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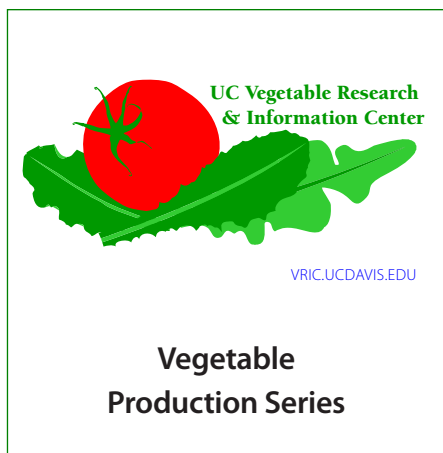
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CILANTRO PRODUCTION IN CALIFORNIA

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PRODUCTION AREAS AND SEASONS

Cilantro (*Coriandrum sativium*), also known as Mexican parsley, Chinese parsley, and coriander, is grown primarily along the southern and central coast of California. Ventura, Monterey, Santa Barbara, and San Benito Counties have the largest production, while smaller areas of production are scattered around the state. In the coastal counties production is year-round, with the main harvest from March through mid-November. Growers in the Coachella Valley (Riverside County) and the San Joaquin Valley plant a winter crop in late September to November for harvest from November through March. Cilantro is often used as a rotation crop; however, some growers may double-crop in a given year.

Yields vary greatly. Annual coastal production averages from 8 to 11 tons per acre (18 to 25 t/ha). Cilantro is hand-harvested and sold in bunches to be used as a fresh herb, as well as mechanically harvested and sold in bulk for food service or processing.

CLIMATIC REQUIREMENTS

Cilantro can be grown under a wide range of climatic conditions. During the summer, the crop matures

in 40 to 45 days. Hot weather causes cilantro to bolt quickly and reduces the development of foliage. Temperatures from 50° to 85°F (10° to 30°C) provide optimal growing conditions. Cilantro tolerates light frost.

VARIETIES AND PLANTING TECHNIQUES

Varieties. Commonly planted varieties of cilantro include Long Standing, Leisure, Santos, and Terra. Many varieties are appropriate for spring, summer, and fall production; however, bolting is a concern for summer plantings. Santos is commonly grown during the winter months.

Planting. Cilantro is grown on beds 40 or 80 inches (1 and 2 m) wide. The 40-inch beds are typically planted with two lines per bed; seedlines may vary from 2 to 5 inches (5 to 13 cm) wide. The 80-inch beds are planted with 24 to 33 seedlines to entirely cover the bed top. Depending on the desired plant population, 25 to 100 pounds per acre (28 to 112 kg/ha) of seed are used. Seed are placed at a depth of 0.25 to 0.50 inch (0.6 to 1.3 cm).

SOILS

Cilantro can be grown on a wide range of soil types as long as tilth, nutrient levels, and moisture are appropriately maintained. Cilantro is considered salt sensitive; when soil electrical conductivity (EC) exceeds 1.0 dS/m, yields decline at a rate of 12% to 14% per 1 dS/m increase in soil EC.

IRRIGATION

Depending on initial soil conditions, 2 to 4 inches (610 to 1,220 mm) of water are applied using sprinklers to moisten soil for tillage and seedbed preparation.

CILANTRO ACREAGE AND VALUE

Year	Acreage	Average yield (tons/acre)	Gross value/acre
2009	4,050	8.50	\$5,108
2008	4,579	8.63	\$5,206
2007	4,154	8.68	\$6,857
2006	2,809	8.58	\$7,926

SOURCE: California Agricultural Commissioner's Report Data 2010 (Ventura, Monterey and San Benito Counties).

Overhead sprinklers are used for germination of seed. During the spring and summer months, short sprinkler applications usually follow an initially long irrigation every 2 days until emergence to prevent the formation of a soil crust and to replace moisture lost by evaporation. Most growers produce the entire crop with sprinklers, though continued use of sprinklers favors infection and spread of leaf spot diseases. Some growers use furrow irrigation after emergence of crops grown on 40-inch beds. Because the crop cycle is usually less than 45 days, solid-set sprinklers are often used to minimize labor. Operating sprinklers in windy conditions can greatly reduce irrigation uniformity and cause uneven emergence and growth.

Cilantro has a relatively shallow root system and thrives on frequent, short irrigations to maintain uniformly moist soil for maximum production. However, care must be taken to avoid saturated conditions that promote leaf diseases. Cilantro requires 5 to 8 inches (1,525 to 2,440 mm) of water to meet evapotranspiration requirements during the summer. Total water applied between seeding and harvest ranges from 6 to 12 inches (1,830 to 3660 mm).

The combination of soil moisture monitoring and weather-based irrigation scheduling can be used to determine the water needs of cilantro. Water use is highest when the leaf canopy is near maximum size. Soil moisture tensions are typically targeted for less than 20 to 30 cbars (20 to 30 kPa). The water extraction of cilantro can be estimated using reference evapotranspiration data adjusted with a crop coefficient, which is closely related to the percentage of ground covered by the leaf canopy. Because evaporation represents a majority of the water loss during the early stages of growth, a crop coefficient between 0.3 and 0.5 should be used for overhead sprinklers until the canopy is greater than 30% cover. At a maximum canopy cover of 85 to 90%, the crop coefficient is nearly 1.0. The California Irrigation Management Information System (CIMIS, <http://www.cimis.water.ca.gov>) coordinated by the California Department of Water Resources provides daily estimates of reference evapotranspiration for most production regions of California.

FERTILIZATION

Soil analyses are the best indicators of the adequacy of phosphorus (P) and potassium (K). Soils with bicarbonate extractable phosphorus less than 10 ppm phosphorus may require up to 200 pounds per acre (224 kg/ha) of P₂O₅, and soils with greater than 30 ppm typically require no more than 50 pounds per acre (56 kg/ha) of P₂O₅. Soils with less than 100 ppm of ammonium acetate-extractable potassium may require up to 150 pounds per acre (168 kg/ha) of K₂O applied preplant to ensure adequate

potassium supply, while soils with greater than 150 ppm ammonium acetate-exchangeable potassium are unlikely to respond to potassium fertilization. Most California soils have adequate availability of micronutrients; where micronutrient deficiency occurs, zinc is often the most limiting nutrient. A mature, high-yielding crop of cilantro contains 70 pounds per acre (78 kg/ha) of nitrogen per acre and therefore has moderate nitrogen needs. Total nitrogen application rates on the Central Coast typically range from 100 to 120 pounds per acre (112 to 135 kg/ha) of nitrogen split between a small amount applied preplant and the remainder applied when the crop is well established. Moderate amounts of supplemental applications of nitrogen may be applied if the stand of cilantro is allowed to regrow after harvest for a second cut. The nitrate quick test taken before fertilization can provide good information on levels of residual nitrate in the soil and the nitrogen fertilizer needs of the crop (see the UC Vegetable Research and Information Center publication *Efficient Nitrogen Management for Cool-Season Vegetables*, http://vric.ucdavis.edu/pdf/fertilization_EfficientNitrogenManagementforCoolSeasonvegetable2007.pdf).

INTEGRATED PEST MANAGEMENT

Weeds. Challenges to weed control in cilantro include

- the plant germinates slowly and competes poorly with weeds early in the crop cycle
- the crop is planted in dense stands, which limits the use of cultivation
- mechanical harvest necessitates weed-free crops at harvest

The current choices for herbicides for use on cilantro are limited and do not generally provide control of all of weeds found in production fields. As a result, growers provide preplant weed control by rotating into fields with low weed pressure and by using preirrigation followed by shallow cultivation or flaming to kill an initial flush of germinated weeds before seeding the crop. Hand-weeding is generally needed prior to harvest operations for weeds not controlled by cultural practices or herbicides. As a result, weeding costs can be very high in cilantro unless weed control programs are carefully planned and executed.

Insects and nematodes. Beet armyworm (*Spodoptera exigua*), cabbage looper (*Trichoplusia ni*), and green peach aphid (*Myzus persicae*) sometimes cause economic damage.

Larvae of both beet armyworm and cabbage looper damage cilantro by feeding on leaves. High numbers can kill seedlings or slow their growth. They also cause damage by contaminating the marketable product with their bodies and frass. Monitor twice a week for eggs and larvae after seedlings

emerge. Treat plants when numbers of small larvae are large enough to stunt growth. Cultural control can suppress beet armyworm and cabbage looper populations. Disc fields immediately following harvest to kill larvae and pupae. Cleanup of weeds along field borders is also important.

Green peach aphids damage cilantro plants by sucking out plant sap. High populations can make plants stunted, with curled and twisted leaves. Aphids excrete honeydew as they feed, and the honeydew promotes the growth of black sooty mold. Aphid bodies, honeydew, and the associated sooty mold can make the cilantro unmarketable. In addition, aphids transmit several virus diseases that infect plants. Monitor the field twice a week, paying special attention to the edges, which are usually the first area infested. If high numbers develop, treat plants as soon as possible. Destroying weeds along field borders and discing crop residue immediately after harvest helps reduce breeding habitat for insects.

Cilantro is susceptible to root-knot nematodes (*Meloidogyne* spp.) and stubby-root nematode (*Paratrichodorus* sp.). Rotation away from infested fields is recommended.

Diseases. Bacterial leaf spot (*Pseudomonas syringae* pv. *coriandricola*) is commonly found in cilantro plantings and can be a serious problem. The bacterium is seedborne and water-splashed onto the foliage of seedlings. Rain or sprinkler irrigation spreads the bacteria, causing water-soaked lesions on foliage. The lesions develop a purplish margin with a tan, necrotic center. Clean seed and furrow or drip irrigation to maintain dry foliage are the most effective means of control. Copper or other bactericides are not very effective.

Another disease of cilantro is Fusarium wilt, caused by the soilborne fungus *Fusarium oxysporum*. Early infections result in the wilting, collapse, and death of young seedlings; this phase of the disease resembles damping-off diseases seen in other crops. If infected at a later stage, cilantro plants exhibit poor growth, stunting, yellowing, collapse, and death. The vascular tissues of these larger plants show a red to brown discoloration of the xylem. Research indicates that this cilantro pathogen is host-specific to cilantro and will not infect other Apiaceae plants; similarly, the Fusarium yellows pathogen of celery (*F. oxysporum* f. sp. *apii*) does not infect cilantro. The only effective management option for growers is to not plant cilantro in fields having a history of this disease.

Cilantro is susceptible to three virus diseases. Carrot motley dwarf (CMD) is a disease that affects carrot, dill, parsley, and cilantro. It is caused by the co-infection of two viruses, *Carrot redleaf virus* and *Carrot mottle virus*, and results in leaves turning yellow and red. These viruses are aphidborne and

are usually found in fields near carrots. A second virus disease, cilantro yellow blotch, causes cilantro leaves to develop bright yellow blotchy lesions. The pathogen causing this problem has not yet been characterized. The third virus disease in cilantro is caused by *Apium virus Y*. This virus causes cilantro leaves to develop mosaic patterns and cleared veins. Affected plants can be stunted. *Apium virus Y* is vectored by aphids, infects several other Apiaceae crops (especially celery), and may be spread to crops by aphids that feed on infected **poison-hemlock** (*Conium maculatum* L.), an Apiaceae weed. For all virus diseases, management involves keeping vectors under control, removing weed reservoirs around fields, and if possible avoiding the planting of cilantro in fields having a history of these diseases.

HARVESTING AND HANDLING

For bunched product, cilantro is harvested by cutting plants either just below the soil or at 1.5 to 2 inches (4 to 5 cm) above the crown; bunches are formed and tied together with a rubber band or twist tie. Cilantro is mechanically harvested, and the product is conveyed to shallow bins or totes. The mechanically harvested product can be used for either dehydrated product or fresh in food service packs for use in restaurants and other outlets. Bunched cilantro is packed in 10-pound (4.5-kg) boxes packed with 30 bunches; nonbunched fresh cilantro is packed into plastic bags of various sizes for use in food service.

POSTHARVEST HANDLING

Fresh cilantro is usually hydrocooled or iced as soon as it is received at a storage facility. Boxes are held at 33° to 35°F (0.6° to 1.7°C) while waiting for shipment. In these conditions, cilantro should have a shelf life of at least 14 days. Exposure to ethylene shortens shelf life by increasing decay and yellowing. Modified-atmosphere packaging with 5 to 10 percent carbon dioxide can extend shelf life at storage temperatures of from 40° to 50°F (4° to 10°C).

MARKETING

California ships cilantro to all parts of the United States every month of the year. Some product is also exported to Mexico.

COSTS OF PRODUCTION

Costs of production of cilantro depend on location, and costs such as water, land lease and amounts of inputs (fertilizer, pesticide, etc.) depend on weather and soil. Generally, cilantro production is labor intensive, especially in harvesting and post harvest handling.

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