

GROWING AVOCADOS IN THE SAN JOAQUIN VALLEY



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The authors are James H. LaRue, Farm Advisor, Tulare County, Visalia; Ray D. Copeland, Superintendent, Lindcove Field Station, Exeter; and John Pehrson, Subtropical Horticulture Specialist, Lindcove Field Station.

COVER PHOTO

**Most San Joaquin Valley avocado plantings
are located in warm areas in or near the base
of the foothills.**

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GROWING AVOCADOS IN THE SAN JOAQUIN VALLEY

The avocado belongs to the laurel family, which includes cinnamon, camphor, and sassafras. Most cultivated species are native to Mexico and Central or South America; a few of today's commercial varieties were brought to California directly from their native areas, but most originated as chance seedlings from trees derived from original imports. There are three general types (races) of avocados: Mexican, Guatemalan, and West Indian. The large, old seedling trees growing in the San Joaquin Valley are either Mexican or Mexican hybrids.

The usually smooth, thin-skinned, green or black fruit from Mexican race trees ripens 5 to 8 months after blossoming in April. Flavor may be good, but in most cases the small-sized fruit has thin skin resulting in easy bruising and poor shipping quality. Because they also have a large seed, these fruits are usually undesirable for market. Mexican race trees have more cold resistance than trees of other races. When crushed, their leaves have a characteristic anise odor. Zutano and Susan are the principal Mexican race varieties in the San Joaquin Valley.

Trees of the Guatemalan race tend to bear larger fruit with thicker and rougher skin than those of the Mexican race. They are more susceptible to frost, and leaves of the cultivated varieties do not have an anise scent. The fruit ripens 14 to 17 months after blossoming. Hass is the major Guatemalan variety grown in southern California.

Tree and fruit characteristics of the West Indian race are similar to those of Guatemalans, but the fruit is generally lower in oil, and ripens 6 to 9 months after blossoming. Fruit and trees are more sensitive to frost than are Mexican and Guatemalan races. While only a few West Indian avocados grow in California and rarely produce any fruit, Florida's production comes principally from varieties of this race and from West Indian-Guatemalan hybrids.

Some apparent hybrids between races are recognized. The Fuerte, for example, is believed to be a Mexican-Guatemalan hybrid.

VARIETIES

More than 600 named varieties of avocados have been grown in California, but only a few proved satisfactory for commercial planting and many former leading varieties have been replaced by better varieties. Because of the frost hazard in the San Joaquin Valley, commercial avocado production is restricted to fall-maturing Mexican or Mexican hybrid groups. Many varieties other than Zutano and Susan are being evaluated at the University of California Lindcove Field Station near Exeter and in various avocado orchards in the Valley.

Zutano bears fruit 2 or 3 years after planting and is in full bearing in 6 to 7 years. A consistent annual producer, *Zutano* cannot withstand more than an hour or two at 25° F without sustaining considerable flower and bud damage. The smooth, pear-shaped fruit is light green in color, fair in quality and occasionally is susceptible to blossom-end breakdown and corkiness.

Susan, like *Zutano*, comes into bearing early. The dark green, pear-shaped fruit ripens about 2 weeks earlier than *Zutano*. *Susan* is more frost resistant than *Zutano*. Fruit quality is fair and trees tend to have an alternate bearing habit.

Bacon, Santana, Victor, Nowels and many other varieties have been commercially grown in the San Joaquin Valley but none seems better than *Zutano*. *Fuerte* is grown in a few "warm" hillside locations but is less frost resistant than *Zutano* or *Susan*.

The ideal variety for the San Joaquin Valley is yet to be discovered. Growers, plant breeders, and others seek an avocado variety that combines high fruit quality and good production with frost resistance and proper time of maturity. Until a better variety is found, *Zutano* and *Susan* appear best for Valley conditions.

CLIMATE REQUIREMENTS

Commercial avocado varieties presently grown in the San Joaquin Valley exhibit climate requirements

similar to lemons, but they tolerate less wind. Some plantings may be considered marginal because of occasional severe winter freezes. Trees should be confined to warm areas where normal low winter temperatures will not cause tree damage. Many tender varieties grown commercially in southern California have been killed outright or have frozen severely, even in the San Joaquin Valley's "warmer" citrus-growing locations. Damage to Mexican varieties is usually confined to some defoliation and killing of the previous season's shoot growth.

Flower buds overwinter in the tips of the previous season's growth which is tender and easily damaged by cold weather. Radiation frosts occasionally kill flower buds, resulting in a reduction of bloom and fruit.

High summer temperatures may cause some fruit to shed, but if trees are well supplied with water during this period the "June drop" is minimized.

SOIL REQUIREMENTS: LAND PREPARATION

Avocado trees are adapted to a wide range of soils and can be successfully grown on most soils in the warmer areas of the southeastern San Joaquin Valley. Good soil drainage is essential and there should be no hardpan or rock layer within 3 feet of the soil surface. Lime deposits reduce growth and cause chlorotic leaves. Where water remains on or close to the surface, avocado trees grow poorly and may eventually die.

Some soils in these areas contain much clay and are sloping and rough. To minimize land preparation and to ensure proper irrigation, sprinkler, drip, fogger or micro-jet systems are generally utilized. Avocado trees usually do not grow or produce well in the San Joaquin Valley when irrigated with furrows. Wherever possible, large rocks in drives or tree holes should be removed. Hardpan soils require ripping and leveling to improve water penetration and reduce runoff.

PROPAGATION

Growing good avocado nursery trees requires skill and experience. The advantages of growing your own trees should be weighed carefully against purchasing trees from a reliable nursery. Seed source for rootstock seedlings is important in growing avocado trees and should be from trees of the Mexican race. Seed should come from a disease-free source. (Both avocado root rot fungus [*Phytophthora cinnamomi*] and sun-blotch virus may be carried in the seed.) Good seed sources in California are from large, old Mexican seedlings. Seed from commercial Mexican race varieties (Zutano, for example) may also be used. Commercial nurseries have avocado root rot resistant rootstocks (such as G-6 and Duke 7) available.

Mexican race seed is harvested in the fall and stored until planted in March and April, the preferred planting time in the San Joaquin Valley. Seed may be stored dry at about 40° F. In a hothouse or hotbed, seed may be planted (base down) as soon as they mature, usually in November or December. More uniform



Newly planted avocado trees show burlap wraps provided for sunburn protection during the first summer. White latex paint on the trunk or cardboard cylinders are also used.

germination is promoted by cutting a thin slice off the tip of the seed.

When it is not possible to pick the fruit from the tree, it is advisable to heat-treat the seed to ensure freedom from fungus (*Phytophthora cinnamomi*) infection. This treatment requires immersing the seed in a hot water bath (120° to 125° F) for 30 minutes. It is important to use an accurate thermometer so that the fungus will be killed with no damage to the seed.

Most avocado trees propagated in California are container-grown tip grafts. Container-grown trees may be held for up to 18 months from seed before being planted in the orchard. Properly hardened, well-grown, older tip grafts are sturdy and able to withstand high summer temperatures the first year following field planting.

Field-grown nursery stock, although rarely grown, is handled similarly to citrus.

Established avocado trees of almost any size can be top-worked (grafted) in late March or April to change varieties. Seedlings are occasionally planted in the orchard and then grafted to a desired commercial variety. Saw-kerf (notch) or bark grafts are most commonly used. Follow-up care is important. Grafts should be rewaxed as often as necessary to keep the scions from drying out. Tree trunks should be whitewashed or painted with white latex paint to prevent sunburn. Scions should be shaded for sun protection and carefully staked and tied to prevent wind breakage.

PLANTING TREES

Zutano trees are tall and upright growing, but with early pruning they can be trained to a more spreading shape. On sandy loam, loam or decomposed granite soils, where trees can be expected to grow very large, Zutano trees should be planted no closer than 22x22 feet, no farther than 25x25 feet. Trees planted too close eventually crowd each other, and shading at the bottom portions of trees results in lower yields and higher picking costs because most fruit is produced at the tops of trees.

Young avocado trees should be planted as soon as danger of spring frost is past. Plant container-grown trees in holes dug only as deep as the container and about 8 inches wide. Remove the plastic cylinder or container from around the roots when planting. The top of the container soil should be level with ground

surface and the sides backfilled with topsoil and firmly tamped (not packed). Irrigate immediately after planting and as frequently as necessary to ensure adequate moisture to the roots and to eliminate air pockets. If emitters are used a basin is not necessary, but emitters should be operated immediately upon planting and continuously until the soil about the ball is thoroughly wet. Prolonged saturation should be avoided.

A safe rule is to put nothing into the tree hole except good topsoil. About 6 to 8 weeks after planting, 1 tablespoon of commercial fertilizer, well watered in, should supply enough nitrogen to the tree. Nitrogen can also be applied through the irrigation system.



A cardboard cylinder filled with chipped bark helps insulate young tree trunk against damage the first winter. The chipped bark is used as mulch around the tree the next growing season.

Cardboard cylinders placed around the trunks help prevent rodent damage and sunburning. Whitewashing or painting exposed tree trunks with white interior latex paint protect them from sun for the first year or two. Lightly spraying leaves at planting time helps protect them from sunburn.

Weeds around the base of the tree should be hoed or sprayed as frequently as necessary to prevent competition for moisture. Care must be taken to avoid weed spray damage to the trunk and foliage. A few pre-emergence herbicides are available for use around young avocado trees.

Before the first fall frost occurs, trees may be wrapped with insulating material for protection. Coarse sand or

other insulating material, such as chipped bark, may provide frost protection when placed around the trunk inside a 6- to 8-inch diameter tree wrap. It is important to protect the trunks of young trees. Even if exposed branches are killed, a tree may regrow the next season from sucker growth on the protected main stem.

CULTIVATION

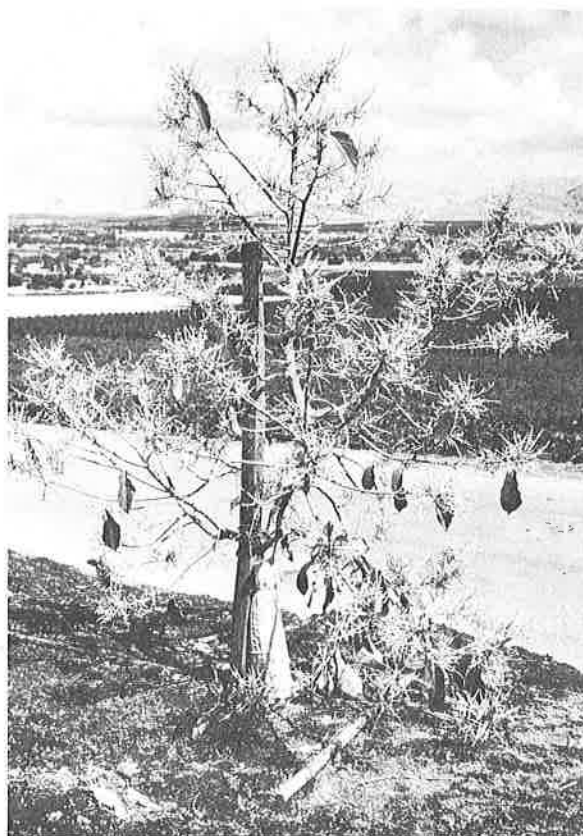
Most avocado orchards in the San Joaquin Valley are under nontillage. When trees shade the ground, cultivation for weed control is usually unnecessary. Avocado trees are shallow-rooted, and when properly fertilized and irrigated they should not be cultivated. Discing serves only to reduce the number of tree roots near the soil surface.

Each orchard location presents its own special problems of soil management. Because many hillside locations have limited soil depths, weed control by means of nontillage with recommended herbicides usually gives good results. Before trees shade the soil, row middles may be allowed to support volunteer weed growth for cover and where possible may be controlled by mowing. This helps control hillside erosion during periods of heavy rain.

IRRIGATION

Avocado trees require more frequent irrigation than citrus. Young trees, particularly those newly planted, need moist soil for vigorous growth. Soil kept adequately moist around young trees during hot summer months helps prevent sunburn and heat damage. This does not mean that the soil should be permitted to become saturated—wet soils are to be avoided.

Low-volume irrigation systems are widely used in San Joaquin Valley avocado orchards. For maximum usefulness, such systems must be designed to deliver enough water to provide adequate moisture in the tree root zone during periods of high water use. A mature tree may require 45 to 60 gallons per day in the heat of the summer. Drip emitters do not always provide avocado trees with enough water well distributed in the root system during periods of hot weather. Fogger and micro-jet (micro-sprinkler) systems provide water to the root system in a more uniform pattern resulting in better growth and fruit production under San Joaquin Valley conditions.



Young Zutano trees like this one frequently bloom so heavily that they defoliate. New leaves soon grow from the center of the bloom clusters.

FERTILIZATION

A grower may determine nitrogen (N) fertilizer requirements for his orchard by experimenting (using leaf analysis) with various rates, or by a combination of techniques. Late-summer leaf analysis shows that 1.6 to 2.0 percent N is the normal range for bearing trees. One pound of N per tree per year usually provides sufficient N for growth and fruiting of healthy bearing trees. Fall or winter is a good time to apply N to the soil. Split applications are advisable on sandy soils where leaching may occur. Frequent light applications during the growing season may be applied with a low-volume irrigation system.

It is easy and efficient to apply N to a young tree through a low-volume irrigation system. A small calculated amount is applied at various times in summer (amount and frequency depends upon soil type and tree size). The amount should be increased as tree size increases. Young trees are easily injured by excessive N applications. Leaf "burn" or defoliation and dieback may result, so rates should be carefully calculated.

Zinc deficiency commonly occurs in avocado trees. It is corrected by applying zinc sulfate or chelated Zn to the foliage as a spray by air or ground rig.

Iron deficiency (iron chlorosis) is common in some trees, especially those on calcareous soils. Yearly applications of iron chelate to such soils around the drip line of the tree, or through the low-volume irrigation system, may help correct iron deficiency. Excessive moisture in heavy soils aggravates iron chlorosis.

FROST PROTECTION

Young trees, which can be easily damaged by frost, must have adequate frost protection for their first 2 or 3 years. Older trees may also need the protection provided by wind machines. Water from irrigation systems may provide some heat release for radiation frost protection.

Adequate frost protection should be evaluated for each orchard location. Providing wind machines and heaters for an orchard rarely subjected to frost damage may cost more than the occasional "freeze year" tree injury and flower bud loss. On the other hand, trees planted in areas where radiation frosts are frequent and severe may require protection nearly every year during the winter months.



Both wind machines and orchard heaters may be used to protect foliage and dormant flower buds from winter freezes.

TRAINING AND PRUNING

Zutano and other upright-growing varieties require early training. Terminal shoots should be pinched to promote lateral growth. Such pinching is necessary beginning the second growing season and continues until the tree is properly shaped. This helps give the tree a better, stronger spread. If upright-growing avocado trees are not trained early, they tend to grow too high. After a few years about 2/3 of the crop is produced in the upper 1/2 of the tree. Often it is necessary to use both ladders or picking platforms and picking poles to harvest fruit from tall trees. By starting early in the life of the tree, pruning (selected annual topping) will help restrict the tree's height. Fruit will be produced closer to the ground and more evenly throughout the tree.

DISEASES

Avocado root rot. The most serious disease affecting avocados is caused by the fungus *Phytophthora cinnamomi*, which attacks small, fibrous roots, resulting in sparse foliage and pale green and drooping leaves. Branch dieback with eventual tree collapse occurs as the disease progresses. Although this fungus is not native to the U.S., it has spread into much of California—over the past 50 years the fungus has destroyed many thousands of acres of avocados in California and it continues to spread. It can be introduced into new areas by ornamental nursery stock grown in infected soil, as well as by commercial avocado trees and seeds from fruit that has lain on infected ground. Infection is widespread in San Joaquin Valley orchards. Once established, the fungus spreads by water and orchard traffic, and there is no known practical method of eliminating it from the soil. Trees should be purchased only from reputable nurseries that follow certification program procedures to minimize possible root rot infection.

Growers should restrict traffic entering orchards; field workers, farm advisors, pickers or others who have been in other avocado orchards must have clean, mud-free shoes. As an added precaution, they should step in a container of disinfectant to sterilize shoes. The same precautions apply to equipment—vehicles, ladders, boxes, bins, etc.; all should be free of mud before entering the orchard.

Sun-blotch. This virus disease is transmitted by budding, grafting, or through seed. Trees having the disease may be stunted with fruit yield and quality

greatly reduced. Green twigs on the infected tree may have yellow or whitish streaks. Green fruit has yellowish or white depressed markings or streaks. Black fruit has red depressed streaks. Some trees with sun-blotch show no symptoms and are known as symptomless carriers.

There is no cure for sun-blotch; the only method of prevention is careful selection of scion wood and seed. Trees with sun-blotch should be immediately destroyed; they cannot be top-worked to eliminate the virus.

Verticillium wilt. Trees of all ages may exhibit damage caused by this fungus disease. Sudden wilting of leaves on one branch or the whole tree indicates infection. As leaves turn brown, they may remain on the tree for several months and a characteristic dieback occurs from the terminal growth back to the branches or trunk. It is unwise to plant avocados on ground having previous history of Verticillium-susceptible crops (e.g., cotton or tomatoes).

PESTS

San Joaquin Valley avocados are relatively free of insect pests. The amorbia moth is widespread and may cause fruit and leaf damage. The Omnivorous looper may feed on leaves and sometimes on fruit, but rarely needs control. Diabrotica beetles are sometimes found chewing on foliage of young trees, especially those planted next to fields where grasses and weeds dry up in late spring.

Deer can damage orchards planted near foothills, and wire cages or fences to protect young trees may be necessary. Repellent sprays or noise-makers also help. As with many other tree crops, particularly those growing adjacent to open fields, rodent control is essential.

POLLINATION

Avocado varieties grown commercially in the San Joaquin Valley are self fruitful. Because of a peculiar flowering habit, avocado flowers cannot pollinate themselves but must rely on other flowers on the same tree or adjacent trees for pollination. Wind cannot fully be depended upon for pollen transport, thus bees

(1 to 2 hives per acre should be adequate) are the primary pollen carrier from flower to flower. Daily temperatures are usually adequate for good bee activity during bloom in April. There is no evidence to show that cross variety pollination increases fruit set. Variety alternate bearing often results in heavy orchard bearing one year with a light crop the next, particularly in the Susan. Other varieties (Bacon, for example) are light producers in the San Joaquin Valley, bearing a satisfactory crop only every few years. In most locations Zutano is a consistent annual bearer.

HARVESTING

Fruit is clipped from the tree close to the stem-end shoulder. Most pickers use citrus picking sacks which they carefully empty into bins. Ladders are commonly used to pick fruit higher in the tree—in very tall trees ladders and picking poles are used.

Avocado fruit must contain 8 percent oil by weight (or an equivalent on a dry weight test) before they are considered legally mature for shipping. Oil percentage does not change after fruit has been picked, therefore it is necessary to have several different-sized fruits tested before picking. After the fruit reaches 8 percent oil the oil content increases rapidly, but once the fruit is picked its oil content does not increase. Fruit of varieties grown commercially in the San Joaquin Valley does not always hold well on the tree after reaching legal maturity. Fruit must be watched carefully to see that it does not become overmature and soften or russet and crack on the blossom end.

MARKETING

For two decades the San Joaquin Valley's small volume of fall avocado production has found a ready market. Harvests have come at a time when the market is in short supply. With heavy planting of the Hass variety in mild coastal areas, and increased plantings of fall maturing varieties in the Riverside areas, it appears likely that the short-supply advantage will lessen. Hass can be held into the fall months near the coast. How well the market absorbs the increased volume of fruit from the vast new plantings in southern California, and what the effect of this increase will be on the San Joaquin Valley crop market, remain to be seen.