WALNUTS

Walnut Production in Yolo and Solano Counties of California

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Forward:

This production manual was written to provide a concise guide for Walnut farmers within Yolo and Solano counties and to provide a text for the Yolo/Solano Walnut Mini Course held November 27, 2001. Some practices reported are unique to this area of the Sacramento Valley.

I have tried to present information that applies to local growing conditions. The principles and ideas conveyed are gained from over 30 years of experience in working and conducting research on Walnuts.

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For more information, readers may request the University of California, Division of Agriculture, Walnut Production Manual #3373 from their local Cooperative Extension Office.

Cover: Photos by Wilbur Reil

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Walnuts can grow on a wide variety of soils, although they do best on deep soils that are well drained. Generally they grow best on sandy loam, loam or clay loam soils. Very heavy clay soils and clay soils that are not well drained are considered poor soils for walnuts. Walnut roots extend down to five or six feet and need this depth of soil with good drainage for proper growth.

In preparing land for planting to walnuts, the land needs to be level enough to eliminate any of the low areas where water can accumulate. The land should be either ripped or if structural differences occur within the soil, should be slip plowed or each individual planting site backhoed. Soil structural differences, especially if the soil structure is layered with sand stratas or with heavy clay stratas at different depths, will restrict root and water movement through the root zone. Roots require both water and oxygen for proper growth, therefore we want loose friable soil extending throughout the root zone so there is movement of water and oxygen. It is also necessary for the roots to grow throughout a large area to provide anchorage for the tree.

Land that has been previously planted to trees may require fumigation. Root samples can be taken to determine nematode counts, but it is very difficult to take samples for phytophthora or oak root fungus. Past experience, evaluation of the trees and tree losses that have occurred previously are better indications in evaluating whether you have Armillaria or phytophthora problems within the soil. Soils that have not been planted to trees for a long time generally do not need to be fumigated in Yolo or Solano counties.

Trees are planted either at the same depth they grew in the nursery or in some cases are planted on mounds, ridges or berms. On heavy soils that are not well drained, planting the trees on berms or mounds allow for more water drainage away from the trunk of the tree. This allows better drainage and aeration and better growth of the trees. If water accumulates around the tree trunk, the tree can die, whereas when the trees are planted on mounds or berms, the same tree will live and grow well. Berms or mounds need to be created at the time of planting or before planting. Proper soil preparation should be done the year preceding planting. If all farm work is accomplished when the soil is dry the preceding year, planting can occur in the winter or early spring. Soil preparation in the winter is difficult because of winter rains and wet soils. Waiting until early spring to do soil preparation can delay planting into late spring. Poor tree growth occurs from a short season if plantings are delayed past tree ideal planting time.

ROOTSTOCKS

There are currently three rootstocks used for planting walnut orchards. All trees or almost all horticultural trees have a rootstock and then the desired variety grafted on top. Rootstocks provide anchorage, water adsorption and disease resistance. The variety that is grafted on top then does not have to have good root characteristics but can be selected for superior nut qualities. The rootstocks currently being used are Northern California black walnut, Paradox; which is a hybrid rootstock crossed between Northern California black walnut and English; and English. Each rootstock has certain positive attributes and some disadvantages.

The Northern California black is easily obtained; it is one that has good deep anchorage, especially in excellent soils. It does not grow well on waterlogged heavy soils. The Paradox is better in those situations. The Northern California black walnut does not get serious crown gall problems and it is better in high boron areas.

Paradox rootstock will be much better in wetter areas and in heavy clay soils. All varieties are compatible and produce well on Paradox rootstock. Two problems that Paradox has are it shows more symptoms of boron toxicity and it gets crown gall severely. In some cases crown gall has become a major problem on Paradox rootstock.

English is a third rootstock. It is not as precocious as the other two rootstocks nor is it as good on heavier wet soils. It gets severe crown gall and is not as good in most situations as the other two rootstocks. English will tolerate blackline disease whereas trees are killed on both Northern California black and Paradox. With increased Blackline disease in the county, English rootstock maybe needed in some orchards in the areas of high Blackline disease.

VARIETIES

Currently there are five varieties that are being planted plus two varieties that are used as pollenizers. These varieties are Chandler, Howard, Tulare, Hartley and in a few cases Vina. Scharsch Franquette is used to pollinate Hartley and sometimes Chandler. Cisco is used to pollinate Chandler and Howard. Chandler has been the principle variety that has been planted for the last fifteen to twenty years. It is an excellent variety with very light colored kernels. The variety cracks very easily into halves. The variety blooms late in the spring so it avoids walnut blight problems caused by early rains. It avoids the early part of the codling moth flight. Chandler harvests late. We have never lost a crop because of early fall rains preventing harvest, in the last ten to fifteen years. There is a potential that some year we may get a rainy wet season and some of the crop could be lost.

More recently Howard is being planted more. Howard blooms almost as late as Chandler so it avoids walnut blight and codling moth problems. It is an excellent quality nut, with kernels as light colored as Chandler. It does not break in halves as easily as Chandler. It harvests about ten days before Chandler, which means that all the Howard harvest can take place before Chandler. It is a very small tree that needs to be planted much closer together than Chandler.

The Tulare variety is a recent University of California release. We do not have as much experience with this variety. It is a fairly large tree, which grows vigorously. It harvests about the same time as Howard. The tree size is much bigger than Howard. The tree tends to grow very upright. Yield potential appears to be heavy. Nut quality is slightly less than Chandler and Howard but is much better than most other varieties. Trees bloom the same time as Howard, which is quite late in the season, avoiding most blight and codling moth problems. Harvest occurs about mid-season with Howard.

The fourth variety mentioned is Hartley. It is an old variety. It is a terminal bearer, while all the others listed are lateral bearers. This mean that it normally will not bear on shoots rising from lateral dormant buds but only on terminal buds. It is slower in coming into production after planting. Hartley is a large tree when it matures. The bloom usually occurs mid-season the same time or slightly ahead of Howard and Tulare. It has very little codling moth or blight problems. Harvest is also mid-season, a few days after Howard or Tulare.

Vina has been extensively planted but is not usually planted today. Vina blooms earlier than the other four varieties and therefore is more subject to blight and codling moth damage. The tree is fairly vigorous. It tends to be very willowy with many limbs growing horizontally. Harvest timing is a week before Howard, Tulare and Hartley. The nut quality when the tree is young is good with a shelling percentage about fifty percent. Nut size and shelling percentage will decrease, as the trees get older.

Chandler, Hartley and Howard require a pollenizer to cover the later bloom. Generally five percent in a planting have been recommended although more recently growers have reduced this number to 2 to 3 percent in larger plantings and in areas where there are other walnut orchards. Pollen is distributed by wind and will travel considerable distances. Generally pollenizers are planted crosswise to the direction of prevailing spring winds. To reduce the number of trees to about 2.5% the trees cannot be planted in solid rows but are planted every third, fourth or fifth tree in the outside row and in rows every 300 to 500 feet across the orchard.

Scharsch Franquette has been used to pollinate Hartley and it also has been planted in Chandler blocks. It is a terminal bearer. It produces few catkins to shed pollen for the first 6 years. It also bears few nuts when young. It forms a large tree so it fits with a Hartley planting but is much larger than Chandler and can cause crowding when used with Chandlers. Production is low. Cisco was introduced as a pollenizer for Chandler and Howard. It is a tree about the size of Chandler but will also fit in a Howard planting. It produces catkins when about four years old. Yield has been low.

Tulare does not need pollenizers. A few Chandler is sometimes planted in a Vina block for pollination but most blocks are planted with no pollenizers.

SPACING

Walnuts usually form fairly large trees. Spacing in a standard orchard can be from twenty-two feet between trees and between rows to as much as thirty-six feet between trees and rows. When trees are planted at a close spacing, generally they are planted with the idea that about half the trees will be taken out at some future date. Trees planted in a square pattern, can have half the trees removed over time very effectively and remain productive. If they are planted in a diamond, a triangle or some other configuration, it is sometimes very hard to remove trees without leaving very large distances between trees.

Trees like Howard can be maintained for the entire life of the orchard at either twenty-six or twenty-five feet. Trees such as Chandler, Vina and Tulare should be planted at twenty-eight to thirty-feet apart. Hartley is usually planted between thirty and thirty-six feet apart. If early production is desired, double planting and then removing half the trees is possible. More

recently some of the growers in the county have tried to maintain the Chandler, Tulare and Vina blocks at tight spacings of twenty-four or twenty-six feet by using mechanical pruning in the winter time to separate the trees and to maintain tree size.

Walnut trees can also be planted in a hedgerow configuration. A hedgerow is a planting where trees down the row are much closer together than between rows. All the varieties mentioned here, except Hartley have preformed reasonably well to very well in hedgerows although in many cases Chandler performs as well in conventional plantings as is hedgerow. Hedgerows cost more to establish because more trees per acre are planted. The hedgerow concept will usually give higher early production. It is very beneficial where land costs are high or where it is desired to get the trees into production as soon as possible.

Row spacings about twenty-two or twenty-four feet apart usually have performed well for hedgerows. Trees that are very small, such as Howard, are planted either eleven or twelve feet down the row. More robust varieties such as Tulare or Vina will do better when they are spaced further apart; at about fifteen to sixteen feet between trees, down the row. This gives a lot more trees per acre than conventional plantings. Production is usually a function of the number of trees per acre for the first few years. After the fourth year all the pruning is done mechanically with large machines that will saw limbs on one side of the tree one year and then cut the limbs on the other side the following year. This alternate year pruning has performed very well. Mechanical pruning is much cheaper than hand pruning.

PLANTING

Walnuts are planted in the winter or early spring when weather permits. The soil should be moist but not exceedingly wet. The hole is augured or dug with a shovel. The soil should be friable, so that when you back fill after putting the tree in the hole, the soil will settle around the roots. At the time of planting the hole should be augured or dug to the appropriate depth. I do not like to see the hole any bigger or deeper than will accommodate the roots. It is said jokingly, that roots should be planted downward when they go in the hole. When holes are dug with an auger the outside of the hole has dirt that falls back in. The hole then is not deep enough to accommodate the roots. If this dirt is not dug out or pushed towards the center when the tree is planted the outside roots will curl up and point upwards. This can cause severe problems with root establishment and trees do not grow well or may die.

Trees that are planted in the wintertime can be purchased bare root from the nursery. The roots need to be kept moist after they are dug. Freezing temperatures can also kill the very small feeder roots. Trees that are planted in the spring should be placed in cold storage before the new roots have started in the spring. When planting starts, remove only enough trees from cold storage to plant that day. Do not remove trees that are going to be planted for the entire week at one time.

Trees should never be planted any deeper than they were in the nursery. Allow also for dirt to settle around the tree and the tree to settle. I have seen trees settle anywhere from one inch to three inches deeper than what they are actually planted. Trees that are planted high, trees that are planted on a mound, or berm and the soil then mounded up around them to allow for drainage, especially if the soil is clayey, do better than trees that are planted flat and definitely much better than trees that settle into a hole after planting.

Trees that are planted in the winter in moist soil usually do not require additional water until after growth starts in the spring. They usually can grow six inches to a foot before additional moisture is needed. Growers should dig down and examine the soil near the roots to see if it is drying out. You don't want excess moisture in early spring, as it will cause severe drowning and damage to the root. Trees that are planted in the spring, if the moisture is ideal and the soil firmed back around the roots usually will not require any additional moisture until the tree has started to grow. Soil that has a dry surface and is augured where some of the dry dirt falls in the hole at planting time, may require additional water around the crown. This will help to wet the dry soil that fell back in the hole and to settle some soil into air pockets. Be careful about applying too much water. Two or three gallons will usually be sufficient. I question if any of the trees need over five gallons. Measure the amount applied. Do not try to estimate the application.

Walnut trees that are grafted in the nursery should be cut back to about four viable buds above the graft union at planting time. This means that you are going to cut most of the tree off. Generally you will have a tree that is fourteen to thirty inches tall. Ungrafted trees should be cut off at fourteen inches. Most of the roots were left in the nursery at digging. The top is cut back severely to balance the top growth with that of the roots that remain on the tree. We want as vigorous a tree as possible. A very vigorous tree will grow a very strong trunk and establish good roots the first year after planting.

An eight-foot stake is driven two feet into the ground approximately one foot away from the tree on the windward side. The strongest shoot is tied loosely to the stake every foot to eighteen inches as the tree grows.

PRUNING

Pruning is done for a number of reasons. It shapes a tree, helps develop strong limbs to hold crops and allows light into and throughout the tree to develop better fruiting wood. Pruning of young trees is done primarily to shape the trees and to develop strong scaffolds.

The first year after pruning in the orchard the tree should be allowed to grow rapidly. The most vigorous shoot is selected for the trunk and is tied loosely to the stake. All of the limbs are allowed to grow except those that are low to the ground and are growing from the rootstock. Shoots are pinched back with the tips removed any time they are in the tractor path or they compete with the central leader being tied to the stake. The more leaves present on the tree the bigger the root system the tree will have. At the same time if all the shoots are allowed to grow vigorously the central leader being tied to the stake usually will not be as big. Heading side shoots stimulates more energy towards the central leader. Leaves manufacture nutrients for the tree and roots so that the more leaves left on the tree during the growing season the stronger the

tree will be. I like to see all the trees about nine to twelve feet or more in height at the end of the first year. Normally, I will not top the tree until the first winter, after it is dormant. At that time it should be headed at six and a half feet into good round wood. If it doesn't get this tall it should be cut into good round wood. Don't just remove a few inches from the top of the tree, as the tree will not grow as strong as desired the following year. The necked buds need to be removed in the dormant time. This promotes the second bud under the necked bud to grow. The second bud develops into a more horizontal limb that is much stronger and can support heavy crops.

Pruning the second and third year dormant season pruning develops the four to six scaffolds that originate from the main trunk. Do not select limbs close together that are merging opposite each other. The first scaffold should be selected at about five to six feet high, facing into the prevailing wind. The next limb should be selected at about ninety degrees from the first scaffold and six to twelve inches above the lower scaffold. The next two or three scaffolds are selected from limbs in the next three to five feet going in the opposite direction from the first two limbs. No central leader is needed after the original four to six scaffolds are selected. The selected scaffolds are headed with ⅓ to ½ the current seasons growth pruned off. On vigorous trees several of the limbs three feet from the ground or higher that are not needed for scaffolds can be left unheaded or just slightly tipped and maintained as fruiting limbs for two to five years. These are then removed when they become crowded or become shaded by the canopy above. On weaker trees it is best to remove limbs that are not needed for scaffolds to stimulate more vigor into the selected scaffolds. During the fourth and succeeding years severe heading cuts that remove one third to one half of the current seasons growth are made during the winter on those secondary limbs growing from the scaffolds that are needed to continue to grow and shape the tree. Depending on the size of the tree, this may require eight to twenty heading cuts per tree.

On mature trees, when they have reached full size, pruning is then needed to allow light to penetrate into the canopy, maintain healthy buds and remove dead and diseased limbs. Pruning is also done for height control to lower the height so that sprays can reach the tops of the trees. There is no reason that trees need to be any higher than thirty feet. When we have trees planted closer together than thirty feet between rows we don't want the trees any taller than the distance between trees. Sometimes we need to maintain tree height to twenty to twenty-five feet. This allows proper light penetration throughout the canopy. To allow light into the interior of a mature tree, a few cuts need to be made in the upper center part of the tree. This may require cutting one very large limb from the center on tall trees. Removal of the center limb usually will open the center up to light penetration from the top and into the northern part of the canopy. Light will create healthy buds that will produce strong clusters of two or three nuts rather than very weak spurs which many times will not set any nuts. Light is extremely important in developing strong buds. In orchards that are quite dense, where trees have grown together, limbs need to be shortened so that light penetration can also come in from the side of the canopy. One of the ways to describe this is to maintain each tree as an individual tree. The entire pruning does not have to be done in one year when reshaping older trees that have gotten too large. Pruning can be done in stages over several years, which allows some light to develop new wood. Pruning back to this new wood will develop a strong canopy. Crossed limbs or limbs that are crowding one another also should be removed. Just think of light whenever you are pruning old trees. In mature orchards, pruning does not need to be done every year but may be done every other or every third year, provided you are making adequate cuts to keep the tree at the desired height and also allowing light penetration within the canopy.

IRRIGATION

Orchards can be irrigated by many different methods. Furrow or border checks are older methods that tend to be less efficient than other methods. Generally more water has to be applied at the upper end and also will accumulate at the lowest point of the field saturating those areas to provide adequate moisture in the middle two thirds or three quarters of the orchard. Sprinkler irrigation is more efficient. The older type sprinkler systems, of moving portable aluminum pipe or the hose pull system, requires labor to move the system each day. The solid set sprinkler is costly to install, but does not require labor to move sprinklers. Micro sprinklers are very effective where they cover approximately fifty percent or more of the ground surface. Systems such as drip irrigation can be used in a few situations in walnuts provided that the water will move laterally from the drip emitters. Fifty percent of the total root area needs to be wetted by the drip system. This usually requires multiple drip irrigation hoses per tree row.

Irrigation water management is extremely important in walnuts. Walnuts require frequent irrigation throughout the summer months. Improper irrigation can be either applying not enough water or not applying water frequently enough. An understanding of the soils that the trees are planted on and the water holding capacity of the soil are important in determining the frequency of irrigation. Generally, sprinkler irrigation or flood irrigation, replenishes water throughout the entire root zone each irrigation. On micro or mini sprinkler and drip irrigation the water is replenished frequently in a small area of the root zone. An orchard that has at least fifty percent of the total area covered with leaf canopy will require as much water as a full-canopied orchard. Much of the evaporation occurs on the sides of the smaller trees that make up for the open areas between trees. An orchard that has a lot of cover crop on the orchard floor will require more water throughout the winter and early spring than an orchard that is clean cultivated. Generally a walnut orchard, in this area, requires between forty-two and forty-five inches of water per year. An inch of water would be the amount of water that would cover the surface one-inch deep. This is more water than many of the other tree crops use. Most of that water is needed in the hot summer months of June, July and August. Irrigation systems should be designed to apply adequate water during those three months. As much as eight or nine inches per month may be needed. In designing a system normally fifty percent or more of the total ground surface needs to be wet or wetted by the irrigation system to apply adequate water to the tree. Most soils in the county have high water holding capacity. It is important to keep the trunk and the ground surrounding the trunk of the tree as dry as possible. Planting the tree on mounds or berms will allow water to drain away from the trunk. Design sprinkler systems so a minimal amount or no water is applied directly to the trunk. Another consideration is that root diseases, primarily Phytophthora or Armillaria, requires free moisture to spread and requires moist conditions for growth. Normally if standing water or saturated areas do not last longer than twenty-four hours at one time very little Phytophthora will develop. After twenty-four hours, the longer the ground stays saturated, the more disease develops. Systems should be designed to minimize or eliminate saturated conditions longer than twenty-four hours.

Water needs to be applied to the trees before they completely deplete all the available moisture in the root zone. Roots will extract water from throughout the rooting area although the water is depleted quickest from the upper part of the root zone. The trees then will extract water from deeper in the soil.

Checking the top one to two feet of soil moisture can be used effectively in determining when to irrigate. Checking deeper moisture is important to evaluate how well the irrigation system is replenishing deep moisture.

Weather reports during the summer that list evapotranspiration can be used effectively to determine the amount of evaporations that has occurred and the amount of water that is required to replenish the moisture. It does not tell the contribution of winter rains and the water holding capacity of soil. Winter rains in the Yolo and Solano area generally are adequate to wet the soil profile for several feet. In dry years irrigation may be needed during the winter months to establish moisture throughout the root zone. I like to use the formula that six inches of water is needed each month during December, January and February to get adequate water in the ground to start the season. A total of eighteen inches, which is the average rainfall in Woodland, is needed to have water down to six or seven feet. The tree can draw from this reservoir as the season progresses to supplement needs during extremely hot days.

Growers have a very difficult time determining when to start the first irrigation in the spring. Generally a person should use a probe or a shovel and dig to determine how dry the soil is at one, two and three feet. If the soil is extremely wet, irrigations in the early spring should be postponed until the tree uses most of the water in the upper two or three feet. This will decrease the chances of disease and will establish healthy roots deeper in the soil profile. Once irrigations are started, using evapotransporation can be a good tool towards determining when additional irrigations need to be made.

BORON

In Yolo County we have considerable acreage that is impacted by boron in the irrigation water. Most of the area that gets water from the Yolo Flood Control and most of the area that has under ground water that is recharged from Cache Creek has a high boron content in the water. This can be about one part per million to several parts per million. Water over one part per million Boron can cause leaf burn. The leaves in the spring usually start out quite green with no burn. As the season progresses boron moves into the leaves but will not redistribute in the tree, therefore the oldest leaves become burned. The boron accumulates primarily between veins. The first symptom is slight yellowing between veins. As the season progresses there will be marginal burn as scallops between the veins and then the entire leaf will have burnt sections between the veins. The boron itself does not affect the fruit buds for the following year. With burnt leaves, less growth occurs. With fewer buds because of high concentrations of boron, the crop is reduced. Canal water will generally be high in boron early and late in the season, but during the summer boron concentration is lower. Irrigating only when the concentration is lower is preferred. Boron will stay fairly constant throughout the year in wells. If a well is over two parts per million, it should not be used. Water that is between one and two parts per million boron can be used but with the expectation that leaves will burn considerably.

FERTILIZER

Walnut trees require large amounts of nitrogen fertilizer each year. Nitrogen fertilizer is necessary in all soils in California and needs to be replenished. A two ton walnut crop removes approximately one hundred pounds of actual nitrogen. This needs to be replaced each year be either applying commercial fertilizer or by growing a cover crop. In some areas of the county, irrigation water contains nitrogen and can contribute nitrogen to the tree. The tree needs one hundred pounds of nitrogen. Generally, most of our application methods are only about fifty to seventy percent efficient. Therefore about two hundred pounds of actual nitrogen per acre per year is needed. I do not like to see it applied in a single application. A minimum of two applications and on our lighter textured or sandier soils, three or four times throughout the spring and summer months is better. Roots need to be growing for the adsorbtion of nitrogen to occur. Roots only grow when leaves are present on the tree therefore applications, in the spring, late spring and summer either before or post harvest, are good times to apply the fertilizer. It takes as much as a month for the nitrogen to move from the roots into the upper part of the tree. Applications can be made through the irrigation system by either dissolving a dry product into the irrigation water or injecting liquid fertilizer. Applications can also be made to the soil surface as a dry granule or liquid and then irrigated in. Legume cover crops that are used for nitrogen need to be incorporated in the soil to obtain the maximum amount of nitrogen.

Leaf analysis taken can be beneficial to evaluate tree nutrition. Normally, a nitrogen leaf level over two and a half percent is ideal. The University of California recommendations list 2.2 or 2.3 for the leaf level as adequate. Higher rates allows for all the trees within the sample block to have an adequate amount for excellent growth. Adding additional quantities of nitrogen to trees with levels over 2.8% is wasteful and in a few cases could injure production through extensive growth shading the interior part of the canopy.

Fertilizing young trees is important. Frequent light applications of nitrogen will be much better than one or two heavier dosages and will have less chance of burning the foliage. A thorough irrigation is necessary following application. On young trees, an application rate of about one ounce of nitrogen per year of age of tree, applied at any one time, is usually safe. That means that if a tree is two years old, two ounces of actual nitrogen should be applied each application. In most systems you can apply fertilizer every two or four weeks at that rate. This will encourage tree growth. If most trees are growing very luxurious with a few weak trees within a block, you can fertilize the weak trees and encourage them to catch up.

Potassium deficiency in the county is becoming more of a problem. Trees growing on soils high in magnesium may show deficiency. Leaf analysis in July can determine if it is low, borderline or adequate. Potassium is very difficult to apply so that the trees can absorb it. Potassium attaches to the clay particles in the soil and becomes unavailable to the roots. It should be banded in the tree row on non-tillage orchards in the fall. On tilled orchards it should be drilled in one or two bands to the tilled depth. Water can then be applied to the bands to carry the potassium at to the roots.

Zinc deficiency is showing up more, especially in our older orchards. Zinc causes pale interveinal chlorosis leaves with wavy margins and little leaf symptoms. Zinc can be analyzed in the summer leaf sample, if no zinc was applied to the foliage. If zinc is applied foliar, it will always show adequate in leaf samples that year because it cannot be washed adequately off the surface of the sample leaves. To correct zinc deficiency it can be applied as a foliar spray. Generally the best time is in mid-spring after some of the foliage is out and some of the bloom has occurred.

WEED CONTROL

Weed control is very important around the tree trunk and to eliminate competition to the trees. Weeds compete very strongly for nutrition and water with young trees. It is imperative to have good weed management in young orchards to encourage the growth of the young tree. Weeds around the trunk of older trees are competitive and hold moisture that can cause root and crown diseases. A clean orchard floor is needed for harvest. There are many residual herbicides that can be applied to both non-bearing and bearing trees that can be used effectively. The important thing is to be able to identify the weed population that you have and then select the weed control material that will be effective. There are also contact herbicides that can be applied and are effective. Most orchards have a sprayed strip to control the weed growth down the row so that any activity such as disking or mowing is done in a single direction. Orchards with berms or with micro or drip irrigation cannot be cross-cultivated or cross-mowed. It is imperative to have a clean strip to control the weeds in the tree row in these orchards.

Care is necessary when applying contact herbicides to young trees to not injure the tree. Some of the contact herbicides can go through the bark of young trees and can damage or kill the tree. When applying herbicides, the sprayer pressure should not exceed thirty pounds. Higher pressure will normally cause volatilization of the spray droplets that can drift onto of the foliage and cause problems.

Normally a cover crop is maintained between rows to help in water penetration, build soil structure and to provide some organic matter that will add buoyancy to the soil. This can be a planted cover, a planted cover allowed to reseed itself after initial planting, or native vegetation that reseeds itself. Mowing in the early spring should not be close to the ground, but should be four to five inches above the orchard floor. This allows for more growth of the cover crop.

INSECTS

There are a number of insects and mites that can be a problem in walnuts. Normally the two that we are most concerned with are codling moth and Walnut Husk Fly. Codling moth is a major pest that will attack walnuts. It bores into the nut and causes a damaged or off grade nut. If damage occurs early in the season, the nut will fall and will be destroyed in summer before harvest. If damage occurs late, the nut remains on the tree until harvest and will be an insect off grade when the nuts are harvested. Insect sprays, pheromone confusion and sanitation can be used for control. In the variety section, the late blooming varieties avoid part of the first generation of codling moth.

Walnut husk fly does not enter the kernel or meat of the nut but works on the husk. The fly will cause a black area that absorbs heat and can stain the shell. It can also cause the kernel to darken. Husk Fly is generally worse in large dense canopied trees or trees near black walnuts. It mainly attacks the Hartley variety but it will attack and can be a problem in all varieties. Usually you do not have the problem until August or September. It is controlled fairly effectively with a protein supplement bait plus an insecticide that is sprayed in large droplets on the lower canopy. It does not have to be a complete coverage spray.

DISEASES

Walnut blight is a spring disease that requires free moisture to multiply and infect the small developing nutlets. It is worse early in the spring because of rains. Copper sprays are used effectively for its control but the copper sprays must be applied before the rain occur. Some strains of Walnut Blight bacteria have developed resistance to copper. Other chemicals in combination or alternating with copper sprays will provide control. In Solano and Yolo counties we have found little copper resistant bacteria. Generally one to three sprays are necessary for excellent blight control in county walnut orchards on late blooming varieties. Early blooming varieties will require more applications and may require additional chemicals and combinations.

The other principle diseases that we have are root diseases such as Phytophthora root rot and Armillaria root rot. Water management is a primary key to control of these diseases.

HARVEST

Harvest of walnuts in California occurs in September and October. Walnut harvest is done mechanically. The nuts are shaken on the ground and harvest proceeds with the nuts picked up and harvested as soon as possible after shaking. The ground needs to be prepared so that it is smooth without any ruts or crevices where nuts will not be able to be sweep. The nuts are shaken by an inertia trunk shaker or a limb shaker. They are then sweep into windrows. A pick up machine then picks the nuts up, blows leaves out and puts the nuts into a trailer. The nuts are then taken to the huller to be hulled. At the huller the nuts are placed in a flotation tank that removes rocks or dirt clods. Since nuts are lighter than water they will float. A chain drags them out of the water, where they then drop into brushes with stiff wires that scrap the hull from the nut. The nuts go through a revolving cage where the hulls fall through and are taken to the trash bin. The good nuts roll through the cage to the end, then are sorted and placed in a dryer. Dryers are usually forced air dryers. Additional heat can be used up to but not over 110 degrees Fahrenheit. Hotter temperatures will cook the nuts and cause them to become dark and rancid. Drying may require a few hours to twenty-four hours or longer. Nuts are able to be stored when they have moisture levels below eight percent. A grower does not want to dry them below eight percent because he will be losing money when they are dried too much. There are various instruments that can determine moisture levels. One is electronic that will measure the moisture between two plates installed in the dryer bin. For small lots, cracking a few of the wetter nuts and finding that the nut itself is not rubbery and can not be wiggled back and forth but is fairly firm will be sufficient. Early in the season there will be wet nuts and dry nuts in the same load. Usually it takes an additional twenty-four hours after drying for the moisture content to equalize between the wetter nuts and the dryer nuts within the tank for all of them to be close to the same

moisture. Nuts will crack easier with fewer small pieces and produce more halves when the nut moisture is at or over eight percent when cracked. Growers that are going directly from a huller to a cracker and selling their own nuts will find that nuts at eleven or twelve percent moisture will crack better and have a higher percent halves and large pieces. Nuts that have been stored will crack easier with more halves when moisture is eight percent than when drier.

MARKETING

Walnuts are marketed in shell to wholesale buyers. Currently in California there is a cooperative that buys approximately fifty percent of the crop and there are a number of independent handlers that also buy. None of the independents are as large as the cooperative. It is usually a long time commitment between the grower and the handler, whether it is a cooperative or an independent. Arrangements should be made with the buyer ahead of time. Nuts are delivered in bins or in bulk. On delivery the nuts usually are dropped into a pit. A sample is extracted automatically and graded to determine quality and price. Many times a price is not agreed upon by harvest, while other times the price maybe agreed upon.

The price is always stated as an in-shell price based on quality, color of the kernel and the size of the nut. Some of the nuts are sold to the consumer in shell, while other nuts are shelled. The grower receives a price per pound on the in-shell product after deductions for off quality, insect damage or any other grade defects. The handlers do not want nuts that are cracked or broken. These broken nuts will turn rancid quicker than the nuts that are intact. Light kernels are thought to be higher quality than darker kernels.

Partial payments are made on delivery by the cooperative. Additional payments occur during that year and the following year. Generally the independent buyers or handlers pay some on delivery and the balance in subsequent payments. Time and method of payment should be decided at the time of sale.

Additional References:

- Walnut Production Manual, University of California, Division of Agriculture and Natural Resource, publication #3373
- University of California, Cooperative Extension, 2001 Sample Cost to Establish Walnut Orchard and Produce Walnuts: Northern San Joaquin Valley
- University of California, Cooperative Extension, 2001 Sample Cost to Establish Walnut Orchard and Produce Walnuts: Sacramento Valley **(Available in early 2002)**
- University of California, Integrated Pest Management, Walnut Pest Management Guidelines
- Integrated Pest Management of Walnuts, University of California, Division of Agriculture and Natural Resource, publication #3270

*Contact your local Cooperative Extension office to obtain copies.