

WATERMELON PRODUCTION IN CALIFORNIA

AZIZ BAAMEUR, University of California Cooperative Extension Farm Advisor, Santa Clara County; **TIMOTHY K. HARTZ**, University of California Cooperative Extension Specialist, Department of Plant Sciences, University of California, Davis; **THOMAS TURINI**, University of California Cooperative Extension Farm Advisor, Fresno County; **ERIC NATWICK**, University of California Cooperative Extension Farm Advisor, Imperial County; **ETA TAKELE**, University of California Cooperative Extension Farm Advisor, Riverside County; **JOSE AGUIAR**, University of California Cooperative Extension Farm Advisor, Riverside County; **MARITA CANTWELL**, University of California Cooperative Extension Specialist, Department of Plant Sciences, University of California, Davis; **JAN MICKLER**, University of California Cooperative Extension Farm Advisor, Stanislaus County

PRODUCTION AREAS AND SEASONS

Watermelons (*Citrullus lanatus*) are produced in the northern Central Valley (Sacramento, San Joaquin, and Stanislaus Counties); Central Valley (Kern and Tulare Counties); and southern California deserts (Imperial and Riverside Counties). Statewide, watermelons are planted from December to early July for harvest from mid-May to late October. Yields reach 40 tons per acre (90 t/ha) under ideal conditions. Lower yields often reflect depressed watermelon prices as much of the crop is left in the field.

WATERMELON ACREAGE AND VALUE

Year	Acres	Average yield (ton/acre)	Gross value/acre (\$)
2005	14,000	24.5	5,439
2006	14,900	25.5	5,763
2007	13,400	25.5	5,763

Source: California Agricultural Statistics 2007 Crop Year-October 2008, NASS Web site, http://www.nass.usda.gov/Statistics_by_State/California/Publications/California_Ag_Statistics/index_casbutn.asp

VARIETIES

Seeded (Diploid) Varieties

Sangria and Fiesta are popular All-Sweet hybrids that are oblong and dark green with broken, light green stripes. The flesh is bright red with black seeds. Calsweet, the most popular open-pollinated variety,

has striped skin and red flesh. Also grown is the hybrid Royal Sweet, with striped skin and dark pink flesh. Sultan is an early-maturing, high-yielding hybrid. Icebox watermelon varieties grown in the northern San Joaquin Valley include Sugar Baby, Baby Doll, and Tiger Baby.

Seedless (Triploid) Varieties

Seedless varieties have in recent years accounted for the majority of the California watermelon acreage. Commonly used seedless varieties include Fandango, Super Cool, Nova, Laurel, Wonderland, Fire Cracker, Quality, Ultra Cool, Millionaire, AC 532, AC 5032, and AC 5244. Additionally, miniature seedless watermelon varieties, sometimes referred to as personalized watermelons, are now being commercially produced for grocery store sales. Popular miniature varieties include Precious Petite, Petite Perfection, Solitaire, and Extasy.

Triploid varieties are transplanted because of low seed vigor and high seed costs. Seed costs range from \$700 to \$1,200 per pound (\$1,540 to \$2,640 per kg), and each transplant costs from \$0.28 to \$0.35.

In each production field, up to 30 percent of the seedless watermelon planting is dedicated to seeded pollinator varieties such as Royal Sweet, Calsweet, Fandango, and Sangria. Fruit from the pollinators are sold as a separate product. However, in large-scale seedless watermelon production in low desert and San Joaquin Valley production areas, pollinators that do not produce a marketable fruit (Supper Pollinizer--SP-4, Patron, or Jenny) are used.



PLANTING

Seeded Watermelon

In large-scale production in desert areas of Southern California and in the San Joaquin Valley, few seeded varieties are currently grown. Watermelons are planted on flat beds 80 inches (2 m) wide and 8 to 12 inches (20 to 30 cm) high. In direct-seeded plantings, seed is placed 0.5 to 0.75 inches (1.2 to 1.9 cm) deep. After thinning and sidedressing, furrows are re-formed prior to furrow irrigation. For transplants, a single drip irrigation tape is laid 6 to 8 inches (15 to 20 cm) below the bed surface. Black plastic film, 72 inches (1.8 m) wide, is then laid flat on 80-inch (2-m) beds to heat the soil and reduce weeds. Seeds or transplants are then planted directly through the plastic. Transplants are set 24 to 36 inches (60 to 90 cm) apart. About 6 inches (15 cm) of the plastic is covered with soil at the edges to hold the mulch in place.

Seedless Watermelon

Common seedless watermelon planting configurations are one row of the seeded variety (pollinator) for every 2 to 3 rows of the seedless variety. However, other novel configurations are being used. The most popular is the mixing of seedless and pollinator varieties within the same row. In within-row plantings, the ratio of seedless to pollinator plants ranges from 2:1 to 5:1. As the seedless to pollinator ratio increases, the number of beehives should be increased to ensure pollination.

SOILS

Watermelons grow best on nonsaline sandy loam or silt loam soils. Light-textured fields warm up faster in the spring and are therefore favored for early production. Very sandy soils have limited water-holding capacity and must be carefully irrigated and fertilized to allow for high yield potential. Clay soils are generally avoided for watermelon culture, but they can be productive if irrigated with care to prevent prolonged saturation of the root zone (a condition that favors the development of root rot pathogens) and to allow good drainage between irrigations.

IRRIGATION

Although watermelon is a deep-rooted crop able that can tolerate a significant degree of soil moisture stress, peak production requires timely irrigation. After crop establishment (either by seed or transplant), irrigation may be withheld for a period of several weeks to encourage deep rooting. However, irrigation should be managed to minimize water stress throughout the fruit set and fruit sizing periods. Water stress during early fruit development can result in small, mis-

shapen fruit, and the occurrence of blossom end rot (a physiological disorder in which the blossom end of a fruit ceases to grow and becomes dark and leathery). As harvest approaches care must be taken to avoid large fluctuations in soil moisture content, as heavy irrigation (or rainfall) can result in fruit splitting.

In the past, watermelon was usually irrigated by the furrow method; irrigation was applied based on soil moisture status. In recent years, many growers have adopted drip irrigation. Drip irrigation lines are typically buried in the center of the soil beds. The irrigation system may be renovated each production season or left in place for a number of years, depending on the grower's management scheme and crop rotation. Drip irrigation scheduling is determined by potential evapotranspiration (ET_0) estimates and crop growth stage; frequency of irrigation can vary from once a week early in the season to daily during times of peak water demand. Some growers use drip irrigation lines placed in every other furrow after crop establishment. While this approach may not provide the full yield potential of a buried, in-row system, it does provide improved irrigation control compared with furrow irrigation, and the system is portable, which eliminates management issues associated with crop rotation. Regardless of irrigation technique, care must be taken to minimize wetting of the bed tops. Fruit in contact with moist soil may develop unsightly ground spots and fruit rots.

FERTILIZATION

Watermelon has moderate nutrient requirements compared with other vegetable crops, and due to its deep rooting it is efficient in extracting nutrients from the soil. A high-yield watermelon crop will typically contain less than 160 pounds per acre (180 kg/ha) of nitrogen (N) in its biomass, and, since most soils supply some nitrogen, the application of nitrogen beyond this amount is seldom warranted. Phosphorus (P) fertilizer requirement is a function of soil test phosphorus level and soil temperature at the time of planting. Soils with greater 20 PPM bicarbonate extractable phosphorus require little or no phosphorus fertilization. Soils below that level may require as much as 150 pounds per acre (168 kg/ha) of P_2O_5 , with phosphorus requirement increasing in colder soil and with lower soil test value. Soils with more than 120 PPM exchangeable potassium (K) can support high-yield watermelon production without fertilization, although a maintenance application of up to 150 pounds per acre (168 kg/ha) of K_2O can be used to maintain long-term soil fertility. Soils below 120 PPM exchangeable potassium should be fertilized with up to 150 pounds per acre of K_2O to ensure peak production.

P should be applied preplant. Potassium application can be made preplant, after planting, as a sid-

edress application, or delivered in irrigation water (fertilization). Nitrogen application is typically split between a small preplant and one or more in-season applications. In drip-irrigated culture, small weekly nitrogen fertigations may be used to time nitrogen delivery to crop uptake rate.

POLLINATION

One to two bee colonies per acre should be placed in the field when male flowers begin to appear. Poor pollination often causes misshapen fruit. A watermelon plant seldom produces more than 2 to 3 harvestable fruit. While it is too expensive to remove all excess fruit, misshapen and split fruit may be culled in the field to allow the plants to channel nutrients into marketable fruit. Care must be taken to prevent the bee colonies from being exposed to pesticides.

INTEGRATED PEST MANAGEMENT

For detailed information about integrated pest management for watermelons, see the UC IPM Pest Management Guidelines for Cucurbits Web site, <http://www.ipm.ucdavis.edu/PMG/selectnewpest.cucurbits.html>, or consult your local UCCE Farm Advisor. Herbicides, insecticides, and fungicides should always be used in compliance with label instructions.

Insect Identification and Control

Whiteflies, cutworms, beet armyworms, aphids, spider mites, darkling ground beetles, leafhoppers, cabbage loopers, and leafminers are the most serious insect pests of watermelon. Rind scarring from worm damage is a serious defect that reduces market value. The silverleaf whitefly, *Bemisia tabaci* Biotype B (also known as *B. argentifolii*) causes direct feeding damage to watermelon and fruit contamination via honeydew deposits that support growth of sooty molds. Silverleaf whitefly is also a vector of two viruses diseases (Cucurbit yellow stunting disorder and Cucurbit leaf crumple) that affect watermelon yield and quality.

Disease Identification and Management

Powdery mildew (*Podosphaera xanthii*) can rapidly cover leaves, causing reduced crop growth and premature defoliation. Subsequently, losses in fruit yield and quality (due to sunburn) may occur. Repeated fungicide applications are often necessary to avoid economic damage due to powdery mildew. Selection and rotation of effective fungicides is critical for controlling powdery mildew epidemics, especially in growing areas where fungicide resistance in the *P. xanthii* population has been reported.

Charcoal rot (*Macrophomina phaseolina*) and *Monosporascus* vine decline (*Monosporascus cannon-*

ballus) are soilborne diseases most often observed when temperatures are high and plants are stressed. Both diseases commonly occur in the desert, and they occasionally cause damage in the southern San Joaquin Valley. Death of crown leaves combined with gray stem lesions are symptoms associated with charcoal rot. *Monosporascus* vine decline may cause complete canopy collapse when fruit are 2 to 3 weeks from harvest. Structures diagnostic for *M. cannonballus* can be seen as small, black, round structures protruding from dead root tissue of affected plants.

In the northern San Joaquin Valley, *Verticillium* wilt (*Verticillium dahlia* and *V. alboatrum*) may be a problem. *Verticillium* wilt causes yellowing of the foliage and wilting. In severe cases whole plants may die.

Fusarium wilt (*Fusarium oxysporum* f. sp. *neveum*) Race 1 is present in many California soils. It typically affects runners on one side of the plant, but in advanced stages it may cause the entire plant to wilt. Watermelon varieties with resistance to *Fusarium* Race 1 are available but may be ineffective in soils with a high *Fusarium* Race 1 population. The reduction in canopy coverage that occurs in response to infection by soilborne pathogens exposes fruit to sunburn.

Cucumber mosaic virus (CMV), *Papaya ringspot virus* (PRSV-W), *Watermelon mosaic virus* (WMV), and *Zucchini yellow mosaic virus* (ZYMV) are aphid-transmitted viruses that cause leaf distortions and mosaics. Yield losses are most associated with mixed infections (2 or more viruses) and virus transmission at early stages of crop development.

Cucurbit yellow stunting disorder virus (CYSDV) is a whitefly-transmitted virus recently detected in Arizona and in the Imperial Valley, California. This virus causes severe yellowing of the leaves and is moved in symptomless watermelon transplants.

Sudden wilt is characterized by premature plant death that commonly occurs after fruit set. The precise cause is not well determined, but a complex of environmental conditions and pathogens including *Fusarium* spp., *Rhizoctonia* spp., and *Pythium* spp. may be implicated. Extreme waterlogging or drought conditions that reduce plant resistance can contribute to watermelon sudden wilt.

Physiological Disorders

Physiological disorders are caused by nonpathogenic agents that affect fruit quality. Usually, aesthetic quality is degraded. The cause can be either one or a combination of environmental, genetic, or nutritional factors.

Blossom-end rot (BER) is caused by uneven irrigation that leads to calcium (Ca) restriction. BER can be avoided by even irrigation and proper nitrogen and calcium management.

Misshapen or pear-shaped fruit can be caused by poor pollination that leads to restricted growth at the stem end due to the absence of developing seeds. Poor pollination can be minimized by increasing the number of beehives in the field. Cold temperatures can also cause misshapen fruit.

Hollow heart is marked by cracks in the heart of the watermelon fruit due to accelerated growth in response to ideal growing conditions facilitated by ample water and warm temperatures.

Cross stitches are elongated necrotic wounds (0.5 to 1.0 inch long) that are perpendicular to fruit length. The cause of cross stitches is unknown.

Sun scald (burn) results from exposure to intense solar radiation that leads to dehydration and overheating damage of the rind tissue. Sun scald can be alleviated by covering the fruit with vines or straw material.

Weed Management

Most growers use only mechanical cultivation and hand-hoeing for weed control in the low desert growing regions. However, herbicides are used in the northern San Joaquin Valley. Herbicides are applied with shallow incorporation, and transplants are placed with the roots below the treated zone. Postemergence herbicides are used to control grasses. Methyl bromide was commonly used in the past in field fumigations, but now metam sodium is used for preplant weed suppression.

HARVEST AND HANDLING

Watermelons do not slip from the vine or emit an odor when ripening, unlike muskmelons. Indicators for picking watermelons include color change (the most reliable), blossom end conditions, rind roughness, and drying of the nearest tendril to the fruit (less reliable). A sharp knife should be used to cut melons from the vines; melons pulled from the vine may crack open. Harvested fruit are windrowed to nearby roadways, often located 10 beds apart. A pitching crew follows the cutters and pitches the melons from hand to hand, then loads them in trucks to be transported to a shed. Melons should never be stacked on the blossom end, as excessive breakage may occur.

Loss of foliage covering the melons can increase sunburn. Exposed melons should be covered with vines, straw, or excelsior as they start to mature to prevent sunburn. Each time the field is harvested, the exposed melons must be re-covered. Most fields are picked at least twice. Some fields may be harvested a third or fourth time, depending upon field condition and market prices.

Seeded melons are sorted and packed in large, sturdy, tri-wall fiberboard containers. The melons are sorted according to grade: number 1, 14 to 26 pounds (6.4

to 11.8 kg), and number 2, 8 to 14 pounds (3.6 to 6.4 kg). Inferior melons may be sold at nearby markets; culls (discolored, misshapen, sugar-cracked, blossom-end rotten, and insect-damaged fruit) are discarded. Containers that hold 60 to 80 melons and weigh 1,100 to 1,200 pounds (500 to 545 kg) are shipped on flatbed trucks to terminal markets or wholesale receivers. The containers are covered to prevent sunburn in transit.

Seedless melons are sorted according to size and packed in cartons containing 3, 4, 5, 6, or 8 fruit. "Fours" and "fives" are preferred sizes; "sixes" and "eights" are common later in the season after the crown-set melons have been removed from the vine. The rough gross weight of a carton is 40 to 50 pounds (18 to 22.7 kg). Seedless melons may also be sold in large bulk containers.

Personal seedless watermelons are sorted by size and packed in single-layer boxes containing 6, 8, 9, or 11 fruit. Shipping boxes roughly weigh 34 pounds (15 kg) and arranged 50 boxes per pallet

POSTHARVEST HANDLING

Watermelons may lose crispness and color in prolonged storage. They should be held at 50° to 60°F (10° to 15°C) and 90 percent relative humidity. Sugar content does not change after harvest, but flavor may be improved due to loss in acidity of slightly immature melons. Chilling injury will occur after several days below 41°F (5°C). The resulting pits in the rind will be invaded by decay-causing organisms.

MARKETING

California produces approximately 330,000 tons (302 T) of watermelon per year (1.95 million for the United States, average of 2004–2006), grossing an average of \$72 million per year (\$367.3 for the United States) for the same period. Limited supplies of California watermelons are available beginning in May. Production peaks in August, and the season ends in November. Most California watermelons are marketed in the western United States and Canada. Major competition in the market comes from Mexico, Arizona, and Texas.

COST OF PRODUCTION

Costs of production of watermelon would vary depending on location. Costs such as water and land lease vary by the production area, and the amounts of inputs such as fertilizer, pesticide, etc. depend on weather and soil. Generally, watermelon production is labor intensive, especially in harvesting and postharvest handling. For more information, see *Sample Cost to Establish and Produce Watermelon, Imperial County, 2004*, at the UC Davis Agriculture and Resource Economics Web site, <http://ucce.ucdavis.edu/files/filelibrary/5600/42709.pdf>.

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FAX (510) 643-5470
E-mail: danrcs@ucdavis.edu

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