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Cucumber Production in California

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The major production areas for fresh-market and pickling types of cucumbers *(Cucumis sativus)* in California are San Joaquin, San Diego, Ventura, San Benito, and Riverside Counties. In the nationwide market, California ranks second in fresh-market (slicing) cucumber production and fifth in pickling cucumber production. In the lower Sacramento Valley, planting begins in May for harvest from mid-August through mid-October. In Southern California, cucumbers are planted under plastic tunnels in January for harvest from mid-March through June. Fall production in Southern California is planted from March through August for harvest from May through November. The time from plant emergence to harvest is approximately 55 to 70 days depending on the selected variety.

Table 1. Cucumber Acreage and Value

Year	Fresh-market	Pickling	Total acres	Total crop value
2000	6,600	4,400	11,000	$67,744,000
1999	6,500	4,400	10,900	$67,128,000
1998	6,000	4,500	10,500	$66,265,000
1997	6,300	4,200	10,500	$57,969,000

Source: California Department of Food and Agriculture. 2001. Agricultural Resource Directory. 126–130.

CLIMATIC REQUIREMENTS

Cucumbers are very tender, warm-season plants that grow best in temperatures from 65° to 75°F (18.3° to 23.9°C) with a minimum temperature of 60°F (15.6°C) and a maximum of 90°F (32.2°C). Cucumber seeds germinate in soils at temperatures from 60°F (15.6°C) to 95°F (35°C). Seeds do not germinate well at temperatures below 60°F (15.6°C). Cucumber plants are very susceptible to chilling injury in the field; prolonged temperatures below 55°F (12.8°C) cause chilling injury to plants (pitting, water-soaked spots, and decay). Cucumber seed is relatively vigorous, and stand establishment is not generally a problem if appropriate soil preparation, temperature, and soil moisture conditions are met.

VARIETIES AND PLANTING TECHNIQUES

Common slicing varieties planted in California include Dasher II, Conquistador, Thunder, Slicemaster, and Sprint. Most of the slicing varieties set fruit parthenocarpically and do not require bees for pollination. Common pickling varieties planted in California include Eureka and Valaspik.

Seed is planted in Central California with vacuum planters and planting sleds. Furrow irrigation is usually used for cucumber production in Central California and the desert regions. In-row spacing of 8 to 12 inches (21 to 31 cm) and row spacing of 36 to 72 inches (91 to 183 cm) are normal for cucumber production. Closer spacing is used for pickling varieties, and wider spacing is generally used for slicing varieties.

UC PEER REVIEWED

In coastal Southern California, cucumbers are generally direct seeded by hand 3 to 5 inches (8 to 13 cm) to the side of drip lines in single rows with 20-inch (51-cm) spacing on 60-inch (152-cm) beds. Approximately 1½ pounds of seed are used per acre (1.68 kg/ha). Some transplanting is done in early spring under plastic tunnels. Vines are often trained to prevent fruit from developing on wet soil. Luxuriant plant growth leads to poor fruit set so it is important to keep plants growing at a steady rate. Internode length should be maintained at about 2 inches (5 cm).

ROW COVERS

Row covers are used for frost protection and to control growing temperatures in fall, winter, and spring production in coastal Southern California.

Air temperature is usually increased by 6° to 20°F (3.3° to 11.1°C) inside enclosed row covers at midday, depending on the type of tunnel and materials used. Soil temperatures are increased by 4° to 8°F (2.4° to 4.8°C) in the daytime to a depth of 3 inches (7.6 cm). Heat is released at night from the soil and held in the tunnel by water that condenses on the inside of the plastic tunnel. Early- and late-season production of warm-season crops allows growers to target more profitable markets.

Tunnel Row Covers

Construction. Installation of tunnels is usually done well in advance of planting to avoid rain delays and to assure planting on the desired date. To avoid wind damage, the two plastic sheets are pinned down at the soil level with the same clothespins that will secure them to the apical wire at planting. Two sheets of plastic are laid 26 to 28 inches (66 to 71 cm) apart down the center of 60-inch (152-cm) rows with 6 to 8 inches (15 to 20 cm) of one edge of each sheet anchored into or covered with soil. A 16- to 18-inch (41- to 46-cm) cover height is created by placing 26-inch (66-cm) stakes every 10 feet (3 m) down the center of the bed (fig. 1). An apical 16-gauge wire is stapled to the top of the stakes and tied to anchor stakes at the end of each row. Support hoops are created to cover an area 26 to 28 inches (66 to 71 cm) wide. This is done by forcing each end of a 70-inch- (178-cm-) long piece of 9-gauge wire into the ground over the apical wire. One hoop is placed at each stake, and two additional hoops are placed equidistant between each pair of stakes. The plastic sheets are pulled up to cover the hoops forming a tunnel. At the top of the tunnel, the two sheets overlap 3 to 4 inches (8 to 10 cm) and are pinned to the apical wire with strong clothespins (figs. 1 and 2). Three or four pins are used between stakes. In windy areas, row covers should be constructed with extra hoops placed around the outside of the

Figure 1. Workers construct tunnel row covers to protect cucumbers from low temperatures and wind.

Figure 2. Completed tunnel row covers.

plastic and over the supporting bottom hoop. This outside hoop keeps the plastic from flapping and tearing in the wind. Where severe winds are a problem, "twistems" are used to secure the top hoop, bottom hoop, and apical wire together. This reinforced construction has weathered even moderately heavy storms.

Venting and Management. The two-sheet construction of the tunnel row cover permits the clothespins to be released so that one side of the cover can be dropped down for planting, weeding, pesticide application, or other cultural operations. Venting is accomplished by pinning the top edge of the row cover back to the hoops. For early venting, a 1- to 2-inch (2.5- to 5-cm) triangular opening can be made at each hoop and this top space widened as the plant grows or as seasonal spring temperatures increase. Where row ends face into the wind or tunnels are on a slope, the tunnel ends can be opened for venting. Later in the season both sides of the plastic are moved down the wire hoops until the entire row cover is open at the top. Most row covers are constructed using one or two perforated plastic sheets. This provides built-in venting that allows firmer plant growth and avoids excessive midday temperatures.

Cucumbers are more tender than tomatoes or peppers. Venting should not start until 50 to 70 days after seeding. Plants should fill most of the inside of the tunnels before venting begins. The small, triangular vents described above are opened at each hoop a few days before the first harvest. At the completion of the second harvest, both sheets are lowered 3 to 6 inches (8 to 15 cm) on the hoops. After three to four harvests are completed, the plastic tunnel is converted into a double windbreak by placing the hoops sideways along the sides of the rows and securing the plastic to them. These windbreaks protect the plants from foot traffic as well as wind and are left up until harvesting ends.

Materials for Rigid Tunnel Row Covers for Cucumbers

The following materials and equipment are needed to build rigid, two-sided row covers or tunnels:

- plastic laying apparatus
- 1.5 to 3.0 mm clear, plastic sheeting, 36 inches (91 cm) wide with a haze factor of 12 to 20 percent (solid or perforated with ¼-inch (6.5-mm) holes, 3 inches (8 cm) apart
- 9-gauge wire cut in 70-inch (178-cm) lengths
- strong clothespins
- rolls of 16-gauge wire
- heavy-duty stapler gun
- 1-inch-by-1-inch (2.5-by-2.5-cm) in-row stakes (stake height depends on crop)
- 2-inch-by-3-inch (5-by-8-cm) anchor stakes for ends of rows

Note that 60-inch (152-cm) rows require 18,000 feet of plastic sheeting per acre.

Irrigation and Frost Protection. All commercially grown cucumbers in coastal Southern California are produced using tunnel row covers and are currently drip irrigated. A small furrow is usually made near the drip line inside the tunnel to channel away excess moisture during rain. This small furrow helps prevent wash outs of tunnel sides.

Plastic row covers alone generally give little frost protection. When row covers are combined with drip irrigation, however, another level of protection is obtained. Running the drip irrigation system during cold weather releases heat in the tunnel and protects plants.

Floating Row Covers

Floating row covers are one-piece, loose-weave, bonded fabric without supporting hoops or stakes. They "float" or rest on top of the crop as it grows. Floating covers reduce labor costs for installation and venting by about 80 percent but do not provide the same level of temperature protection as tunnel row covers. Clear, plastic material generally provides more temperature protection (from 2° to 3°F [1.2° to 1.7°C] warmer) than bonded fabrics. With moderate weather and sunny days, there is little difference between bonded materials and clear, poly covers. If the weather is cool, however, clear plastic has the advantage.

Row cover materials vary in how well they transmit light and heat energy to the soil and maintain nighttime temperatures that are higher than the ambient temperature. All row covers increase daytime temperatures. However, bonded fabrics allow about 10 percent less light energy to reach the soil than clear, plastic covers. Polyethylene allows more heat radiation to escape at night than does polypropylene. Porous, bonded materials also transfer heat out of row covers by air mixing. This is probably why these materials appear to be less effective under windy conditions.

Cost of Row Covers

The cost of row covers varies depending on the efficiency of the installation crews, the type of material selected, and the price per pound of the material. The approximate cost for tunnel row covers, including labor, is $1,000 per acre ($405/ha) (1.5 mil, standard tunnel on 60-inch [152-cm] beds).

MULCHES

Soil mulches are commonly used to modify soil temperatures, control weeds, conserve water, protect fruit from soil moisture, protect plants from insects, and control erosion. The color and clarity of the mulch dictates how it affects soil temperatures. Table 2 shows the effects of different mulches on soil temperatures during night and day.

Table 2. Effects of Different Mulches on Soil Temperatures

Mulch color	Nighttime effect on soil	Daytime effect on soil
clear	warms	warms
black	warms	no effect
white	warms	cools
aluminum	warms	cools

In addition to affecting soil temperature, opaque mulches control weed growth. Black mulches become hot and may burn fruit that touches them during the day. Aluminum mulches are also used to disrupt aphid flights and decrease the chances of aphid-transmitted diseases. All mulches help conserve soil moisture and control soil erosion.

Cost of Mulch

The cost of mulches varies depending on the skill of installation crews, type of material selected, and price per pound of the material. The approximate cost for mulch, including labor, is $450 per acre ($182/ha) (1.5 mil, 4-ft [122-cm] wide plastic on 60-inch [152-cm] beds).

SOILS

Cucumbers are planted on a wide variety of soils. Lighter soils are usually selected for earlier maturing fields. Cucumbers are a deep-rooted crop that grows best on deep, fertile, well-drained soils. Very light soils that have excessive drainage and poor moisture-holding potential should be avoided. Cucumbers are fairly salt tolerant. Research has shown yield reduction of 10 percent starting at 3 dS/m (ECe in mmho/cm @ 25°C). Composted green waste or manure can be added to soils before planting to increase water-holding capacity and to supply nutrients to the crop.

IRRIGATION

Cucumbers require frequent irrigation during the growing period. Too little soil moisture, particularly when fruit is filling, can cause poorly shaped and curved cucumbers. Fields should be maintained at or near field capacity to avoid plant stress and to keep plants growing at a constant rate. The use of tensiometers to monitor soil moisture and leaching is recommended.

Table 3. Tensiometer readings vs. available soil moisture

	Tensiometer reading (cb) at		
	field capacity	20% depletion	40% depletion
sand	10–15	20–25	30–35
loam	15–20	25–30	35–40

FERTILIZING

Research indicates that fertilizer rates of 80 to 150 pounds per acre (90 to 168 kg/ha) of nitrogen, 50 to 200 pounds per acre (56 to 224 kg/ha) of phosphorous, and 0 to 200 pounds per acre (0 to 224 kg/ha) of potassium are adequate for maximum yields, depending on soil type and nutrient carryover. Slicing cucumber growers in Southern California typically apply 300 pounds per acre (336 kg/ha) or more of nitrogen and 150 pounds per acre (168 kg/ha) each of phosphorous and potassium through a drip system during the growing season. Growers generally apply approximately 60 pounds per acre (67 kg/ha) of nitrogen per month during periods of rapid growth and harvesting.

Growers should take annual soil samples to establish the nutrient status of their soils. This helps in determining the amount of nutrients that need to be applied during each cropping cycle. Growers should periodically perform tissue analyses during the season to evaluate the nutrient status of the plants in order to make effective corrections to the fertilization program over time. Accurate, timely, and usable information about soil properties, residual nutrients, and plant nutrition is essential to making fertilizer management decisions that will assure the highest yields and crop quality. A regular program of properly obtained and analyzed soil and plant tissue samples, and accurate record keeping on a field-by-field basis is necessary for effective fertilization program planning and control.

INTEGRATED PEST MANAGEMENT

Detailed information about IPM for cucumbers is available on the UC IPM website 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.

Disease Identification and Management

Damping-off (seedling mortality caused by *Phytophthora*, *Fusarium, Pythium,* or *Rhizoctonia* fungi) can be a problem in cool, moist soils. Proper irrigation and the prevention of plant stress can minimize these diseases.

Two major foliar diseases affecting cucumber are downy mildew *(Pseudoperonospora cubensis)* and powdery mildew *(Erysiphe cichoracearum, Sphaerotheca fuliginea)*. Infections of these diseases can be distinguished by the location of the symptoms. Downy mildew develops on the underside of the leaf, and powdery mildew develops on the topside of the leaf surface. It is important to use resistant varieties and preventive fungicide sprays, as well as maintain good weed control since powdery mildew also infects many weed species.

Angular leaf spot *(Pseudomonas syringae* pv. *lachrymans)* symptoms can appear as water-soaked lesions on the underside of leaves. Infected spots fall out, leaving angular holes. This disease is seedborne. Fungicide sprays are helpful at the first sign of angular leaf spot symptoms. Scab *(Cladosporium cucumerinum)* can infect leaves and fruit. On leaves, it begins as "water-soaked" spots that progress into angular or circular necrotic lesions. Affected fruit have large, sunken lesions with "watersoaked" margins. Scabs may ooze sap. Alternaria leaf spot *(Alternaria cucumerina)* can cause leaf and fruit spots. Target leaf spot *(Corynespora cassiicoloa)* also causes severe leaf spot on cucumbers. Affected fruit are unmarketable. Target leaf spot is more common in tropical and subtropical areas. A preventive fungicide spray program is required to control this disease.

There are several viruses that can infect cucumbers. Plants infected with the cucumber mosaic virus (CMV) do not produce much fruit. Many cucumber varieties are resistant to CMV, but they are not immune. Other common viruses that affect cucumbers are squash mosaic virus (SqMV), watermelon mosaic (WMVII), papaya ring spot (PRSV-W), zucchini yellow mosaic (ZYMV). SqMV is transmitted by cucumber beetles, and the others by several aphid species. Chemical control of viruses is difficult. Treating for insects may minimize in-field virus spread but does not stop the spread of virus diseases by migratory aphids. Maintaining healthy and vigorous plants seems to be the best strategy of control for these viral diseases.

Root knot nematodes *(Meloidogyne incognita)* are common to all cucurbits and many other crop species. Plants appear stunted and off color even though adequate nutrition is provided. When infected plants are pulled up, roots are found to be knotted and swollen with growths that may result in a matted root system in severe cases. Crop rotations with a nonsusceptible crop are important. Alternate plantings of a trap crop to limit nematode reproduction may be effective. Soil fumigation is also effective, but expensive.

Verticillium wilt *(Verticillium dahliae* and *V. albo-atrum)* is a vascular wilt disease that infects cucumber plants through the roots. Initial symptoms include leaf wilting and yellowing. Vascular tissue appears brownish in cross section. Plants eventually collapse. This fungus survives in infected fields for several years. Crop rotation, soil sterilization, and soil solarization are the only effective controls.

Fusarium wilt (*Fusarium oxysporum* f. sp. *cucumerinum*) is another serious soilborne problem in cucumber plantings. This disease may be expressed as damping-off of young seedlings or as rapid wilting and vine decline in mature plants as they encounter stress. A yellow or brown discoloration may occur in the water conducting tissue when the stem is cut in cross section. Race-specific resistance is widely available in commercial seed lines. Use disease resistant varieties. Fungus may survive in infected fields for many years and may be spread from field to field by farm equipment.

HARVESTING

Slicing cucumbers are hand harvested one to three times per week depending on weather and stage of growth. Pickling cucumbers are generally harvested more frequently, especially when production is for the smallest Gherkin type of pickling cucumber. The smallest Gherkins are harvested daily or every other day depending on the weather and stage of growth.

POSTHARVEST HANDLING

Cucumbers are inspected in the field for mechanical damage, disease, and cosmetic defects. Unmarketable cucumbers are pulled off the plants and left to be disced into the soil after harvest is completed. Marketable cucumbers are sorted by size and quality and packed in fiberboard cartons. Size classifications represent the number of cucumbers packed in the standard carton. Fruit is generally graded and sized in sheds and packed by counts of 30, 32, 36, 40, 42, or 46 per fiberboard carton. Box weights average about 25 to 30 pounds (11.4 to 13.6 kg). Yields of 2,000 to 3,000 cartons per acre (4,940 to 7,410 cartons/ha) (25 to 40 tons/acre [56,000 to 89,600 kg/ha]) in coastal Southern California are considered good. Yields of 3,000 to 4,000 cartons per acre (7,410 to 9,880 cartons/ha) (40 to 50 tons/acre [89,600 to 112,000 kg/ha]) have occasionally been achieved from spring fields.

Slicing cucumbers can be stored for 10 to 14 days at temperatures between 50° and 55°F (10° and 12.8°C) and 85 to 90 percent relative humidity. Cucumbers are sensitive to ethylene and should not be stored with other produce that generate ethylene.

MARKETING

Cucumber prices are high in the winter months when supplies are low. Mexico meets most of the U. S. demand during winter, and prices tend to drop in the summer months when U. S. production is highest. For more information about market price fluctuations, visit the University of Florida's Market Information System at http://mis.ifas.ufl.edu/~market/market.html.

FOR MORE INFORMATION

You'll find detailed information on many aspects of vegetable production in these titles and in other publications, slide sets, and videos from UC ANR:

Commercial Greenhouse Vegetable Handbook, Publication 21575

Harvesting Fruits and Vegetables, Video V86-AE

Honey Bee Pollination of Cantaloupe, Cucumber, and Watermelon, Publication 7224

Pests of the Garden and Small Farm: A Grower's Guide to Using Less Pesticide, 2nd Edition, Publication 3332

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