvest interval

Zeta-cypermethrin is typically tank mixed with spinetoram or esfenvalerate for lepidoptera control.

Thiaomethoxam

Trade Name & Formulation: Actara
Application Timing & Frequency: Apply one to two applications per crop according to observed pest pressure
Typical Application Rate & Method: Applied at 0.47 lb per ai/ acre per application. Two applications per crop usually with a ground rig
REI & PHI: 12-hour restricted entry; 4-day pre-harvest interval

Actara is usually tank mixed with tank mixed with esfenvalerate or spinetoram. Will provide additional aphid control.

Alternative Chemical Controls:

Permethrin (Ambush, Pounce, various generic) has moderate control for larvae and adults. Rotational materials that can be used late in crop production cycle due to short pre-harvest interval

Bifenthrin (Brigade WSB) moderate control on cabbage looper and cutworm larvae. Rotational material with 5-day pre-harvest interval.

Biological Controls:

Naturally occurring predators that feed on the nymphal stages of lygus bug include big eye bugs (*Geocoris spp.),* damsel bugs (*Nabid spp.),* minute pirate bugs (*Orius tristicolor);* and several species of spiders.

Cultural Controls:

In January, overwintered lygus bugs lay eggs in weeds; eggs hatch in March. Carry out weed control measures in March and early April while lygus are still nymphs. Once adults are present on weeds, they will migrate into artichokes when the weeds are removed. To avoid adult migration in spring, mow or disc under cover crops, especially legumes, before the flower and while lygus are still in the nymphal stages.

Earwig, *Forficula auricularia*

Earwigs feed at night and return to dark, cool, moist places to hide during the day. Common hiding places are under loose clods of soil, debris, trash, or weeds growing along the borders of artichoke fields. Damage occurs to transplants which can result either in slowing plant growth or total destruction of the young transplant. Later in the plant cycle earwigs can enter the artichoke bud damaging bracts and affecting harvest quality.
Chemical Control:

Iron phosphate/Spinosad

Trade Name and Formulation: BUG-N-SLUGGO, bait granules
Application Timing Rate and Frequency: Applied after transplant and continuing through crop cycle according to observed earwig pressure. Total number of applications ranges from 1 to 4 per season
Typical Application Rate and Method: Typical rate ranges from 0.014 to 0.28 lb/ai depending on pest pressure. These rates are dependent upon the total amounts of Spinosad applied to the crop. Applied with broadcast spreader for broadcast application or standard granular spreader for row application.
REI & PHI: 4-hour restricted entry interval, 2-day pre-harvest interval.

Spinosad

Trade Name & Formulation: Seduce, granular
Typical Application Rate and Method: Typical rate is 0.0825 lb/ai per application. A maximum of 4 applications per season are allowed at that rate. Applied with a broadcast spreader for broadcast application of standard granular spreader for row application.
REI & PHI: 4-hour restricted entry interval, 2-day pre-harvest interval

ALTERNATIVE CHEMICAL CONTROLS:

Diatomaceous earth. Laid as a barrier surrounding artichoke fields. Applied as a powder in a band that cannot be crossed by earwigs to enter the planted field

CULTURAL PRACTICES:
Drip irrigation aids preventing the wet environment that attracts earwigs into the artichoke fields. Weed control on artichoke field borders and sanitation in surrounding fields eliminates the habitat that attracts earwigs.

Proba Bug, *Proba californica*

Proba bugs are a pest of artichokes grown in the south coast and central coast regions during the late spring and through the summer seasons. Proba bug is a native insect that occurs on coyote brush, *Baccharis pilularis*, a common shrub on coastal mountain range hillsides from Oregon to Los Angeles (UCIPM). Coyote brush is a California native plant which frequently grows along highways and agricultural areas bordering artichoke fields. Proba bugs were a major pest affecting perennial artichokes in large mono crop plantings and remain less of an issue in annual artichoke production.

Adult proba bugs are 0.2 inches in length (0.5 cm). Light brown in color with no distinguishing marks on their body which differentiates the proba bug from the lygus bugs having a distinctive yellow, triangular shaped marking at the base of the forewings. Proba nymphs are greenish-yellow in color, resemble small aphids, but have quicker movements do to overly long legs. Second and third instar nymphs are reddish-brown in color, with the fourth and fifth instar nymphs having light and dark alternate bands on the abdominal segments.

Proba bug activity declines significantly during the winter months due to cold weather. Proba nymphs and adults feed on the young leaves of artichoke plants. They feed with piercing-sucking mouth parts which injects a toxin into the plant which results in the death of leaf tissues around the feeding area. The feeding area wound will expand as the leaves grow, turn into brown necrotic spots that fall off, leaving the leaf with a shot hole appearance. Proba bug feeding damage at the base of the artichoke bud will cause it to turn black making it unmarketable.

Chemical Control

Zeta-Cypermethrin

Trade Name & Formulation: Mustang Maxx
Application Timing & Frequency: Spring through summer for Southern Coastal and Central Coastal regions.
Typical Application Rate and Method: Do not apply more than 0.2 lb ai/acre. Do not make applications less than 14 days apart. Ground rigs are preferred method of' application when possible
REI & PHI: 12-hour restricted entry, 5-day pre-harvest interval

Zeta-cypermethrin is typically tank mixed with spinetroram or esfenvalerate for Lepidoptera control.

Thiaomethoxam

Trade Name & Formulation: Actara
Application Timing & Frequency: Apply one to two applications pre crop according to observed pest pressure.
Typical Application Rate & Method: Applied at 0.47 lb ai/acre per application. Two applications per crop usually with a ground rig
REI & PHI: 12 hour restricted entry; 4 day pre-harvest interval

Actara is usually tank mixed with esfenvalerate or spinetoram. Will provide additional aphid control.

Alternative Chemical Controls:

***Permethrin (Ambush, Pounce, various generic*)** has moderate control for larvae and adults. Rotational materials that can be used late in crop production cycle due to short pre-harvest interval.

Bifenthrin (Brigade WSB) moderate control on cabbage looper and cutworm larvae. Rotational material with 5 day pre-harvest interval.

Biological Controls:
Naturally occurring predators that feed on the nymphal stages of lygus bug include big eye bugs *(Geocoris spp.*), damsel bugs (*Navis spp.*), minute pirate bugs (*Orius tristicolor*); and several species of spiders.

Cultural Controls:
The most important host control for proba bug would be the elimination of surrounding coyote brush, (*Baccharis pilularis*) populations. This would include coyote brush populations growing along roadsides, surrounding fields and in borders. Proba bugs overwinter in the coyote brush as eggs, nymphs and adults with the adults migrating to the maturing artichoke plants in neighboring fields.

Diseases

Powdery Mildew, *Leveillula taurica*

Powdery mildew is the most serious above ground disease problem for artichoke growers usually occurring in late August or September. It is monitored by walking the fields and examining the leaves for mildew mycelium, *L. taurica* is the predominant species involved with powdery mildew on artichoke. It can be found on the underside of older leaves which, if severely infected, will eventually die. This leaf stress slows production of the flower buds. Experimental evidence shows that powdery mildew may reduce yield by 9% per crop. More important than the loss of yield, however is the economic loss to growers resulting from disruption of harvest timing caused by the disease. The delay in harvest due to powdery mildew tend to counteract the effects of gibberellic acid, a plant growth regulator that is applied by growers to accelerate harvest to coincide with the primary market for artichoke.

Chemical Control:

Myclobutanil

Trade Name & Formulation: Rally 40W, plus generic formulations
Application Timing and Frequency: Applied twice usually during bud formation.
Typical Application Rate & Method: 1.20 oz ai/acre. Tank mixed with insecticides, usually applied by ground 2 times a year.
REI & PHI: 48-hour restricted entry period; 5-day pre-harvest interval.
This product is applied by ground rigs only and is usually tank mixed with other crop protection materials.

Trifloxystrobin

Trade Name & Formulation: Gem 500 SC, Flint Extra
Application Timing & Frequency: Applied upon observation of powdery mildew on plants leaves. 7 to10 day application intervals with rotation of other fungicides
Typical Application Rate & Method: 0.12 lb ai/acre. Ground rig application usually tank mixed with other crop protection materials.
REI & PHI: 4-hour restricted entry interval; 0-day pre-harvest interval

Fluopyram/triflloxystrobin

Trade Name & Formulation: Luna Sensation

Application Timing & Frequency: Applied upon observation of powdery mildew on leaves or at bud formation

Typical Application Rate & Method: 0.125 lb. ai/ acre. Applied with ground rig, tank mixed with other crop protection materials, 1 to 2 applications per crop

REI & PHI: 12-hour restricted entry interval; 0-day pre-harvest interval.

Alternative Chemical Controls:

Bacillus pumilus (Sonata) use when powdery mildew first appears and 7-to-10-day intervals between application. Organic registration Sulfur (Microthiol Disperse) use when powdery mildew first appears and 7-to-10-day intervals between application. 24-hour restricted entry interval. Organic registration.

Ramularia Leaf Spot, *Ramularia cynarae*

Ramularia is present on nearly 100% of California artichoke acreage. It damages the leaf and spreads to the flower bud. Severe leaf damage and resultant loss of plant vigor will lead to smaller sizes of marketable buds. The best market is for the "#24" size (24 artichokes/carton). The marketability of the smaller sizes is not as strong. In weak markets, the smaller sizes may not sell at all; in stronger markets, the smaller sizes sell, but at significantly lower prices. Also, the smaller buds result in lower carton units produced per acre. In addition to loss of plant vigor, *Ramularia* leaf spot also may infect the artichoke buds directly, making them unmarketable.

Ramularia is a serious issue for South Coast artichoke growers. It is estimated that the disease is responsible for yield losses of as much as one third in years of severe infection. In the desert, *Ramularia* symptoms appear in late season foliage, but does not do economic damage to the crop.

Chemical Controls:

Difenoconazole/cyprodnil

Trade Name & Formulation: Inspire Super

Application & Frequency: Applied upon observation of circular brown lesions on both the upper and lower surfaces of the plant leaves. 1 to 2 applications per crop

Typical Application Rate & Method: 0.115 lb ai/acre difenoconazole, 0.325 lb ai/acre cyprodnil. Ground rig application preferred, tank mixed with other crop protection materials, 1 to 2 applications per crop season

REI & PHI: 12-hour restricted entry interval; 3-day pre-harvest interval

Azoxystrobin/difenoconazole

Trade Name & Formulation: Quadris Top

Application Timing & Frequency: Applied upon observation of circular brown Lesions on both the upper and lower surfaces of the plant leaves. 1 to 2 applications per crop.

Typical Application Rate & Method: 0.18 lb ai/acre azoxystrobin; 0.11 lb ai/acre difenoconazole. Ground rig application preferred usually tank mixed with other crop protection materials. 1 to 2 applications per crop.

REI & PHI: 12-hour restricted entry period; 3-day pre-harvest interval.

Alternative Chemical Controls:

Sulfur (Microthiol Disperse) use when powdery mildew first appears and 7-to-10-day intervals between applications. 24-hour restricted entry period. Organic registration.

Rally (myclobutanil) also effective powdery mildew control. 48-hour restricted entry period.

Biological Controls:

There are no known biological controls for management of this disease.

Cultural Controls:

It is difficult to control the spread of *Ramularia*. It has been suspected that field equipment spreads the fungus as it moves from diseased sections of fields into healthy areas, or that field personnel spread the disease through fields as they tend to the crop or harvest.

Incidence of *Ramularia* may be minimized by keeping the soil surface as dry as possible. This would be an advantage of drip irrigation over sprinklers.

Root Pathogens, *Verticillium dahliae*, *Pythium* spp.

Verticillium and *Pythium* damage the vascular system of artichoke plants. The result of infection ranges from stunted growth and plant discoloration to the death of the plant. *Verticillium* infection in the field appears to encourage the development of *Pythium* and bacterial problems. Occasionally, soil-sampling and lab testing will be performed confirm the existence of *Verticillium* before planting, but this is not a routine practice. Grower knowledge of the disease history of the field plays a major role in planting and treatment decisions with respect to soil borne root pathogens.

Chemical Control:

Metam-sodium - Metam - potassium

Trade Name & Formulation: Vapam HL - Kpam HL
Application Timing & Frequency: pre-plant, one application
Typical Application Rate & Method: 58 lb to 116 lb ai/ac, applied by shank or subsurface blade into bed
REI & PHI: 48-hour restriction entry; (preplant application)

Do to restrictive regulatory compliance requirements placed on Vapam/Kpam applications including training, buffer zones, fumigation plans by county agricultural commissioner's usage has become limited.

Alternative Chemical Control:

There are no alternative chemical controls efficacious against *Verticillium*

Biological Control:

There are no known biological controls for management of these diseases.

Cultural Controls:
Disease control begins by exclusion of fields with a history of *Verticillium*. However, limitations of available acreage make it infeasible to completely avoid planting in fields with a history of the disease.

Broccoli may be a good rotational choice for *Verticillium* control due to its disease suppressive property when incorporated into the soil at the end of the season. Market considerations, however, make it economically impractical to rotate all artichoke acreage with broccoli.

Weeds

Weed management is a major problem. Not only do weeds divert nutrients from the intended crop, they also provide habitat for insect pests, vertebrate pests, slugs and snails, and also can reduce the efficiency of spray-applied pest control materials. Central Coast Region artichoke fields are host to a broad spectrum of weeds including nettle, mustard, chickweed, oxalis, Malta, shepherds purse, and hoary cress.

Southern coast artichoke fields are host to shepherd's purse, stinging nettle, malva, groundsel, chickweed, pigweed, goosefoot nettle, grasses, London rocket, and in spots, oxalis.

In the desert artichoke fields are host to goosefoot, purslane, lambsquarter, malva, and watergrass.

Chemical Control:

Oxyflourfen

Trade Name & Formulation: Goaltender; plus, generic
Application Timing & Frequency: 1 application prior to transplanting.
Typical Application Rate & Frequency: 0.5 lb. to 1.0 lb. ai/ac is applied utilizing a ground rig. Applications are broadcast bed tops, shoulders and furrows, bed top only or a "reverse band" which is a bed top application where a center 8-inch band is left unsprayed. The herbicide is carried into the soil through the use of overhead sprinkler irrigation.
REI & PHI: 24-hour restricted interval, 5-day pre-harvest interval.

This product works well on most weed, but is weak against chickweed.

Glyphosate

Trade Name & Formulation: Roundup Power Max, generic
Application Timing & Frequency: applied once, fallow bed pre-plant
Typical Application Rate & Method: 1.13 lb ai/acre. Applied with ground rig, pre- plant, broadcast.
REI & PHI: 4-hour restricted interval: NA pre-harvest

A non-selective foliar herbicide used immediately before transplanting or for fallow bed. Rate depends on weed species and weed size. Annual weeds are best controlled when small; control is poor when weeds exceed the maximum size. Gives good annual weed control and some suppression of perennial weeds. Higher application rates are needed for perennial control.

Flumioxazin

Trade Name & Formulation: Chateau SW

Application Timing Rate & Method: 2.04 oz ai/ac. Ground application, pre-plant, bed top or broadcast.

REI & PHI: 12-hour restricted entry, NA pre-harvest interval Flumioxazin may be applied no less than 2 days prior to transplanting. May be applied with backpack sprayer on bed top between established plants.

Alternative Chemical Control:

Pronamide (Kerb 50W) is somewhat effective against pre-emerged weeds. Needs to be used at high rate resulting in excess per acre costs.

Paraquat (Gramoxone SL 2.0) pre-plant contact herbicide. Restricted use. Can be used in backpack sprayer as bed top application between established plants.

Biological Control:

There are no known biological controls for weed management in artichoke fields.

Cultural Controls:

Mechanical cultivation and hand weeding are used for the weed control until the artichoke plants become too large to allow access.

Plant Growth Regulators

Artichoke growers routinely apply gibberellic acid, a plant growth regulator, to accelerate the beginning of harvest.

Gibberellic Acid

Trade Name & Formulation: ProGibb LV Plus

Application Timing & Frequency: Application once or twice at bud initiation.

Typical Application Rate & Method: 10 grams ai/ac, applied by ground usually Tank mixed with crop protection materials.

REI & PHI: 12-hour restricted entry, 7-day pre-harvest interval. Use sufficient water volume to ensure wetting of the entire plant (leaves, stems, and buds).

Vertebrate Pests

Voles, *Microtus californicus*

Pocket Gopher, *Thomomys bottae*

Artichoke fields in the Central Coast Region, Southern Coast and desert regions are experiencing increased rodent populations and damage. Voles will damage all artichoke plant parts while the

pocket gopher damages the root system and shoots at the bed top surface. As California has made rodenticides either illegal or placed more restrictions on their use rodent populations have been increasing resulting in more crop damage or loss.

Chemical Control:

Aluminum phosphide

Trade Name & Formulation: Phostoxin (tablets)
Application Timing & Frequency: Applied twice early in the crop when burrow entrances are visible.
Typical Application Rate & Method: One to 4 tablets are placed by hand into the rodent burrows and covered with dirt. (Soil moisture activates the tablets, creating a fumigation effect.)

The State of California is requiring growers to acquire a Private Applicator Certificate (PAC) with a Burrowing Vertebrate Fumigation (BVF) qualification for property operators and their employees before making an aluminum phosphideapplication.

Chlorophacinone

Trade Name & Formulation: Rozol (pellets)
Application Timing and Frequency: Apply twice early in crop development when burrow entrances are visible. Make later applications when rodent activity is visible.
Typical Application Rate & Method: Place directly into rodent burrows. Apply 1/4 to 1/2 oz per placement with up to 2 oz in areas of activity.
REI & PHI: (not listed on label)

Rozol Pellets has a 24(c) supplemental label for distribution and use only within the State of California for control of California voles (*Microtus californicus)* in artichoke fields.

Alternative Chemical Control:
No other rodenticides are registered for in field use by the State of California. Registrations are restricted to borders, ditches and field periphery.

Biological Control:
Owl houses have been utilized to attract raptors for in field rodent control

Cultural Controls:
Trapping is utilized for both vole and pocket gopher control. As artichoke plants mature, foliage increases, limiting access to fields for trapping. Early in the crop cultivation helps in minimizing rodent infestation levels.

Mollusks

Gray Garden Slug, *Deroceras reticulatum*

European Brown Snail, *Helix aspersa*

Snails and slugs became less of a pest concern in artichoke production with the transition of the majority of the crop from the perennial to the annual varieties. In heavily infested fields, slug and

snail feeding on foliage causes shot holes on the leaf lamina. Slugs are particularly injurious to the buds when they scrape off soft tissues from the artichoke leaf surface. This injury later turns black, and the quality and marketability of the crop is affected.

Chemical Control:

Sodium Ferric EDTA 5% Bait

Trade Name & Formulation: Ferroxx

Application Timing & Frequency: Make applications when populations are observed on both soil surface and plant leaves. Make additional applications after rain or overhead irrigation.

Typical Application Rate & Method: apply 5 lbs. to 20 lbs. per acre depending on infestation levels. Place pellets on soil surface between plants not on leaves.

REI & PHI: No restricted entry; no pre-harvest interval indicated on label

Metaldehyde

Trade Name & Formulation: Deadline Bullets, Durham Metaldyhyde Granules

Application Timing and Frequency: Apply In areas likely to be infested at beginning of planting season. Make applications after rain or overhead irrigation.

Typical Application Rate & Method: Application rates average 0.76 lb ai/acre, applied on bed top between plants.

REI & PHI: 12-hour restricted entry; no pre-harvest interval indicated on label

Alternative Chemicals Control:

Iron phosphate (Leaf Life Sluggo) Can be applied to a field approaching bud harvest without concern of contamination because this product is exempt from tolerance.

Biological Control:

No biological controls for mollusks are available

Culture Controls:

Cut back and working crop residue back into soil, crop rotation and weed control measures.

Emerging Artichoke Production Technologies

In-vitro propagation

In-vitro propagation also known as micro propagation of plant tissue culture that allows for the rapid and efficient reproduction of plants in a controlled, sterile environment, enabling the commercial production of uniform, disease free transplants

Crop rotation for weed and disease control

Weed and disease control through experimentation with crop rotation and cover crops. Potential production practices could utilize fertility building legumes as catch- cover cops or rotation with brassica crops.

Mycorrhizal inoculation

Mycorrhizal inoculation resulting in plant growth improvements and yield increase of annual artichokes. Healthy plants with disease immunity would be available for field transplanting.

Aerial drones

Aerial drones for field scouting and pest management. Drones can be utilized for the precision application of crop protection materials. With the use of drones for field scouting the affected areas of a field can be identified and pest control materials would be selectively applied to those identified areas. Drones could also be employed in the release of specific insect predators or parasites to control artichoke pests observed negatively affecting a field. Drones would limit the need for larger fixed wing aircraft or helicopters being utilized in field aerial applications

Steam injection

Steam injection for weed and pathogen control. The soil injection of steam heated to 140 degrees Fahrenheit in response to the observation of the presence of existing weed seed and soil pathogens could limit the need for mechanical or chemical controls.

DISCUSSION AND SUMMARY

The California artichoke industry went through a major transformation with the change in production from the perennial varieties to the transplanted seeded varieties. The perennial varieties would remain in the same production field for years while the annual varieties would be grown as a row crop and rotated to a different crop after harvest. The increased per acre harvest volume advantage of the annual artichokes resulted in a decrease of artichoke acres from 10,700 in 1998 to 4,111 acres in 2023 (cdfa.gov). The cultural practices of growing artichokes as a row crop result in reductions in soil pathogens, weed pressure, rodent pressure, and various insect pests. This has eliminated the usage of the organophosphate and carbamate crop protection materials in artichoke production. The annual artichoke production region has expanded in the Central Coast Region from being located around the Castroville “Artichoke Center of the World” to having been increased down the length of the Salinas Valley.

California produces nearly 100% of all commercially grown artichokes in the United States. 80% of California’s commercial artichoke production is sourced from Monterey County. Although being the number one grower of artichokes for the nation California artichokes were ranked the 54th commodity for value in the State of California for the 2022 production year (cdfa.gov). During the 2022 production year artichokes represented 1% of Monterey County’s total agricultural market value (countyofmonterey.gov). Artichokes are the “Official Vegetable” of the State of California and also of Monterey County and contributes $38.3 million to the economy there.

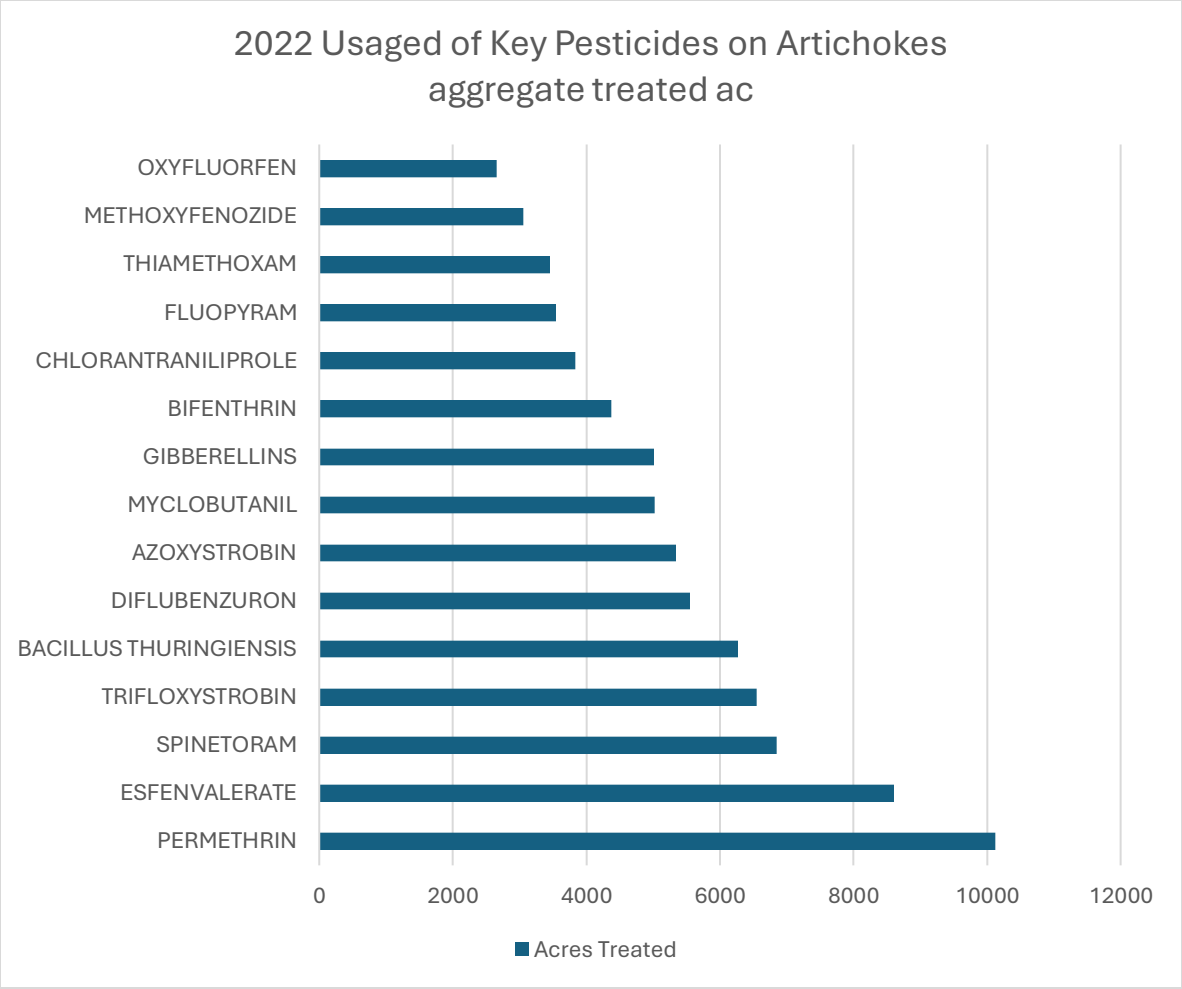
Table 1

Most important artichoke pest control materials, based on 2022 usage data (calpip.cdpr.ca.gov)

Listing is order of Central Coast usage, not necessarily in order of perceived importance.

			Total lb ai applied		
Chemical Name	**Mode of Action**	**Pounds Applied**	**Central Coast**	**Southern Coast**	**Southern Inland Desert**
SULFUR	Fungicide	14454.40	14454.40	0.00	0.00
BACILLUS THURINGIENSIS	Larvicide	4687.17	4533.08	105.38	48.71
EXTRACT OF NEEM OIL	Insecticide	4647.47	0.00	4647.47	0.00
POTASSIUM PHOSPHITE	Fungicide	4385.47	4385.47	0.00	0.00
PERMETHRIN	Larvicide	2727.71	2302.58	11.34	2.36
METAM-SODIUM	Soil Pathogens	2133.59	0.00	0.00	2133.59
BURKHOLDERIA RINOJENSIS STRAIN A396	Larvicide	1970.57	1970.57	0.00	0.00
METALDEHYDE	Molluscicide	1796.78	1796.78	0.00	0.00
DIFLUBENZURON	Insecticide	1235.95	1235.95	0.00	0.00
AZOXYSTROBIN	Fungicide	1223.28	1019.76	203.51	0.00
OXYFLUORFEN	Herbicide	1068.36	775.08	104.02	189.27
TRIFLOXYSTROBIN	Fungicide	789.24	769.40	21.32	0.00
METHOXYFENOZIDE	Insecticide	644.59	604.88	36.89	2.82
KAOLIN	Barrier	532.48	532.48	0.00	0.00

While Table 1 shows usage om terms of total lb. ai applied, another indicator of pesticide usage is *aggregate treated acreage*, which is a measure of the total surface area to which these materials are applied, usually by spray applications, either ground or aerial. *(See Appendix 1, Data Collection and Processing Procedures, Aggregate Treated Acreage*). This statistic incorporates the effects of multiple applications, and serves to add additional environmental exposure information to the lb ai data. Figure 2 represents the aggregate treated artichoke acreage for 2022, summed across all regions for each of the fifteen important chemicals listed in Table 1. Although esfenvalerate ranked seventh in terms of total lb ai applied, it was applied on significantly more acreage than any other pesticide – more acreage than the next four materials combined.



Data Collection and Processing Procedures

Individual County Artichoke Acreage

Total artichoke acreage of 4500 ac for calendar year 2022, as reported in the California Vegetable Review (CASS) was consistent with the total acreage of 4510 ac reported by the California Artichoke Advisory Board (CAAB) for crop year (July1 – June 30) 2021 -22. The CAAB report also provided total acreage by county. To estimate the county-by-county acreage for the 2022 calendar year CASS acreage, the percentage of contribution of each county to the CAAB 2021-22 total was calculated, and the corresponding percentages were applied to the CASS total.

County Pesticide Use Reports

At the time of the data compilation for this report, the most recent year for which statewide pesticide usage records were processed and published by the Department of Pesticide Regulation (CDPR) was 2022. However individual counties collect and record current crop year pesticide usage data. To provide the most recent usage statistics the California Department of Pesticide

Regulation (CDPR) California Pesticide Information Portal (CalPIP) lists a current statewide compilation of pesticide use reports. The (CDPR) (CalPIP) data site provided pesticide use

information for each county in the Central Coastal Region, the South Coastal Region and the Southern Desert Region. This group of counties with artichoke acreage reported to CAAB included Santa Cruz, Monterey, Santa Barbara, Ventura, Riverside and Imperial.

Summation of County Data

Individual county data was compiled by pesticide product, product application amount unit, and application method. For example, one group would consist of all applications on artichoke of esfenvalerate where units applied were expressed in gallons, and application method was byground equipment. For these groups, the amount of product applied and the acres treated were summed, and the application instances were counted. This summed data from each county was combined into a single, statewide searchable database.

Active Ingredient Calculations

After the statewide data was compiled, all units of measure for dry materials were converted (if necessary) to pounds, and all units for liquids to gallons. The objective of making the conversions was to express the applications of materials in units of lb ai/ac. For dry materials, once a material was expressed in lb, the percentage of active ingredient, as listed by the DPR, was used to calculate the amount of active ingredient that was applied. Liquid products required the additional step of factoring in the product density, also obtained from the CDPR. Density (lb/gal) was multiplied by the gallons of product applied for a corresponding weight, and the percentage of active ingredient was applied to this weight When all individual product applications were expressed in lb/ai, it was possible to combine data for applications of the same active ingredient regardless of product formulation. This report utilizes pesticide information compiled by the (CDPR)(CalPIP) database to provide pesticide usage data for each active ingredient applied to artichoke, grouped by region and summed across all regions.

Aggregate Treated Acreage

The term “aggregate” acreage is the sum of the area treated by a pesticide material. This summation may exceed the total planted acreage in some instances. It is not a definitive indicator as to whether or not all planted acreage was treated with pesticide. For example, a grower may have 100 ac artichoke planted. The grower may report four application instances of 50 ac each. This may mean that each half of the field was sprayed twice; it may also mean that the same half of the field was sprayed four time. Regardless the aggregate treated acreage for this 100-ac field would be 200 ac.

One statement that can be made based on the total aggregate acreage, however, arises when the aggregate treated acreage is less than the total acreage planted. If, for example, the aggregate treated acreage is 9 ac vs 100 total acres planted, it is accurate to say that “less than10% of planted acreage was treated,” or “at most, 9% of planted acreage was treated.”

Average Application Rate

The average rate of pesticide application is calculated simply as the total applied amount of active ingredient divided by aggregate treated acreage. For example, Table 1 lists for esfenvalerate 401.41 total lb ai applied to 8479.56 acres. The average rate is 0.05 lb ai/ac:

$$401.41 \div 8479.56 = 0.05\ lb\ ai/ac$$

Esfenvalerate is typically applied on artichoke in the form of a 0.66 emulsifiable concentrate. The calculated average application rate is 0.05 lb. ai/ac is highest product label rate under the parameters of 0.03 to 0.05 lb. ai/ac for artichoke plume moth.

Pesticide Use Tables

Appendix Tables 1 – 4 present a listing of all chemical pest control materials (and plant growth regulators) applied to artichoke in the calendar year 2022, based on data from (CDPR)(CalPIP).

The (CalPIP) data is generated for pesticide use reports submitted by county agricultural commissioners. Adjuvants (e.g., spreaders, stickers) are not included. Tables A1 -A3 show data for individual regions; Table A4 shows data for all regions combined.

Column Heading Key

- "Chemical name" is the common name of active ingredient
- "Number of applications" is the number of times the active ingredient was applied to artichoke
- "lb. ai applied" is the total pounds of active ingredient applied to artichoke
- "Acres treated" is the aggregate treated acres
- "avg. rate" is the total lb ai divided by aggregate treated acres, for average lb. ai/ac.

Table 1 Pesticide usages on central coast artichokes

Chemical Name	Number of Applications	Pounds Applied	Acres Treated	Average Rate
ESFENVALERATE	694	401.46	8479.56	0.05
BACILLUS THURINGIENSIS	595	4533.08	6085.25	0.74
PERMETHRIN	534	2302.58	8425.61	0.27
DIFLUBENZURON	462	1235.95	5547.61	0.22
TRIFLOXYSTROBIN	440	769.40	6392.98	0.12
SPINETORAM	408	316.04	5746.72	0.04
MYCLOBUTANIL	363	452.66	4526.78	0.10
AZOXYSTROBIN	280	1019.76	4435.30	0.23
BIFENTHRIN	248	363.17	3652.03	0.10
FLUOPYRAM	247	414.77	3413.28	0.12
GIBBERELLINS	244	44.44	2199.86	0.02
CHLORANTRANILIPROLE	240	373.85	3402.45	0.11
METHOXYFENOZIDE	212	604.88	2824.70	0.21
THIAMETHOXAM	208	126.96	2710.85	0.05
IMIDACLOPRID	179	232.51	2065.10	0.11
OXYFLUORFEN	155	775.08	2035.80	0.38
METALDEHYDE	151	1796.78	1802.00	1.00
SPINOSAD	130	103.75	910.03	0.11
SULFUR	117	14454.40	1952.90	7.40
BACILLUS VELENSIS	108	65.64	471.80	0.14
SPIROTETRAMAT	104	86.18	1264.90	0.06
BACILLUS ALTITUDINIS	95	25.44	448.40	0.06
FLUMIOXAZIN	94	98.78	1101.40	0.09
PYRETHRINS	91	18.66	1073.05	0.02
GS-OMEGA/KAPPA-HXTX-HV1A, VERSITUDE PEPTIDE	62	32.91	767.64	0.04
COPPER OCTANOATE	56	181.43	382.30	0.47
REYNOUTRIA SACHALINENSIS	52	62.67	269.50	0.23
DIFENOCONAZOLE	49	54.00	765.10	0.07
BURKHOLDERIA RINOJENSIS STRAIN A396	40	1970.57	337.70	5.84
ALUMINUM PHOSPHIDE	28	5.63	308.90	0.02
CHROMOBACTERIUM SUBTSUGAE STRAIN: PRAA4-1	27	154.29	193.60	0.80
EMAMECTIN BENZOATE	20	2.25	151.90	0.01
CYPRODINIL	17	11.84	302.60	0.04

ZETA-CYPERMETHRIN	16	6.91	260.60	0.03
POTASSIUM PHOSPHITE	16	4385.47	939.80	8770.94
FERRIC SODIUM EDTA	13	268.75	141.00	1.91
CHLOROPHACINONE	13	0.29	161.20	0.00
PROPYZAMIDE	10	140.22	112.60	1.25
PENDIMETHALIN	10	113.22	116.00	0.98
AZADIRACHTIN	10	1.43	61.50	0.02
BACILLUS SUBTILIS	8	0.05	59.00	0.00
PARAQUAT DICHLORIDE	6	52.79	49.80	1.06
KAOLIN	4	532.48	46.70	11.40

Table 2 pesticide usage on THE SOUTHERN Coastal region

Chemical Name	Number of Applications	Pounds Applied	Acres Treated	Average Rate
PERMETHRIN	77	422.76	1686.19	0.25
GIBBERELLINS	109	34.41	1385.38	0.02
AZOXYSTROBIN	53	203.51	904.45	0.23
EXTRACT OF NEEM OIL	38	4647.47	848.50	5.48
THIAMETHOXAM	45	35.03	747.13	0.05
BIFENTHRIN	44	71.07	723.21	0.10
MYCLOBUTANIL	25	49.70	496.99	0.10
DIFENOCONAZOLE	14	38.84	339.70	0.11
METHOXYFENOZIDE	7	36.89	224.80	0.16
CHLORANTRANILIPROLE	10	21.68	216.93	0.10
IMIDACLOPRID	7	20.48	165.50	0.12
TRIFLOXYSTROBIN	4	19.84	160.14	0.12
FLUOPYRAM	3	16.35	132.04	0.12
BACILLUS THURINGIENSIS	4	105.38	130.10	0.81
QUINOXYFEN	6	11.34	118.69	0.10
OXYFLUORFEN	10	104.02	118.00	0.88
SPINETORAM	4	5.64	102.69	0.05
PYRETHRINS	15	4.11	102.20	0.04
HALOSULFURON-METHYL	20	6.89	78.50	0.09
ESFENVALERATE	11	3.68	74.00	0.05
CLETHODIM	9	8.26	68.25	0.12
SPIROTETRAMAT	2	6.33	62.60	0.10
FLUMIOXAZIN	13	7.72	52.00	0.19

BACILLUS VELENSIS	2	3.57	41.75	0.09
SPINOSAD	3	0.02	20.25	0.00
IRON PHOSPHATE	3	0.32	20.25	0.02
GLYPHOSATE	3	30.23	16.00	1.89
ZETA-CYPERMETHRIN	1	0.10	4.00	0.03

Table 3 southern inland desert region

Chemical Name	Number of Applications	Pounds Applied	Acres Treated	Average Rate
GIBBERELLINS	81	13.86	1427.09	0.01
SPINETORAM	56	43.32	996.39	0.04
OXYFLUORFEN	39	189.27	499.05	0.38
IMIDACLOPRID	13	74.03	283.71	0.26
CHLORANTRANILIPROLE	11	20.53	215.90	0.10
SPIROTETRAMAT	9	14.99	122.87	0.12
HALOSULFURON-METHYL	10	2.87	95.00	0.03
PENDIMETHALIN	9	105.13	94.10	1.12
SPINOSAD	5	21.32	83.48	0.26
PROPYZAMIDE	4	98.03	72.88	1.35
PYRETHRINS	4	3.16	69.48	0.05
BACILLUS THURINGIENSIS	7	48.71	55.60	0.88
ESFENVALERATE	4	2.49	55.00	0.05
AZADIRACHTIN	6	0.73	30.24	0.02
PERMETHRIN	2	2.36	15.87	0.15
COPPER OCTANOATE	2	11.34	13.60	0.83
METHOXYFENOZIDE	1	2.82	10.00	0.28
METAM-SODIUM	1	2133.59	9.00	237.07
BACILLUS SUBTILIS	1	0.01	8.10	0.00

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References

National Agricultural Statistics Service (NASS b) 2022 Census of Agriculture, County Profile: Monterey, California. https://www.nass.usda.gov

California Agricultural Statistics Service (CASS) 2023 Vegetable and Melon Acreage 2013 - 2022

USDA NASS Field Office/ California Department of Food and Agriculture https://www.cdfa.ca.gov

California Artichoke Advisory Board (CAAB) "California Artichoke Facts". http//www.artichoke.net

Bari, M.A. 1998. Artichoke Pest Management Evaluation, Artichoke Research Association

California Department of Pesticide Regulation (CDPR) (CalPIP) California Pesticide Information Portal https://calpip.cdpr.ca.gov

UC IPM Agriculture: Pest Management Guidelines Artichoke https:ipm.ucanr.edu/agriculture/artichoke/#gsc.tab=0

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