Growing Pistachios in New Mexico

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Public interest in pistachio cultivation has increased in New Mexico over the past five years. Pistachio nuts produced in the state seem to be of excellent quality, suggesting the crop may have a commercial future in southern New Mexico.

HISTORY

There are about 11 species of pistachio trees *(Pistacia* spp. L). *P. vera* is the only species grown commercially because it produces fruit of adequate size to be marketed. Species such as *P. atlantica, P. terebinthus* and *P. integerrima* are used as rootstocks for *P. vera.* The pistachio's origin is still uncertain, but most experts agree that it probably originated in Central Asia. Most pistachio production occurs in countries with arid climate. Turkey, Iran, Afghanistan, Italy, and Syria are the principal pistachio producing countries, outside the United States. Pistachio nuts are grown mainly for export in those countries. Trees are also grown in Pakistan, Greece, India, and Australia. The USDA Plant Introduction Department introduced the tree in California about 1904, but it was not promoted as a commercial crop in California until 1929. Several cultivars have been introduced throughout the years. Much of the research work was done at the USDA research station in Chico, CA. In the past 10 years, production and pistachio acreage has significantly increased in California. New Mexico growers are also getting interested, and some commercial orchards have been planted, mainly in Otero county. Small acreages are being planted in Luna, Doña Ana, and Eddy counties.

CLIMATE

Southern New Mexico counties are well suited for commercial growing of pistachio trees. Summer temperatures above 100°F are described as ideal. Pistachio trees thrive on heat; better nut filling and less blanks are produced in hot-weather climates. However, winters need to be cold enough to complete their dormancy (a rest period during winter). Three-leaflet leaves are produced instead of the normal five-leaflet leaves when cold requirements are not met. About 1,000 accumulated hours of temperatures at 45°F or below are required for pistachio trees to break dormancy, and to start normal growth in the spring. Trees should not be planted above 4,500 feet elevation because cool summer temperatures do not promote good kernel development. Also, temperatures below 10°F can kill the tree, especially young trees. *P. terebinthus* is more resistant to cold than *P. atlantica,* especially in those areas where cold weather drops below 15°F. *P. integerrima* is the most affected by cold weather. Pollination is carried out by wind only; therefore, mild winds during pollen shed would help. Pollination usually takes place in early to mid-April. Strong desiccating winds in spring may interfere with pollination and reduce crop set.

SOIL AND WATER REQUIREMENTS

Pistachio trees grow in virtually all soils. However, they grow better in deep, sandy loam soils. Tree density should be increased in poorer soils. This will permit maximum production earlier than in orchards planted with more space between trees, and in about the same time as those planted in good soils. Pistachio trees are long-lived, tap-rooted and can grow to 20-30 feet tall. Like any other fruit or nut tree, well-drained soils are needed for optimum growth. Hard pans in the subsoil should not be closer than 7 feet from the surface. About 2-acre feet of water are required in a mature orchard, including one or two deep irrigations during winter. Pistachios are drought tolerant, but for commercial crop production there must be adequate soil moisture during

late winter, spring and early summer. Critical stages during these times require not only good nutrition but good soil moisture. Within a month after pollination (mid-April to mid-May), pistachio trees will grow vegetatively and will form flowers for the following year. Nuts will be filled during July and first half of August. Depending on the season, the last irrigation is usually done the first or second half of August, and harvest starts in late August to early September. Pistachios do not tolerate wet feet. Avoid ponding water around the trees. Pistachio trees are highly tolerant to saline conditions. Trees grow well in some orchards irrigated with water containing 3,000-4,000 ppm of soluble salts.

POLLINATION

The pistachio is a dioecious tree, meaning male and female flowers are produced on separate trees. Insufficient pollen is a primary cause of crop failure. One male (pollinator) tree for 8 to 10 female trees (producer) is recommended. A good orchard layout will be to plant a pollinator in the middle of a nine-tree block throughout the entire orchard. Border rows on the upwind side should be planted with pollinators, too. Female flowers do not have nectar petals that could attract bees for insect pollination. Pollen transfer depends entirely on the wind.

COMMERCIAL VARIETIES AVAILABLE

All commercial varieties belong to *P. Vera* species. 'Kerman' is the only female tree recommended for commercial plantings. Most recent California plantings are of this variety. 'Kerman' is an open-pollinated seedling from seed collected at Rafsinjan near Kerman, Iran.

'Kerman' has higher chilling requirements than other varieties. It has a tendency to alternate bearing, although it has not been showing it yet in New Mexico. It produces an acceptable nut size for the market, but some blanks are produced (sometimes 25%) in every crop. Two other female varieties, 'Sfax' and 'Joley,' produce a greater number of split shells than 'Kerman'. They also have lower cold requirements than 'Kerman'. 'Sfax', trees produce fewer blanks than 'Kerman', do not go into alternate bearing and the fruit does not have physiological disorders. However, they produce smaller nuts than 'Kerman' trees. 'Sfax', may be better suited than 'Kerman' in areas with mild winters. 'Red Aleppo', another female variety, was thought to be promising, but its shell does not open well. In fact, to date, all three female varieties mentioned, other than 'Kerman', are not widely planted in California.

'Peters' is the main male variety available to pollinate 'Kerman'. It produces good quality pollen and sheds its pollen when 'Kerman's' female flowers are receptive. Pollination and fruit set usually take place in the first half of April in southern New Mexico. Pollen shed of 'Peters' trees sometimes does not pollinate some 'Kerman' flowers that become receptive later. Two USDA selections, '2-16' and '2-18', are male trees that release pollen from male flowers later than 'Peters' flowers, especially '2-18'. They can be used to complete the overlapping of pollen shed, covering the whole period of flower receptivity in the 'Kerman' trees. 'Chico', another male variety sheds pollen earlier than 'Peters'. It is recommended mainly to pollinate 'Sfax' and 'Red Aleppo' varieties; however, these varieties are not commercially planted.

ROOTSTOCKS

There are 11 species of genus *pistacia,* but only four species are widely used in the pistachio industry. 'Kerman' (female) and 'Peters' (male), which are*P. vera,* have been already mentioned. *P. atlantica* has traditionally been the rootstock of choice for 'Kerman' and 'Peters'. Several studies conducted throughout the years have indicate pistachio trees produce and grow better with *P. atlantica* rootstock than with *P. terebinthus,* another rootstock. Both of these rootstocks are nematode resistant. However, experience in New Mexico indicates that bud take on *P. terebinthus* tends to be more difficult than on *P. atlantica.*

In New Mexico, *P. terebinthus* rootstock has been more cold tolerant than *P. atlantica.* The former is a slow grower, but once established, grows as well or better than the latter. A disadvantage of *P. terebinthus* is that it has the tendency to start growing again in the fall, which could be a problem with early freezes, especially in years when trees do not go into dormancy early. *P. atlantica* not only has a greater percent take of buds, but trees will grow bigger than those of *P. terebinthus* and will produce earlier.

Pistachio orchards in California have been infested with the fungal disease verticillium wilt in the past 10 years, which affects the root system and kills the tree quickly. A new rootstock, *P. integerrima* is apparently resistant to both nematodes and verticillium wilt without affecting yields. Resistance to verticillium wilt is apparently related to the ability of the tree's root system to regenerate roots as fast as they are killed by the fungus. *P. integerrima* is marketed as Pioneer Gold. It may have a problem in New Mexico because it is not winter hardy and may be winter killed. A new cross between *P. integerrima* and *P. atlantica,* named Pioneer Gold II, seems to be equally resistant to verticillium wilt, but more cold tolerant than Pioneer Gold I. A new

cross between *P. integerrima* a and *P. lentiscus*, developed by the University of California and known as UCB1, is becoming popular among nurserymen. It is more vigorous than other rootstock and claims to be verticillium wilt resistant as well. Another rootstock, *P. Chinensis* is susceptible to cold winters (like *P. integerrima)* and is not as compatible with *P. vera* ('Kerman') as the other species mentioned. *P. mexicana* characteristics are not well known in commercial orchards.

SPACING AND PLANTING PROCEDURES

Tree spacing in New Mexico varies mostly from 17 feet by 17 feet to 20 feet by 20 feet (few growers have planted to 24 feet by 24 feet). It needs to be emphasized that trees planted in fertile soils need to have more space than those planted in poor soils. Some growers use the square system while others use the triangular planting system (also called hexagonal). Growers could also plant on a rectangular system. The triangular system allows planting about 15% more trees per acre while keeping the same spacing between trees. Planting filler (temporary) trees may be appealing to growers, in areas where agricultural land prices are high. This system allows growers to reach optimum yields per acre faster. However, planting costs are more expensive, and there is an additional cost when temporary trees are removed to prevent orchard crowding.

A good planting system seems to be spacing the trees 12 feet apart in rows spaced 24 feet apart. Pollinator trees are planted every third tree in every direction, always having two rows without pollinators (Fig. 10). This puts a pollinator in the center of a nine-tree rectangle, and growers can plant 150 trees per acre with- 16 pollinator trees. Pistachio trees grow slowly and removal of temporary trees (every other row) will not be needed for 15 to 20 years. After tree removal, final tree spacing will be 24 x 24 with 75 trees per acre, including 8 pollinator trees (Fig. 10). Pistachios do not tolerate crowding. Lower branches die out as soon as trees are being shaded. Yields go down because the photosynthetic area is reduced, which decreases the cropping surface of the canopy. Removing pistachio trees in alternate rows should be done as soon as lower branches start dying.

Preparing land to plant pistachio trees is similar to that followed for other fruit trees. Soil should be chiseled, plowed, and disked for the proper tilth. Whenever a hardpan or caliche layer exists in the top 7 feet, it should be broken because pistachio trees are deep rooted and are affected by waterlogging.

Pistachio trees form and regenerate roots slowly, and do not lend themselves to being handled bare-rooted. Most nurseries sell seedlings (rootstocks) in containers that can be planted directly into the ground. Rootstocks need to be budded with 'Kerman' and 'Peters' budwood to ensure the development of the desired variety (fruit and nut trees do not come-to-true from seed). It is a common practice to plant containerized seedlings in the spring and bud them in July or August with current year budwood. Budding is done when seedlings in the field reach the right thickness, (at least pencil width). Budded trees can also be planted but this practice triples tree cost.

Some growers may want to start their own seedlings from seed. This takes longer to get the right seedling size for final planting, but it reduces the cost of seedlings. Seeds need to be stratified to make them germinate. Stratification involves soaking the seeds for about 3 hours in cool water. Put seeds in a mixture of sand and peat moss and store in a refrigerator for 6 weeks at about 40°F. Stratification may not be needed for easy-to-germinate species like *P. atlantica.* Just wrap seeds in moist burlap and put them in a cool dark place until they germinate. Seeds should be inspected often because the seeds need to be planted soon after sprouting.

Germinated seeds should be transferred to peat pellets and placed in a well-lit location. Seedlings grown in peat pellets will be planted later in special paper pots or paper-mache containers, usually 7-8 inches in diameter and 18 inches long. Containers can be filled with sterilized soil or soil media containing 1/3 peat moss, 1/3 vermiculite and 1/3 perlite. It is important to keep peat pots and planted containers moist. Container-grown plants must be set out in the orchard when roots reach the bottom of the container.

PLANTING, BUDDING, TRAINING AND PRUNING YOUNG TREES

Non-budded trees are usually grown and sold in paper-mache containers. Containerized seedlings are meant to be planted in holes dug in the orchard without being disturbed. However, these containers do not break down fast enough in New Mexico soils, so trees need to be removed from containers before transplanting. Carefully remove rootball from container because barerooting will damage the seedling. Position the plant so the base of the tree is level with the ground. Trees should be planted about an inch deeper than the depth it was grown in the container. A single, upright seedling trunk, free of lateral shoots, should be developed in the first 18 inches of the seedling's trunk. All growth above those 18 inches is retained, allowing the rootstock to be nourished.

Established seedlings (3/8- to 1/2-inch in diameter) should be budded in the fall. Depending on planting time and seedling size, seedlings can be budded the same year they are planted or the following year. Experience has shown current-year budwood increases the

bud take dramatically. T-budding is the most common propagation method. Buds usually are placed on the windward side. Budding high in the rootstock leaves space for rebudding, if necessary. Seedlings (rootstocks) must be growing vigorously to get a good percentage of bud take. Ample, but not excessive, moisture before and after budding improves chances for a good bud take. This requires good irrigation practices to keep the soil moist. Buds can be forced into growth 2 to 3 weeks after insertion, either by heading back the top seedling to 2 inches above the bud or by ringing just above the budding section.

Training the bud shoot correctly during the first 5 years in tree's life will develop the desired tree shape, especially when mechanical harvesting is going to be done. Training normally starts the second year, when the bud starts growing. First, the tree is staked with a 1-1/2" x 1-1/2" x 5' stake. Drive the stakes about 6 inches into the ground, about 4 inches away from the young tree, preferably facing the bud and on the upwind side. As the bud shoot grows, it needs to be tied along the stake to develop a straight trunk.

Modified open vase. Two main pruning cuts are done to train pistachio trees: Pinching, which means eliminating only the terminal (end) bud of new shoots, and cutting or heading back, which involves cutting 1/3 to 1/2 of 1- or 2-year branches. In established trees, whole branches are eliminated with what are called thinning cuts. When the new shoot reaches about 4-1/2 to 5 feet, new shoots should be pinched in the summer to cause growth of lateral buds. If trees do not grow well for summer pruning, the trunk will be cut back during the first dormant pruning. A strong trunk needs to be developed for mechanical harvesting. The lowest scaffold (permanent) branch should be about 4 feet from ground level. The pistachio tree is trained to a modified open vase, with three to four healthy branches evenly distributed around the trunk, spaced about 8 inches apart vertically.

Selecting permanent branches is done during the second summer; temporary branches will be pinched at this time and eliminated during winter. If selected permanent (scaffold) branches are 30 to 36 inches long, pinching encourages lateral growth. If trees are not pruned during summer, selection and heading back of the primary scaffolds is done the second winter. Secondary branching is encouraged this way. During the third winter, select two vigorous laterals near the end of each permanent branch. Lateral branches should be well-spaced, filling the expanding fruiting area of the tree. Secondary branches should be headed back to about 30 to 36 inches. The same procedure is used during the fourth winter when two tertiary scaffolds will be selected and cut back about 30 to 36 inches. This pruning pattern is continued for a few years until the entire framework of the tree is established. Pistachio trees are trained to grow upward and outward, and develop into a modified open-vase shape. The center of the tree is kept open to admit sunlight for better flower formation and fruit set, which might be needed by the fourth or fifth winter. Secondary branches should be eliminated with thinning cuts.

Pistachio trees can sunburn in New Mexico if trees are trained to open vase-shape like in California. The high sunlight in New Mexico may force pistachio growers to limit thinning cuts of secondary branches to prevent sunburn in branches. It also protects trees more when branches are bent down by the weight of the foliage and the nuts. Pistachio trees will probably respond well to the central leader shape used to train pecan trees in New Mexico. This system is more suitable for mechanical harvesting than the open vase.

Only minor pruning cuts are needed once the tree framework has been established. It is necessary to know some facts about growing characteristics of pistachio trees to understand pruning recommendations for grown pistachio trees:

a) most deciduous trees produce at least one vegetative and one or two flower buds per node, but pistachio trees produce few vegetative buds in the shoots. They normally stay dormant and most, if not all, buds are flower buds;

b) pistachio trees have a strong apical dominance, meaning that shoots tend to grow from the terminal bud, and no laterals are produced unless the branch tip is removed (pinching or heading back);

c) trees produce flowers laterally on shoots;

d) tree branches spread more every year, and the fruiting area is located farther from the center every year.

The pistachio tree's growing patterns are better understood when some of its growing habits are compared to other trees. Its apical dominance is similar to pecan trees. Fruiting area grows away from the center every year like peach trees. Flower initiation occurs the previous year like apple trees.

When bearing pistachio trees are about 15 years old they begin to suffer from reduction of shoots and fruiting. A rejuvenation pruning is needed to maintain proper tree shape and to promote formation of new fruiting wood or scaffolds and branches. The pistachio does not respond to conventional pruning because the tree produces few lateral vegetative buds because of the apical dominance exerted by the terminal vegetative bud (the growing point in each shoot). Pruning efforts should be aimed at removing terminal buds by heading back branches, which eliminates apical dominance and stimu-

lates renewal growth from the scaffold branches. This type of pruning should be done in the winter before the off year of production to minimize yield loss. Tree size and vigor dictates the severity of heading back pruning cuts.

Severely pruned trees (cutting branches more than 1 inch in diameter) produce more and longer shoots the year after pruning. However, it takes about 4 years for severely pruned trees to out-yield the unpruned trees. Because pruning stimulates new fruit wood, a bearing and mature pistachio tree must be pruned every 3 to 4 years, even if it takes a few years for the pruned tree to out-yield the unpruned tree.

TREE NUTRITION

Nutritional requirements for pistachio trees have not yet been determined. However, nitrogen needs should be similar to other nut trees grown in New Mexico. Do not apply nitrogen fertilizer the year trees are planted. Apply one pound of ammonium sulfate per tree during the second year. Split the rate in two parts, applying half a pound in March and half a pound in June. During the third year, and if trees are actively growing, apply 1 pound of ammonium sulfate in March and 1 pound of ammonium sulfate in June. In subsequent years apply 1/10 to 1/20 of a pound of actual nitrogen (1/2 to 1 lb. of ammonium sulfate) per inch of trunk diameter. The rate for New Mexico orchards (apples and pecans), has been between 100 and 150 lbs. of actual nitrogen per acre. It is important to point out that research conducted in other areas of the country still has not defined the nitrogen needs for pistachio trees. Applications from 0 to 500 lbs. of nitrogen per acre on mature trees and from 0 to 300 lbs. of nitrogen per acre on young trees did not show any difference in growth or yield.

Nitrogen fertilizer should be broadcast and split in two rates; apply half before the first irrigation and the second half in June. Never apply nitrogen after June to prevent vigorous growth that may delay tree dormancy. Trees can be affected by early freezes if they are not fully dormant.

Applying potassium has not produced any results to fruit and nut orchards in the Southwest. Heavy (clayey) soils contain enough potassium to grow trees. However, pistachio trees are usually grown in sandy to sandy loam soils, which need potassium to ensure adequate tree growth. Although, research has not been done to learn the best recommended rates, incorporating 150 to 200 lbs of actual potassium, before planting trees, will help tree-growing conditions for many years. In established orchards, 2–4 lbs of potassium chloride per tree has helped unthrifty trees grow better. Good results have also been obtained when potassium chloride at 12% has been injected through fertilizer shanks or through the drip irrigation system.

Phosphorus applications are not widely recommended because superphosphate, the most common phosphorus fertilizer, is highly insoluble and does not travel down the soil profile. Incorporating 150-200 lbs. of superphosphate into the soil before planting will make it available to the root system for several years. Phosphoric acid (75%), at the rate of 2.5 lbs of actual phosphorus per tree, has been applied through drip irrigation systems in established pistachio orchards with excellent results. For established orchards without drip irrigation, apply monoammonium phosphate (MAP) at the rate of 100 lbs per acre. This fertilizer is more soluble and travels through the soil profile, and is available for the root system. MAP has proven to be a valuable tool in orchards grown in other areas of the country.

Good nutrition levels in pistachio orchards are a must. Besides nitrogen, good potassium and phosphorus levels not only increase yields, but also reduce potential infection by verticillium wilt.

Pistachio trees need to be sprayed with minor elements, about three to four applications per year, one application a month from April to July. Emphasis should be given to boron, copper and zinc, especially boron. Crinkle leaf symptom is usually linked to boron deficiency and is becoming common in pistachio orchards. Some growers apply all these minor elements through drip irrigation. Leaf analysis should be done every year to know how efficient the fertilizer program is in a given orchard. Leaflets (not whole compound leaves) should be sampled for leaf analysis every year during August, about a month before harvest. Non-bearing branches should be sampled to eliminate the effect of variable crop level or mineral-element composition. Pistachio tree behavior should be observed year round so the grower knows the nutritional needs of trees. Leaf analysis, yields, nut quality, and shoot growth (2 to 2-1/2 feet per year) are some of the factors growers need to observe every year.

To get full value of leaf analyses, they should be done every year. There are also some optimum nutritional ranges to look for when conducting leaf analyses in pistachio orchards (Table 1).

HARVEST

Pistachio trees begin bearing the fourth or fifth year after budding. However, a significant crop is not harvested until the seventh or eighth season, with the first full production year occurring around year 12. Pistachio nuts are physiologically mature when the hull separates easily from the shell. Harvesting before or after that critical point results in undeveloped kernels or in stained

Table 1. Nutritional ranges usually found in leaf analyses from pistachio trees.

Element	Range over which normal growth with healthy leaves occurred		
	Percent of dry weight		
Nitrogen N)	25	-	29
Phosphorus (P)	0.14	-	0.17
Potassium (K)	1.0	-	20
Calcium (Ca)	1.3	-	4.0
Magnesium (Mg)	0.6	-	1.2
Sodium (Na)	0.002	-	0.007
Chloride (Cl)	0.1	-	0.3
	ppm		
Manganese (Mn)	30	-	80
Boron (B)	55	-	230
Zinc (Zn)	7	-	14

From *Pistachio Production,* University of California Leaflet 2279.

shells, respectively. There are 7 to 10 days when harvesting can be done without shell-staining occurring. Shell staining increases the longer the nuts stay on the tree. However, stained shells usually result when the hull is not removed the same day of harvest. Staining occurs from tannins in the hull. Production of blanks (seedless fruit) is a problem occurring in *P. vera*. 'Kerman' trees sometimes produce 25%. Seed abortion, or fruit pollinated but not fertilized (low fruit set), have been blamed for this physiological problem. Sometimes nuts grow to normal size without seed. This situation, not associated with tree yield, varies from year to year, from variety to variety and from rootstock to rootstock. Depending upon planting distance and orchard management practices, yields in pistachio orchards could average 2,000 to 3,000 pounds per acre.

Most harvesting in established pistachio orchards is done mechanically. Pistachio trees are shaken like pecan trees to harvest pistachio nuts. That is why it is so important to train the trees properly when trees are being pruned in the early years.

Right after harvest, the pistachio crop needs to be hulled (removing shucks), dried, sorted out, salted, and roasted before getting it into the marketing channels. Salted pistachios do not need to be stored under refrigeration unless they are to be kept in storage for extended periods of times. They must, however, be brittle dry (about 5% moisture) before storage.

BIENNIAL BEARING

After an indefinite number of years, pistachios trees, ultimately produce relative heavy crops of nuts every other year. They are typically biennial or alternate bearers. During the year of heavy crop, abundant flowers buds are produced, but an excessive bud abscision occurs, leading to lower crops the following year. Vegetative growth is most extensive during the year a heavy crop is produced.

DISEASES

Verticillium wilt (*Verticillum dahliae)* has been affecting pistachio orchards in California for years. It was noticed during the 1975-80 period on 5- to 10-year old trees. Several thousand trees have died or have developed symptoms since then. This disease affected both *P. atlantica* and *P. terebinthus* rootstocks. The rootstock *P. integerrima* has been recognized as verticillium wilt tolerant, and has been used for planting several thousand acres of pistachios in California.

Symptoms are manifested as light to rapid wilting, and symptoms may be followed by death. V. wilt is a soil-borne fungus disease. It survives in the soil through multicelled structures called microesclerotia. Microescelerotia are carried in the soil water, farm equipment, and by wind,. After they germinate in the soil and get inside the roots, the mycelium moves to the xylem and spreads. The fungus blocks movement of water and nutrients by occlusion of the tree's vascular system. Toxins may also occur in the vascular system, contributing to the irregular brown discoloration in the trunk and branches.

When rapid wilting occurs, a pistachio tree can die in 1 or 2 weeks. In light wilting, the part of the tree above the point of the vascular infection can die during the season, and the rest of the tree will survive for several years in a weak stage. A cross-section of a severely affected pistachio tree will show rings of brown dots, consisting of discolored vascular tissues. Each affected tree will have a different pattern of discoloration, which is related to the severity of the infection, explaining why some trees die rapidly and others maintain weak growth.

The most recommended way to prevent verticillium wilt is to avoid planting pistachio trees wherever cotton has been planted, and to use verticillium wilt resistant rootstock. Fumigating soil with methyl bromide and chloropicrin before planting helps, but is expensive. In established orchards, replant sites were fumigated by injecting the material 30 inches below ground, but verticillium reappeared 3 years later. Fumigation also controlled verticillium in a 4-foot radius around the fumigation injection, but the roots growing into untreated soil outside the circle picked up the disease again in 3 years.

A technique developed in Israel, called solarization, has been used to control V. wilt in established orchards. Solarization involves laying plastic sheeting on the soil to heat it up and cook out the verticillium. A complete plastic covering is necessary, edges must be sealed and

snugged up around the trunks. The plastic is laid after a deep irrigation and stays in place for about 4 weeks. Solar heating kills the verticillium wilt down to about 48 inches and no heat damage to the root system has been reported. The cost of solarization, around $1,000 per acre, is high, but may prove to be economical in saving established orchards infected with verticillium wilt.

Verticillium wilt has not been much of a problem in California pistachio orchards planted in virgin soils. New Mexico orchards have not been severely affected with it because most of them have been planted in virgin soils.

Cotton root rot

Cotton root rot[1] *(Phymatotrichum omnivorum)* is not widely present in California crops much less in pistachio orchards. However, in New Mexico, it affects a number of crops, including pecans and grapes, which have not been affected in California. It is believed this disease may impair establishing pistachio trees in New Mexico as an alternate crop. No rootstocks are known to be resistant to this fungus. However, in New Mexico, most established pistachio orchards, with the exception of the Deming area, have not been affected by the disease.

P. omnivorum is indigenous to the Southwest and northern Mexico. It persists indefinitely, deep in soil. Native vegetation of the deserts and plains of the southwestern United States and northern Mexico harbor the fungus, often with no symptoms. The first symptom in trees is a slight yellowing or bronzing of leaves. The uppermost leaves wilt within 2 days after bronzing, followed by wilting of lower leaves a day or two later. Permanent wilt occurs later, followed by death of the tree. A sure symptom of trees killed by *P. omnivorum* infection is that leaves remain firmly attached. Susceptible trees often die so suddenly their leaves may retain much of their green color, though dry and brittle.

First symptoms usually appear in July when air and soil temperatures are high. It is common for one to several branches on one side of the tree to wilt and die when only a few roots on that side of the tree are infested.

Significant control of *P. omnivorum* is possible by using various crops as green manure amendments in infested soils. This stimulates new plant and root growth, and helps proliferation of competitive microflora.

Using fungicides and fumigants to control this fungus has not been successful because it is difficult to get these chemicals deep enough in the soil, over a large acreage, on an economically feasible basis. P.*omnivorum* is usually found 2 to 6 feet deep, but may be found below 12 feet on deep-rooted trees. This complicates soil application of available fumigants and fungicides with sufficient volatility and residual effects to control or eradicate the fungus. However, researchers are working with new fungicides that seem to have residual properties, which may reduce orchard losses.

There is a treatment for infected trees and for replant sites where the value of individual trees makes its use practical. It consists of loosening a broad, comparatively shallow basin around the infected plant to a radius equal to or beyond the drip line. The entire area is covered with steer manure or similar organic matter to a depth of 2 inches. Ammonium sulfate and sulfur, each at a rate of 1 lb/10 sq ft are scattered over the manure. The basin is flooded with enough water to soak the soil to a depth of 3 feet This high moisture level must be maintained for several weeks. When trees have shown severe wilting, it is also recommended to prune about one-half the top growth. Recovery may take one or two seasons.

Chemical or plant barriers can also be used to prevent the spread of *P. omnivorum.* Several graminaceous crops, including sorghum and corn, are effective as barriers to the spread of this disease. Using sulfur or calcium chlorate in trenches 4 to 6 inches wide and 4 to 6 feet deep have successfully prevented the spread of *P. omnivorum* for 7 years. As it is the case in V. wilt, it is better to plant in virgin soils than on land previously farmed for cotton. Cotton root rot infestation will be delayed and the tree's root system can be established, allowing the tree to be less affected by the disease.

Crown rot

Crown rot *(phytophtora parasitica)* attacks pistachio trees situated in poorly drained wet areas. Surviving infected trees do not grow well.

INSECTS

Besides the stinkbug and leaf-footed plant bug, no other insect problems have been reported yet in New Mexico pistachio orchards. The navel orange worm (*Amyelois transitella)* is considered the pistachio's major insect problem in California. Females lay their eggs in fruit skin cracks, and the larvae consume the kernels. Early harvest, and an application of insecticides late in the season will reduce damage from this pest to a minimum.

Mites also damage pistachio nuts by producing scar-like blotches on stems and hulls. The citrus-flat mite *(Brevipalpus lewisi)* has been identified as the mite

1 All infornation dealing with cotton root rot *(Phymatotrichum omnivorum*) has been taken from *Phymatotrichum Root Rot Monograph No. 8.* published by the Ametican Phytopathological Society and writen by R.B. Streets and H.E. Bloss from the University of Arizona. Dr. Bloss also revised this portion.

affecting pistachio orchards in California. It could be present in New Mexico because it also affects grapes and several ornamentals.

EPICARP LESION

Researchers are trying to learn the cause of this problem. No bacterium or fungus has been isolated from affected nuts. Lately, however, evidence has been found that the leaf-footed plant bug is the culprit (and probably the stinkbug too). It is much more severe in 'Kerman' than in other cultivars. Lesion development involves the inner layer of the hull, the shell and the kernel's skin. Brown to almost black pea-size spots appear on the nuts. Browning can eventually cover half of the nut's exterior surface. Darkening of the hull sometimes occurs, but most often appears on the shell. In some cases, the exterior of the nut appears normal, but darkening of the shell may occur. Symptoms appear about a month before the hull separates from the shell. Nuts affected early in the season will shrivel and drop from the tree. Those affected later may stay on the tree, but kernel development is poor and shells are incompletely developed and discolored. Spraying to control the leaf-footed plant bug and stinkbug needs to start in May to prevent early infestations.

PISTACHIO USE

Pistachios are served principally as salted nuts. A large percentage of pistachios are marketed in the shell for snack food. Non-split, filled nuts are used for processing. Whole, cull pistachio nuts appear to be acceptable to cattle and sheep as part of their feed rations.

The food industry uses pistachios for cakes, biscuits, pies, candies, and ice cream. They are also used as stuffing for both meat and snacks. Pistachio nuts contain 25% amino acids (mainly essential amino acids), 16% carbohydrates (mainly sucrose) and 55% oil (80% unsaturated oil). Pistachios are also an excellent source of dietary fiber, containing 2.8 grams of fiber per ounce.

ADDITIONAL READING REFERENCES

Ashworth, Lee J. Jr., D. P. Morgan and E. Surber. 1986. Verticillium Wilt of Pistachio. California Agriculture. July-August pp. 21-24.

Ashworth, Lee J. Jr., D. P. Morgan, S. A Gaona and A. H. Mclain. 1982. Polyethylene tarping Controls Verticillium wilt in Pistachios. California Agriculture. May-June pp. 17-18.

Grassberger, R. E., Jr., W. D. Gorman, W. Capener, G. A. Welsh, R. E. Lansford, andE. Herrera. 1987. Economic Feasibility Assessment of Growing Pistachios in Southern New Mexico. New Mexico State University. Agr. Expt. Sta. Research Report 605.

Maranto, J. 1988. Replant early to overcome verticillium in Pistachios. Nut Grower. April pp. 1415.

Maranto J. and J. C. Crane. 1982. Pistachio Production, Leaflet 2279: Division of Agricultural Sciences, University of California.

Streets, R. B. and H. F. Bloss. 1973. Phymatotrichum Root Rot. Monograph No. 8. American Phytopathological Society.

Figs. 1 and 2. Pistachio seedlings.

Fig. 3. Young 'Kerman' tree.

Fig. 4. Dead pistachio tree due to cotton root rot. (Dead leaves do not fall from the tree.)

Fig. 5. Pistachio orchard, ‘Peters’ variety in the left row, ‘Kerman’ in the right row.

Fig. 6. Flower from ‘Peters’ (male) variety.

Fig. 7. Flower from ‘Kerman’ (female) variety.

Fig. 8. Pistachio nuts during the season.

Fig. 9. Pistachio nuts before harvest.

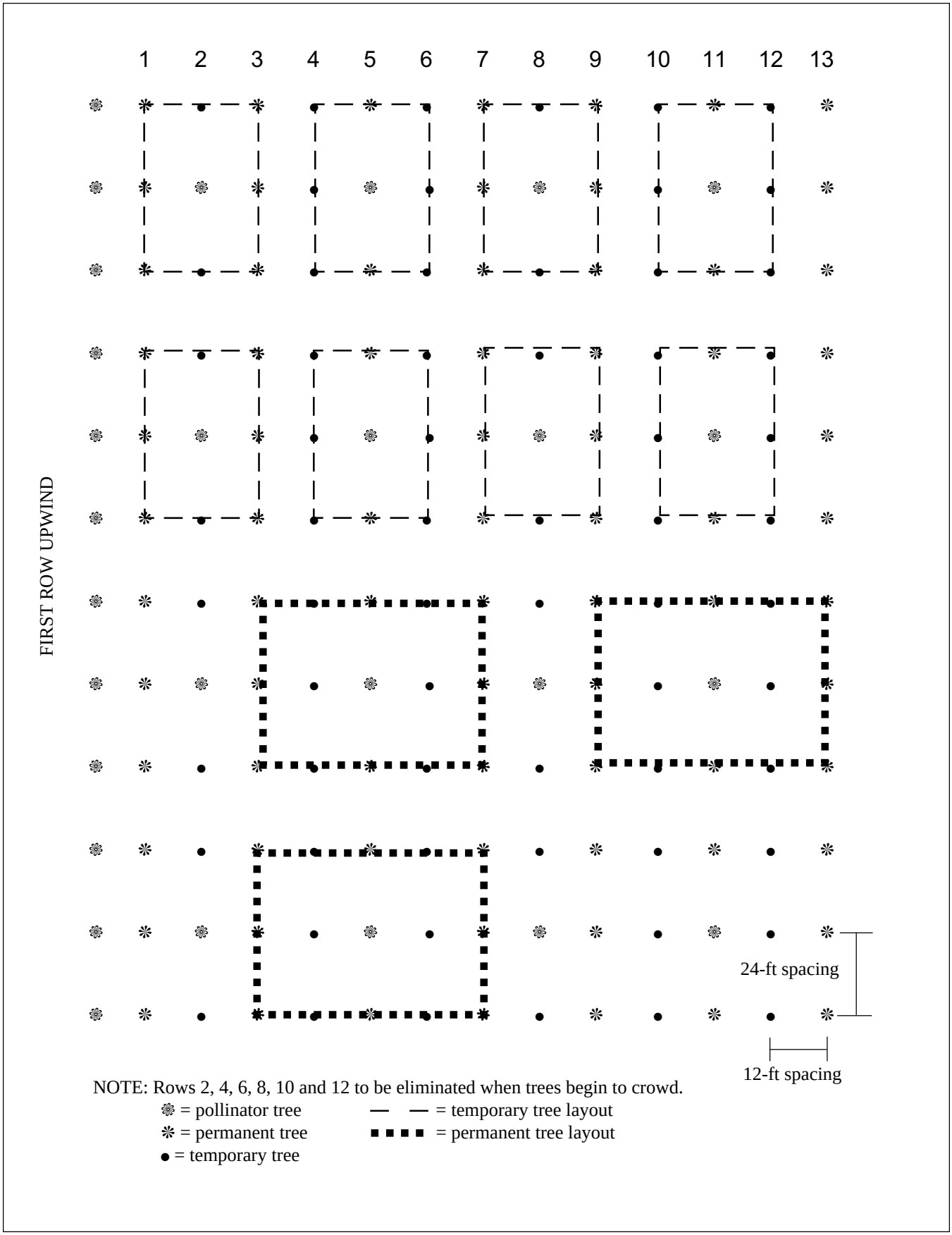

Fig. 10. Temporary and final tree spacing in pistachio orchards.

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