Citrus Orchard Management in Texas

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CONTENTS

Introduction 3

Establishing the Young Citrus Orchard 3

Location and Site Selection 3
Commercial Orchard Varieties 4
Citrus Trees for Planting 4
Planting the Orchard 5
Young Citrus Orchard Care 5
Young Citrus Orchard Cultivation 6
Fertilization of Young Citrus Trees 7
Cold Protection for Young Citrus Trees 8
Pruning Young Citrus Trees 9

Care of the Bearing Citrus Orchard 9

Fertilization of Bearing Citrus Trees 9
Citrus Tree Nutritional Sprays 10
Irrigation of Bearing Citrus Trees 11
Cover Crops for Orchard Use 12
Weed Control in Bearing Citrus Orchards 12
Pruning Bearing Citrus Trees 13
Low Temperature Protection for Citrus Trees 14
Citrus Insects 14
Valley Citrus Diseases 15

Marketing 16

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This manuscript originally was co-authored by W. H. Friend, associate county agricultural agent, now deceased.

Citrus Orchard Management in Texas

Growing citrus fruit is one of the most fascinating types of farming, and it also can be profitable when operated properly. Suitable land, good trees, satisfactory water and sound management are essential in successful citrus fruit production. Weed control, soil fertility, protective spraying or dusting to control pests and diseases, pruning and cold protection are problems that the Lower Rio Grande Valley orchardists encounter.

Some orchardists reside on their property and do most of the orchard work themselves. Others reside in town (frequently out of the Valley area) and pay an orchard care company to take care of the necessary grove operations. Hiring an orchard care company may be more practical until an owner acquires a working knowledge of citrus orcharding.

ESTABLISHING THE YOUNG CITRUS ORCHARD

Location and Site Selection

Selecting a proper location for citrus orcharding is important. An orchard should be located in an area where similar enterprises have succeeded, or if in untried territory, conditions should be favorable for the production and marketing of the citrus fruit that the orchardist wishes to grow.

Climate, soil, drainage, topography, water resources, water service, proximity to hard-surfaced roads and accessability to processing plants and shipping centers are important considerations in selecting a location for a citrus orchard business.

Climatic factors such as critically low temperatures, rainfall, humidity and wind movement affect citrus fruit production. Some portions of the Lower Rio Grande Valley have lower temperatures than others, and the average annual precipitation is greater in the eastern half than it is in areas farther from the coast. Atmospheric humidity and wind movement also are greater near the coast. Longtime, official weather records are the best guides to use in selecting a location for a citrus orchard.

Since soil is important in a longtime farm enterprise such as citrus orcharding, a detailed soil survey and soil and water analysis may be desirable. The roots of the more desirable understocks for citrus trees do not thrive equally well in all soil types. Sour orange and the Tristeza tolerant Cleopatra mandarin are the stocks generally used by commercial nurserymen. Both of them do best in fairly deep sandy loam soil. However, the Cleopatra understocks are affected adversely by high concentrations of lime (caliche) in the soil. Citrus orcharding should not be attempted on heavy adobe clay soils, shallow soils or saline soils.

Topography, or elevation with respect to surrounding land, is important. Land having a rolling topography likely will have good water and air drainage, but it is difficult to irrigate and may be subject to erosion. Rolling land can be terraced, but weed control is a difficult problem in terraced orchards where cross cultivation is impractical. Land with a 2- to 3-percent slope is ideal for orchards. The slope can be changed with modern earth-moving equipment. Grade should be determined by volume of water available for irrigation, the kind of water distributing system to be used, soil type and the soil management system the orchardist wishes to use.

High land is suited for orchard use, since elevation above surrounding areas insures good water and air drainage. However, it has disadvantages in that it may be necessary to relift irrigation water to get it to the highest point and terracing may be needed to prevent serious soil erosion. Avoid planting citrus trees in low areas where water collects, following heavy rains.

Soil drainage is important in selecting a location for a citrus orchard. Good surface drainage is desirable (Figure 1), but subsoil drainage is equally important. A soil auger will enable the appraiser to detect the presence of hard or impervious substrata that might interfere with the downward movement of water. Shallow soils likely will become waterlogged, which may result in the accumulation of harmful amounts of salt. Ponding of water on land adjacent to a prospective orchard may raise the water table and salt content on the good land. Accessability to a functioning, deep drainage ditch is a valuable

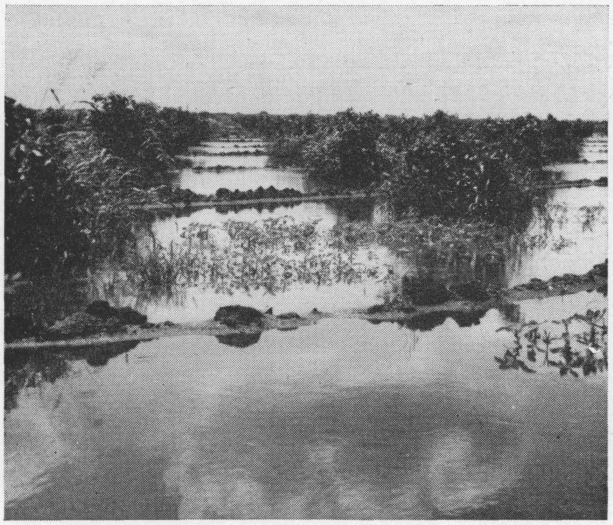

Figure 1. Surface drainage is important. Water on this level pan orchard came from a rain that occurred 3 days before this picture was made.

asset because it makes possible the use of deep tile drains, should they be needed later.

Irrigation is essential in citrus fruit production under average Valley conditions, since normal rainfall is inadequate. Water service is expedited through the use of concrete-lined canals and underground pipelines. An underground reservoir of acceptable well water for irrigation is a valuable asset, since the supply from the Rio Grande may be inadequate some years.

Accessability should be considered when selecting a location for a fruit production enterprise. It is advantageous to be near a town and a fruit processing plant, but proximity to a hard-surfaced road is more important.

An orchard should not be located where it will be subject to drift from a dirt or caliche road. Dust has an undesirable effect on citrus trees and tends to encourage the spread of red scale pests.

Commercial Orchard Varieties

Citrus fruit production is a longtime project, so the selection of varieties for planting is important. The Valley is well-suited for growing fall and winter grapefruit. Late maturing varieties such as Valencia oranges and the portion of the grapefruit crop that is not harvested early may encounter freezing temperatures about 1 year in 5. This freeze hazard has influenced developers of new orchards in their choice of varieties. Red-fleshed grapefruit is still the most popular variety and early oranges are planted more extensively than Valencias.

The most commonly planted grapefruit varieties are Ruby (Redblush), Pink Marsh and Marsh Seedless. A number of growers have encountered a problem with small fruit in the red grapefruit varieties, but good red-fleshed grapefruit have brought the highest prices over a period of years and many growers report excellent yields.

Early varieties of oranges are not equal to those of the Valencia variety in table or shipping quality. However, the trees of early types average considerably more fruit over a period of years—the Navel orange being an exception, since trees of this variety are shy bearers. The popularity of early types is due to the prolific nature of trees of Pineapple, Hamlin and Marrs varieties, and because an occasional crop of Valencia oranges encounters freezing difficulties.

No one can predict what the supply and demand on grapefruit and oranges will be 5 or 10 years after an orchard is planted. However, Florida and California produce more oranges than fresh fruit channels can use and only their best grade is sold as fresh fruit. Grove developers have been following a trend of planting most of the new acreage to red-fleshed grapefruit. It is unfortunate that there is not an early-maturing orange variety that is as desirable as the later maturing Valencia variety. Test plantings of the more prolific strains of Navel oranges are being made to meet the demand for a large, early ripening, seedless orange with good shipping qualities.

Until more desirable and dependable orange varieties can be discovered, red-fleshed grapefruit will continue to be the most popular citrus with developers of new orchards.

Citrus Trees for Planting

The use of good trees of acceptable varieties, on well-adapted understocks, is essential in profitable citrus fruit production. Most standard citrus varieties, when budded on acceptable understocks, are suited to Valley conditions. Cold tender varieties of lemons and limes are more susceptible to freezing injury than grapefruit, oranges or tangerines.

The developer of a new orchard must decide whether to use the relatively new Cleopatra mandarin understock, which is tolerant to Tristeza disease, or the old reliable sour orange rootstock, which is susceptible to the Tristeza virus. "State certified" planting stock also should be considered. Certain sapborne virus diseases are transmitted

through budding. Using buds from parent trees, which State inspectors have shown to be free of the psorosis virus, is the best insurance against psorosis (scaly bark) disease. This deterioration (virus) disease was responsible for poor yields and small fruit produced by many of the early planted trees in the Valley. The nurseryman, or others who propagate citrus trees, are responsible for using budwood only from trees on which repeated inspections have shown them to be free of communicable diseases. Good yield records over a period of years are good indicators as to the health and adaptability of a parent tree, but this fact does not apply in the case of some "masked" virus diseases.

The age of the nursery tree is more important than its size. Trees that caliper 5/8 inch or more 9 months after budding are satisfactory, but trees of comparable age that caliper 3/4 inch are more desirable. Overaged "runts" are undesirable, even at reduced prices.

The nurseryman who supplies the trees usually will contract to stake out the locations, deliver and place the "balled" trees, plant the trees, construct irrigation basins and tank water the trees the first time. This is the safest procedure for orchard developers who are not familiar with the details of planting trees.

Planting the Orchard

Fall is the favored time for planting citrus trees, but "balled" planting stock can be transplanted successfully almost any season, provided the young trees are given adequate care afterwards. Securing good nursery trees is more important than the time of planting.

The next step is staking out the location for the trees. The purchased trees should be delivered at the location just prior to setting time. The site for the orchard should be graded and prepared properly *before* the "laying-out" operation begins. Stakes are set in line at the exact spots where the trees are to be set. Experienced planting crews can line the trees up without wires, double staking and planting boards, but inexperienced orchardists have better results with these conventional methods. Laying out the orchard consists of (1) "squaring-up" the field, (2) measuring out the tree and row locations along the base lines, (3) staking out the individual tree locations, (4) double staking with a planting board and (5) digging the holes.

Spacing actually is a part of the laying-out procedure. The general trend is to plant more trees per acre than formerly. The 25′ x 15′ spacing with eventual thinning to 25′ x 30′ is popular. However, some orchardists set their trees 25′ x 20′ apart (with no intention to thin), while others use the 25′ x 25′ spacing that allows 70 trees per acre.

Proper depth at which the trees are set is important, since "buried" bud unions may cause trouble eventually. Orchard trees should be set about the same depth as they stood in the nursery. The use of a planting board will aid in keeping the trees in alignment and will facilitate planting at the proper depth.

Tamping trash-free soil firmly about the balls prevents air pockets near the roots of the trees. The tree setter should use a tamping bar and his feet to firm the soil around the roots of the newly set trees. Use of fertilizer, sulfur or similar materials in the holes where the trees are set may kill or retard them. It is safer to wait until the trees have become well-established before applying concentrated fertilizer.

Water should be applied immediately after setting to settle the soil around the roots and to supply needed moisture. Additional shovelling will be required to fill depressions that occur after the first watering. Mound several shovelfuls of dry soil around the crown roots to insulate against heat from the sun's rays and to retain moisture.

Mulching the basins with dry grass, weeds, gin trash or other dried organic material completes the tree-setting operation. Winter-planted trees should be "banked" after the second watering.

Young Citrus Orchard Care

Good management of young (nonbearing) citrus orchards is necessary for profitable fruit production. Neglect of the young trees will retard their development and may cause yield reductions in later years.

Intercropping may be practical in young citrus orchards, provided the intercrops are chosen carefully and the trees are given top priority. Short-season crops, such as snapbeans and Southern peas, are favored. Crops which require frequent use of insecticides are undesirable for planting between young trees. Certain insecticides damage citrus trees and most types tend to upset the favorable balance between harmful (parasitic) forms of insects and the beneficial kinds which help to control citrus tree pests. Planting alfalfa and cot-

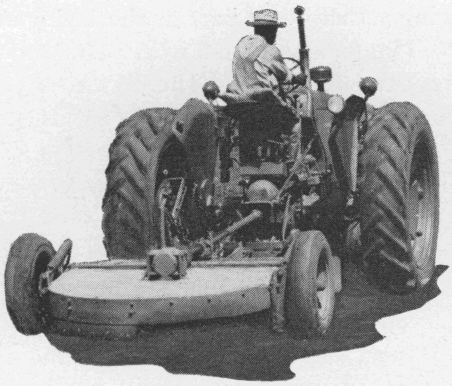

Figure 2. Power driven shredders (oversized rotary mowers) are used to keep orchard weeds and grass under control.

ton in young orchards increases the danger of losses from root rot diseases.

Water may be applied in young orchards as a basin irrigation (tank watering) or as strip watering. Water should be applied *before* the trees reach the permanent wilting stage. Sandy loam soil should be wet to a depth of at least 2 feet. All of the orchard soil need not be watered, but larger basins or wider strips should be used as the trees increase in size. Even 3-year-old trees have extensive root systems. A soil auger or probe will enable the orchardist to determine whether his irrigation procedure is wetting the soil to a sufficient depth in the root zone. The rate at which the water should be applied depends on the type of soil and its permeability. The rate of flow must be retarded on the heavier, clay loam soils through which water penetrates more slowly. It is easier to control the amount of water applied to each tree on level ground, but big heads of water are required where the land is level and the soil light, permeable and covered with vegetation.

Timing of irrigation depends largely on the weather. Rain is most likely to occur in the Valley during April, May, June and in the fall. However, damaging drouths may occur at any season. Weeds are good "indicator" plants; when sunflowers and pigweeds approach the permanent wilting stage, young trees should be watered. The maintenance of organic or "dust" mulches surrounding trees under 2 years of age will help to conserve moisture and promote soil conditions which are favorable for the growth of feeder roots near the surface.

Summer cover crops such as Sudangrass provide wind protection, shade the soil and increase the organic matter content of the soil to a considerable depth in young orchards. Oats may be used during the late fall and winter to shade the soil and compete with the trees for nutrients and moisture which helps keep them in a dormant condition. Growing cover crops in orchards at any season necessitates the use of additional irrigation water.

Inspect young orchard trees regularly and frequently to observe evidence of damage by pests and diseases. Then take appropriate action.

Young Citrus Orchard Cultivation

Cultivation or tillage of the orchard soil is not essential. However, weeds interfere with certain grove operations and they also use water and plant nutrients that the trees may need. Weed

Figure 3. Middle breakers mounted on a front tool bar break the border (left) and facilitate passage of the tractor as the cross borders are being made (right).

Figure 4. The "check" making machine is a popular labor-saving machine.

control may be obtained by disking the soil, chopping, mowing or shredding.

Disking is the cheapest and most efficient method of destroying a heavy growth of weeds and grasses. The tandem disk harrow should be equipped so that the blades will not penetrate deeper than 3 inches. It should be "shielded" to avoid damage to the skirts of the trees. Using a properly gauged offset disk harrow, about once every 60 to 90 days, is the most economical way of controlling grass, weeds and vines in citrus orchards. The grass and weeds are useful as soil-improving cover crops, but vines are a menace. Disking kills cover crops and partially covers them with soil. This hastens decay of the above-ground portion of the cover crop, and the death of the grass and weeds ultimately will cause the roots to decay and improve the soil.

Trees should not be planted on soils that are likely to become so compacted that deep tillage with chisel cultivators or subsoilers is needed.

Weeds and grasses can be cut with rolling stalk cutters (choppers), by mowing or by shredding, Figure 2. However, a heavy ground cover of dry grass and weeds creates a serious fire hazard. Some orchardists erect permanent borders and control weeds and grasses by chopping, mowing or shredding. Others use a combination of disking once or twice a year and mow the weeds when they become large enough to interfere with grove operations.

Another popular system is to use the irrigation borders the second time, obliterate them with a narrow disk harrow and mow or shred the standing weeds.

Using middle breakers in front of the tractor wheels greatly facilitates crossing borders when making cross borders, Figure 3. The "check" making machine helps to speed the job of filling these openings, Figure 4.

Many Valley orchards are kept clean cultivated at all times (Figure 5), while others are kept in permanent sod. Young sodded-over orchards are difficult to maintain, because considerable hoe work is needed to keep Bermudagrass under control around small trees. Clean culture may be needed to conserve water for the young trees.

Fertilization of Young Citrus Trees

Concentrated fertilizers stimulate the growth of young citrus trees, especially ones that are planted on badly depleted cropland. However, in many cases the improper use of fertilizers and agricultural chemicals around young citrus trees results in serious losses.

Fertilizers usually are applied in young orchards to stimulate the growth of the cover crop rather than to supply fertilizer directly to the young trees. Most of the nitrogen and all of the mineral nutrients contained in the "green manure" crop will be returned to the soil, in a slowly available form, after the cover crop is turned under. Native grasses and weeds are efficient "foragers" for most essential mineral nutrients. More clean culture may be needed during water shortages than at other times.

Figure 5. Some orchards are kept clean cultivated most of the year. This is one method of conserving water for use by the trees.

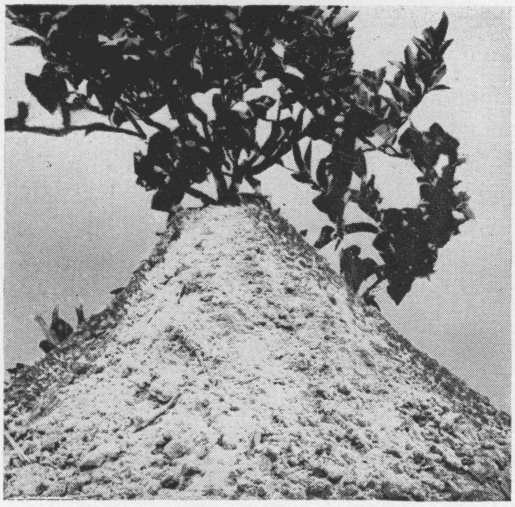

Figure 6. Banking young citrus trees is a time proved method of protecting them from cold temperatures during the winter.

The virgin soils of the Lower Rio Grande delta area were quite fertile, but much of the plant food has been removed by crops, leached out or made unavailable by increasing alkalinity of the soil water and by soil compaction. Nitrogen is the element most likely to be deficient in Valley soils. Nitrogen concentrates are recommended by research workers and are used most extensively by experienced Valley orchardists.

Most Valley soils contain adequate amounts of phosphorus and potassium to supply the needs of the trees and cover crop. Although some orchardists use nitrogen-phosphorus combinations and a few growers use complete fertilizers, young trees do not need these more costly fertilizers. (For specific fertilizer recommendations see Texas Agricultural Extension Service L-222, "General Fertilizer Recommendations for the Lower Rio Grande Valley.")

Concentrated fertilizers may be applied around young trees by hand, but care should be taken to scatter them evenly over the root zone area. Soluble concentrates sometimes are added to the water applied in the tree basins from tank trucks.

"Cyclone" type fertilizer spreaders are excellent for applying concentrated dry fertilizer to cover-cropped orchards nearing the fruit-bearing age. "Dribbling" fertilized concentrate out of cans, at the "drip" lines of the young trees, may do more harm than good. Severe root injury may occur if a light rain follows careless application of concentrates.

Fertilization of the soil should be followed by an application of water, because the added nutrients will not be available for use by the trees until they have been leached into the root zone.

A discoloration of the leaves may result from certain minor element deficiencies, or from excessive amounts of salt or boron. Chlorosis caused by deficiencies of iron, zinc or manganese is most pronounced on orange trees, especially those budded on Cleopatra understocks growing in high lime (alkaline) soils. Chlorosis and mottleleaf (zinc deficiency) also are pronounced on trees growing on compacted soils having poor aeration. The use of finely ground gypsum and sulfur is advisable on such soils.

Good young trees, growing in average Valley soil that is kept adequately supplied with water, should make normal growth without fertilizers; but fertilizers and soil correctives may be needed to help shorten the period between planting and the first profitable production. This is true especially on land that is below average in productive capacity.

Cold Protection for Young Citrus Trees

Most Valley orchardists bank their young citrus trees to protect the trunks against dangerously low temperatures. The first freeze normally occurs in mid-December, but damaging freezes occasionally occur earlier in the month. Most experienced orchardists like to finish banking by December 1 if possible, Figure 6.

Clearing the soil around the young trees of grass and weeds and the preparation of soil for building the banks should take place before banking. Trash-free soil with which to build the bank is difficult to obtain. Trashy, fermentable material mixed with the soil in the bank is undesirable. Such material attracts ants and termites and its decay in contact with the trees may cause bark injury. Double disking on one side of each row of the trees should provide friable soil that is reasonably trash free.

Water sprouts on the trunks should be removed and all wounds should be painted with a reliable wound protectant several days before the trees are banked.

A protective wash which will protect the trunks against soil-borne diseases and insects should be applied a few days before the banking is done. Insecticides in the wash may lose their

potency if left exposed to sunlight and wind too long. Several reliable tree washes are on the market in the Valley. Such protectants should contain not less than 5 percent actual copper in the insoluble or neutral form and about 2.5 percent dieldrin or 5 percent heptachlor or 10 percent chlordane.

Banks should be built as high as practicable to protect the trunks and basal ends of the framework branches. The crotches formed where these limbs attach to the trunks are more sensitive to cold injury than any other part of the tree.

Firm banks store and conduct heat better than loose piles of trashy soil. Banks should be firmed as they are built, and they should be reworked at any time cratering occurs at the tops of the banks.

The tree size limit for banking is difficult to determine. Formerly, trees past their third year in the orchard, or those more than 3 inches in diameter, were considered past banking age or size. Following the freezes of 1949 and 1951, the skirts (spread of limbs) were found to be the determining factors in banking. Until the skirts are long enough to protect the lower extremities of the trees by conserving warmth radiated from the soil, banking is good insurance. Some large-scale operators use small bulldozers mounted on light tractors to push the banks into place so that they can be completed with a minimum amount of shovel work.

Pruning Young Citrus Trees

Pruning is important in citrus orchard management, but it is not as essential as it is with deciduous fruits such as peaches and grapes.

Trees having at least four main scaffold branches and no weak (acute angle) crotches are preferred. The first scaffold branch should be no higher than 18 inches from the ground and the top arterial should be no higher than 30 inches from the ground. In selecting the framework branches, those which form acute angles with the trunk should be avoided because limbs of this type are likely to break under heavy loads of fruit.

Young citrus trees, especially in windy locations, are likely to appear unbalanced and misshapen. Heading back, in conjunction with staking and tying, will help to overcome the effect of wind on young trees. However, windbreaks are more effective in coping with wind movement.

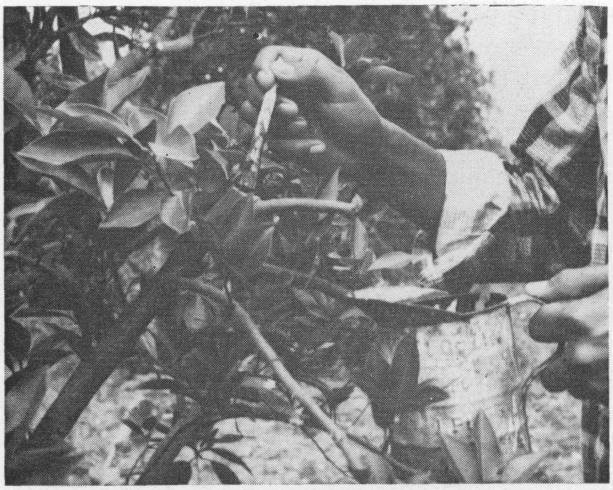

Figure 7. Pruning wounds larger than ½ inch in diameter should be protected with a weatherproof antiseptic paint of the the asphaltom-carbolineum type.

The side sprouting or "suckering" of young trees preparatory to banking is the simplest type of pruning. The cuts should be made smooth and close to the trunks to promote rapid healing. A reliable wound dressing of the asphaltum-carbolineum type should be used to disinfect and seal each wound which might furnish entry to spores of the foot rot fungus or diplodia heart rot, Figure 7.

The corrective and protective pruning which a young citrus tree receives during its early years may determine largely its ability to set and mature maximum fruit crops later.

CARE OF THE BEARING CITRUS ORCHARD

Fertilization of Bearing Citrus Trees

Orchard soils must contain relatively large amounts of nitrogen, potassium and calcium to produce 20-ton-per-acre yields of fruit. Such a crop will require about 90 pounds of nitrogen, 30 pounds of P_2O_5, 120 pounds of K_2O and about 100 pounds of CaO lime. A nitrogen deficiency may become acute in orchards where weed cover crops are allowed to grow for long periods of time. The availability of the mineral elements may be impaired by increasing alkalinity, salinity and compaction.

There is a growing tendency by orchardists to apply most or all of the fertilizer concentrate early in the year, usually during February. Experiments on several types of soil indicate that one application per year is almost as satisfactory as split treatments two or three times a year. Many Valley orchardists apply part of the fertilizer con-

centrate before blossoming starts, and make a second application 2 or 3 months later, if the set of fruit seems to justify the extra feeding. The summer application is more likely to be needed in orchards where weeds and grass are allowed to go uncontrolled.

Nitrogen concentrate is used most commonly on bearing citrus trees. The amount should be sufficient to supply at least 1/5 pound of actual nitrogen for each 70-pound field box of fruit produced. A tree that produced five field boxes of fruit the previous season would receive enough concentrate to supply 1 pound of actual nitrogen as a prebloom treatment. Orchards in sod should receive double or triple this amount if maximum yields are the objective. The fertilizer can be applied as a split treatment (60 percent as a prebloom treatment and 40 percent about May 1).

Nitrogen concentrate will not be available for tree use until rain or irrigation water dissolves and leaches it downward into the root zone. Nitrogen concentrates should not remain on the surface for appreciable lengths of time because some of the nitrogen (up to 25 percent) may be lost by volatilization as ammonia gas. Much of the nitrogen in organic mulches or manure is lost similarly. A light disking to cover the nitrogenous material will prevent this surface nitrogen loss. Phosphorus concentrates should be incorporated with the soil by disking or injection, since phosphate fertilizers do not move far from the application point in alkaline soils.

Methods of applying fertilizer concentrates are important because careless application may result in destruction of valuable tree roots. Most of the active (feeder) roots are under the skirts of the trees, where the orchard soil is more mellow, more favorable for root growth and there is the least competition with weeds for the added plant nutrients. Most of the fertilizer should be applied in this area of greatest root activity, but it is difficult to do, except by hand or with specially designed machines (tillers with fertilizer attachments). Most orchardists apply pelletized concentrate with cyclone-type distributors that throw a fair share of the material under the skirts of the tree. "Ringing" the trees with narrow bands of concentrate is a risky procedure when light rainfall follows such an application.

Citrus Tree Nutritional Sprays

Deficiencies of certain mineral elements cause citrus trees to develop peculiar color patterns and other abnormalities in their leaves. These symptoms are recognized easily and in most cases the condition can be corrected. Where the affected trees are growing in alkaline (high lime) soil, it is difficult to correct so-called "alkali chlorosis" through the use of soil applications of trace minerals such as iron, zinc and manganese. It is more effective and economical to apply the essential minor elements in foliage sprays. They are required by the trees in relatively minute quantities and enough can be absorbed through the leaves to meet normal requirements.

Iron deficiency, characterized by a disappearance of green color from most or all of the leaf area between the veins, is one of the most common deficiencies, especially where trees on Cleopatra or sweet orange roots are growing in alkaline soil. It is a difficult deficiency to correct. Heavy soil applications of 10 pounds of ferrous sulfate per tree may be required, or the trees may be sprayed during the dormant season with a 4-percent solution of ferrous sulfate. This concentration may cause some injury to tender new growth.

Zinc deficiency, also known as "mottle leaf," "little leaf" and "frenching," is a common occurence in Valley orange orchards and in grapefruit orchards located on alkaline soils. It is so common in Florida and California citrus orchards that practically all of the groves in these states receive a spring spray treatment of neutral zinc. Additional zinc sometimes is applied along with the fertilizer. Many Valley orchardists who spray their orange trees during the spring season add sufficient neutral zinc compound to supply 1 pound of elemental zinc equivalent per 100 gallons of spray mixture. The zinc is applied along with the neutral copper used for melanose and greasy spot control and wettable sulfur for the control of rust mites and spiders.

Manganese deficiency—characterized by leaf mottling, without dwarfing of the leaves—is a problem only where trees grow in alkaline soil. It can be corrected by using a neutral manganese compound in quantities sufficient to supply 1 pound of elemental manganese per 100 gallons of spray. It can be used in combination with the neutral copper and zinc and the wettable sulfur applied during the early part of the fruit setting period.

Urea (having a *low biuret* content) is useful for boosting the nitrogen content of the leaves during critical periods. It is used as a low pres-

sure foliage spray at concentrations of 5 to 8 pounds per 100 gallons of water. The lower concentration is used when there are tender new leaves on the trees.

Irrigation of Bearing Citrus Trees

Water has become the most important factor in citrus fruit production in the Lower Rio Grande Valley. The limited supply of irrigation water available for crops in this area places special emphasis on this essential item. The normal amount of rain water that falls annually on Valley citrus orchards is insufficient to produce the many tons of dry matter contained in the leaves, twigs, roots and fruit produced each year by the trees on an acre of land. A minimum of 36 inches of water (including the effective precipitation) is required to sustain an acre of large citrus trees at peak production for 12 months. Where large weeds, grass or planted crops are allowed to grow in the spaces between the trees, the water requirement will be increased approximately 40 percent.

Timing the applications of irrigation water probably is the most important phase of citrus orchard management. Few orchardists in the Valley can water their bearing citrus trees more than four times per year. Thus, the available water supply must be used to meet the minimum requirements of the trees and there will not be much water for growing cover crops. The prebloom water application about late March and the July-August waterings are the irrigations most likely to be needed during a normal year. A November water application may be needed to keep the fruit growing and to help tide the trees over the normally dry winter season.

The orchardist knows the approximate amount of irrigation water that will be available to his orchard. This limited amount of water should be applied only when the trees need it, and in a manner to avoid unnecessary waste. Many orchardists have little more than 12 acre-inches of irrigation water to supply the needs of their trees for 12 months. Four 3-inch irrigations might meet these needs during a normal year, but few orchardists are equipped to apply as little as 3 or 4 inches of water per irrigation. This can be done with sprinkler irrigation. Most orchardists apply about 6 acre-inches of water at each irrigation and this rate allows only two waterings per year where the annual allotment is 12 acre-inches. Under such conditions, orchardists should obtain additional water to maintain their trees in a highly productive state. Acceptable well water is available in some areas and river water allotments are transferable in most water districts. The average Valley orchardist will need more than 12 acre-inches of irrigation water per acre, per year, to obtain good annual crops of citrus fruit.

The methods used for distributing water to the individual trees vary from the commonly used, but inefficient, flooding system, Figure 8, to the efficient sprinkler system, Figure 9. The irrigation system should be designed to fit the water supply, the land to be watered and the soil management system to be followed. The shortage of irrigation water will encourage the use of more efficient

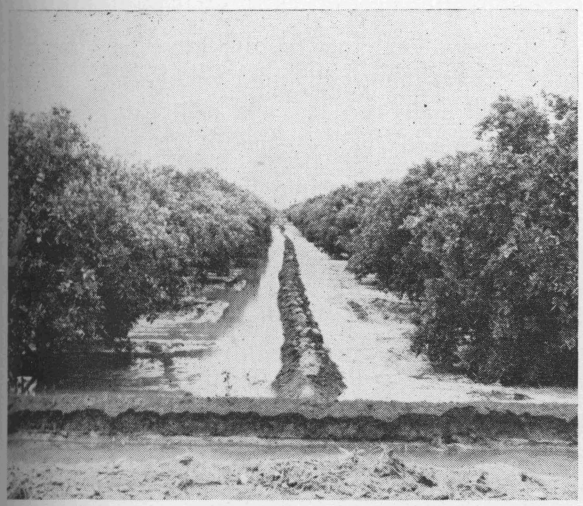

Figure 8. Flooding is the most commonly used method of irrigating orchards but it is the least efficient method.

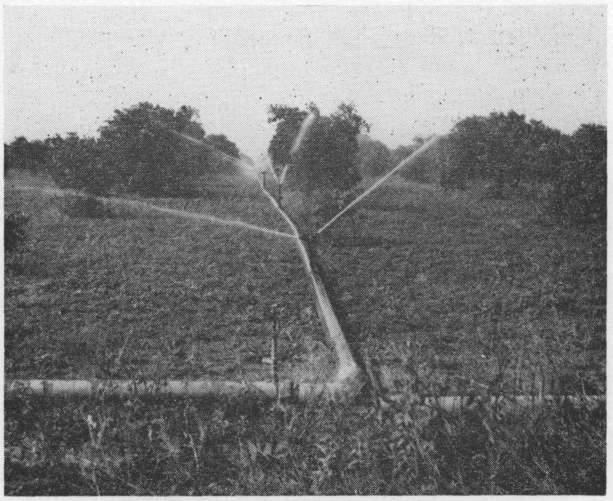

Figure 9. Sprinkler irrigation is most efficient, especially on rolling land.

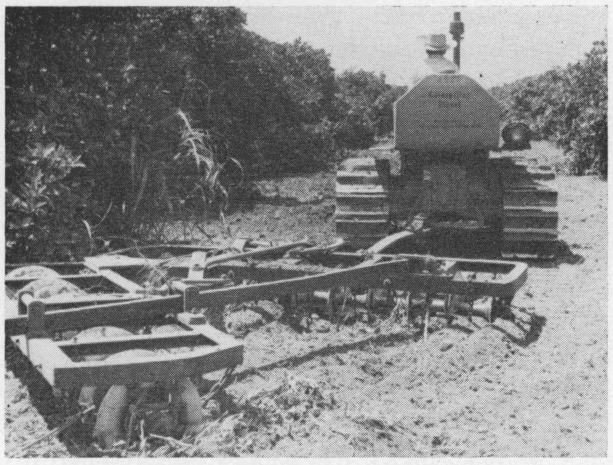

Figure 10. The cover crop disk is most commonly used for destroying weeds and incorporating organic matter. The track-type tractor supplies an abundance of power and is highly maneuverable.

water distribution systems than have been used in the past.

Cover Crops for Orchard Use

Few Valley orchardists plant cover crops in their bearing citrus orchards, but many allow grass and weeds to grow in space not occupied and shaded by the trees. The development of power-driven shredders has encouraged a number of orchardists to adopt the "permanent border and shredded (mowed) sod" method of orchard soil management. Some orchardists have been successful with "clean culture," where weeds and grass are never allowed to grow for more than a few weeks.

The inadequacy of the Lower Rio Grande Valley's water supply to meet all needs will necessitate strict conservation of the available water. If most orchardists cannot irrigate their trees more than four times a year, water will be too precious to use in growing cover crops of questionable value. In young orchards, where shading is not important, several kinds of grasses and weeds will appear and grow rather rapidly after each irrigation or rainy spell. These "volunteer" cover crops should supply enough organic matter to keep the orchard soil in good physical condition, since several weeks' growth of grass, weeds and vines may develop before it is practicable or convenient to disk them under.

Figure 11. Closely mowed sod in conjunction with sprinkler irrigation is a popular system of orchard management.

Research shows that certain grasses are more desirable soil-improving crops for citrus trees than are legumes. Johnsongrass and its near relative, Sudangrass, make good summer cover for orchards where the water supply is adequate. Buffelgrass, Blue panicum and Rhodesgrass are appearing as "escapes" in many Valley orchards.

Closely mowed (shredded) sod orchards soon become permanently sodded with Bermudagrass. It is hoped that Coastal Bermuda will not invade Valley orchards, since it is more difficult to control than the less vigorous Common Bermudagrass. Frequent mowing kills out the more desirable grasses such as Johnsongrass and then Bermuda predominates.

Johnsongrass and pigweeds thrive in young orchards where the soil is disked only once every 60 days during the frost-free season. Native sunflowers, sow thistles and wild mustard grow luxuriantly during winter and spring. Valley orchardists do not have to plant cover crops, because native grasses and weeds usually supply all of the organic matter needed.

Since sod orchards require more fertilizer and more water than cultivated orchards, it is not likely that many orchards will be left in permanent (Bermuda) sod.

Weed Control in Bearing Citrus Orchards

Native grasses, weeds and vines develop rapidly in the fertile soils of the Valley during the rainy seasons and following each irrigation. Weed control is essential in the younger orchards to prevent the natural cover crop from hindering the development of the trees and their fruit crops. A heavy plant cover during the winter will increase the danger of cold injury to the trees. However, disking during the cold-danger period materially increases the cold hazard to the trees, and should be done before the final irrigation.

The idea that cover crops are useful in Valley citrus orchards has caused owners and caretakers to use the minimum amount of weed control. However, the scarcity of irrigation water will necessitate changes in the soil and cover crop management programs, since cover crops compete with the trees for water.

An occasional disking may be needed to break up the sod and hasten the decay of the organic mulch that forms on the surface after repeated mowings or shreddings of the grass cover crop.

The cover crop disk is the most efficient weed destroyer and soil disturber yet devised (Figure 10), but there is a tendency to use heavy ungauged disks too close to the trees. A citrus tree is a shallow-rooted plant and 4-inch disking destroys appreciable quantities of tree roots. Trashy disking which leaves a fair percentage of the cover crop on or near the surface is best for the trees. This trash cover reduces soil erosion by wind and water and reduces soil compaction and runoff during periods of heavy rainfall.

Closely mowed sod demands less water than occasionally mowed sod, Figure 11. However, it is best to disturb occasionally the sod in permanently bordered orchards. This may be done mechanically with a sod renovator, or the grass can be killed with herbicides that are not harmful to trees. Certain petroleum oils are the most effective grass killers.

Weed control facilitates irrigation of the orchard soil. Fair distribution of irrigation water can be achieved on flat orchard soil that is heavily sodded. Where conventional methods are employed, it also is inconvenient to attend irrigation water in an orchard where the soil supports a dense growth of Johnsongrass, sunflowers and tie vines. One trip through the orchard in each direction with a properly shielded and gauged orchard disk will dispose of these impediments and greatly facilitate the distribution of irrigation water.

The cautious use of a properly equipped orchard disk prior to each irrigation, and when grass, weeds and vines are prevalent, is the best answer to the weed control problem in most Valley orchards. Machines which work under the skirts of the trees and save costly hoe work are being used more.

Pruning Bearing Citrus Trees

The removal of dead, diseased and pest-infested branches is the principal reason for pruning Valley citrus trees. It also may be desirable to head back, thin and open up the tops of standard types of citrus, especially Navel orange and lemon trees. Hedging to admit sunlight and to facilitate the passage of husbandry implements is being used in the older citrus producing areas where crowding has become a problem. Thinning "water sprouts," removing dead or badly diseased branches and twigs, cutting out worthless branches and "stubbing back" limbs that interfere with the operation of orchard equipment are good practices.

The best time to prune citrus trees is during early spring, preferably after the mature fruit have been harvested. Pruning during the late fall and winter may shock the trees into a flush of growth and predispose them to winterkilling. Dead wood may be removed from the trees when convenient.

Pruning usually is done to increase the set of fruit, increase the size of the individual fruit and to prolong the productive life of the trees. The trees should be kept within bounds to facilitate the performance of certain grove operations. It usually is not necessary to prune Valley citrus trees to regulate fruiting, except in the case of Navel orange and lemon trees. The opening of the tops or sides to admit sunlight induces inside fruiting of trees growing in orchards where crowding is a problem.

Dead and weak branches frequently serve as "incubators" for fungi which cause heart rot of the wood, twig and leaf "blight" and several types of fruit diseases. The removal of such branches should prolong the life of the trees and increase yields of sound fruit. Old shaded-out limbs which bear only a few leaves should be removed, especially if they are near the ground and interfere with grove operations. However, heavy pruning of the skirts is not recommended, since overpruning may reduce yields. After the trees "meet in the rows," and crowding becomes evident, the lower limbs will be "shaded out" and should be removed.

Pruning tools should be kept sharp, because dull saws and shears tend to tear the bark and make wounds that heal slowly. Shears should be of the type that cuts close to the main branches without bruising. Close cuts heal more rapidly and with less danger of infection than wounds at the ends of short stubs.

Hand pruning shears, lopping shears, pole pruners, saws of various types, a chisel and mallet and gloves are useful in pruning citrus trees. A

Figure 12. Athel (Evergreen Tamarix) is the most popular windbreak plant for valley use.

small paint brush, a bucket of wound protectant and a pair of rubber-soled shoes also will be needed by the tree pruner. Rubber-soled shoes minimize injury to framework limbs when it is necessary to climb the tree to remove unwanted branches. The chisel is a handy tool for removing water sprouts and dead branches along the scaffold branches. The cuts can be made close to the parent limb, quickly, smoothly and with minimum effort.

The use of a safe wound covering which sterilizes the cut surface (without excessive damage to the cambial cells) and protects the exposed wood from invasions by insects and disease is an important followup job. The protectant should be applied within a few days after the cuts are made.

Pruning can be the most costly job in the care of old citrus trees. More than an hour may be needed to prune an old tree. The general tendency is to overprune Valley citrus trees, because vase-form trees are more easily cultivated and dusted or sprayed. However, the loss of bearing surface and the reduction in yields must be weighed against any economy in cultural operations resulting from severe pruning.

Low Temperature Protection for Citrus Trees

Citrus trees are native to tropical and subtropical areas where freezes are unknown, but most of the world's supply of oranges and grapefruit is grown in the near tropics where damaging freezes occur occasionally.

The temperatures which grapefruit or orange trees will endure without suffering serious injury depends on the weather and the condition of the trees. The critical temperature for orange trees is between 18 and 28 degrees F. In the Winter Garden area, where citrus trees are almost dormant during the winter, orange trees have endured temperatures as low as 18 degrees F. and produced a fruit crop that same year. However, temperatures of 28 degrees F have caused serious "wood" loss on Valley orange trees, such as the two freezes in 1935. Trees in an active state of growth are more subject to cold injury than those in a semi-dormant state. Unfortunately, it is not always possible or practical to induce dormancy in Valley citrus trees. Withholding irrigation water to cause drouth-induced dormancy will check the growth of the hanging fruit crop and may weaken the trees to the point where they may be killed by low temperatures. Soil temperatures are high enough during the winter to encourage root development of citrus trees and this activity prevents the cessation of top growth. Soil treatments that tend to lower soil temperatures should increase the cold tolerance of the trees.

Windbreak plants help to reduce wind damage during cold fronts, as well as reduce fruit blemishing caused by high winds throughout the growing season, Figure 12. Care should be taken to select a windbreak plant that does not compete vigorously with the citrus trees for moisture and nutrients.

Some kinds of citrus trees are more resistant to cold than others. Orange trees are more tolerant to cold than grapefruit. Grapefruit and Meyer lemon trees will endure more freezing weather than Temple orange (tangor), Key lime or Eureka lemon trees. A recently set (dormant) tree is more resistant to freezing temperatures than a normal tree in an active state of growth. Trees budded on lemon understock are more sensitive to cold than those budded on sour orange or Cleopatra mandarin stock.

Methods of protecting plants against low temperatures include (1) conserving stored heat, (2) insulating against cold air, (3) adding heat and (4) air circulation. The first method is used by most orchardists to protect the trunks of young trees by banking with soil. The second method consists of placing insulating material around the trunks of young trees to prevent cold air from coming into contact with the bark. The third method might be called orchard heating and is not used extensively by Valley orchardists, because

of the great cost involved and because fast moving winds often accompany cold fronts. Air circulation with so-called wind machines is useful when temperature inversion occurs and the coldest air is near the ground line and there is a layer of warm air at 30 or 40 feet. This method is not effective when wind accompanies the low temperatures.

The conservation of stored heat offers the most effective protection against cold in the Valley. Large banks of soil around young trees absorb heat from the sun and release it to the tree during the night hours. Bare firm soil absorbs and stores quite a bit of heat. When released under the skirts of low-headed trees, this heat protects the framework limbs against considerable cold. Cloud blankets also conserve heat that is radiated from the orchard soil at night. The timely arrival of a cloud cover over the Valley often prevents serious cold damage to citrus trees.

Citrus Insects

Valley citrus trees and fruit frequently are damaged by insects. Some insects cause serious damage to the trees while others mainly affect the appearance of the fruit. Serious insect pests on citrus include the rust mites, scale insects, ants and citrus spider mites. Other insects occasionally may cause damage but they generally are of minor importance. Rust mites cause fruit blemishing (russetting) during the warm season when humid conditions prevail. These tiny pests usually appear in damaging numbers soon after the new fruit crop is set. The first control measures should take place before the rust mites move to the young fruit and cause russetting. Rust mites often will damage the fruit after the fall rains begin. These insects most likely will cause monetary losses to the average citrus grower.

Spider mites thrive during hot dry weather and may damage the leaves to the point that serious defoliation occurs. These insects do more damage than most citrus growers realize.

Scale insects on citrus usually are kept fairly well controlled by their natural enemies, but may appear in damaging numbers in dusty areas, or in orchards subjected to insecticidal drift from row crops planted to windward of the trees. Oil emulsion, of the approved type, is the most effective control for scale insects. Oil emulsion sprays also are effective against citrus spiders. Oil sprays should not be used on bearing trees after mid-August because oil adversely affects the ripening and coloring of citrus fruits and may result in the trees being more susceptible to cold injury. Oil sprays should not be used on trees showing symptoms of drouth stress. The need for an oil spray on citrus should be considered during the 6-week period beginning July 1.

Several kinds of ants usually can be found in Valley orchards. Fire ants (corn field ants) will most likely cause serious damage to young trees but wood ants, large red (harvester) ants and leaf cutting (parasol) ants sometimes are troublesome to orchardists. Soil inhabiting ants can be controlled with heptachlor, dieldrin or chlordane in the form of dusts, granules or low-pressure sprays.

For specific control measures for both insects and diseases, see L-385, "Texas Guide for Controlling Citrus Pests" and "Better Fruit Program for the Rio Grande Valley." Both of these publications can be obtained at county agricultural extension offices.

Valley Citrus Diseases

Disease is relatively less important under Valley conditions than it is in other citrus-producing areas. However, there are several diseases with which Valley orchardists should be familiar.

Psorosis (or scaly bark) is a virus disease of citrus that is spread only by budding from infected parent trees. It is incurable and frequently causes early decline and lowered yields of the infected trees. To prevent losses from this disease, take budwood only from trees known to be free of psorosis infection, or purchase them from State Certified planting stock.

Gummosis of citrus trees causes an abnormal bark condition, characterized by profuse oozing of resinous gum from fissures in the bark of the trunk and framework branches. This disease may be due to nutritional disturbances within the tree or to an invasion of the inner tissues of the tree by some parasitic fungus. Nutritional gummosis usually can be corrected through the proper use of fertilizers and soil correctives, such as gypsum and finely ground sulfur. Infectious gummosis, the type that destroys cambial cells and woody tissue, may be due to a fungal infection which begins in wounds or cracks near the ground line. However, the muddy shoes of pruners and harvest hands who climb the trees may infect scaffold branches with the fungus that causes brown rot gummosis. A type of gummosis that causes rotting

of the heart wood of the trees also is due to fungi which gain entrance through improperly protected wounds. Gummosis may reduce the vigor and productive capacity of severely infected trees to the point where they become unprofitable. Prevention of gummosis is the best control measure, but infection, discovered in time, may be treated successfully through surgical removal of the infected tissue and through medication and protection of the resulting wound.

Melanose and *greasy spot* are fungus diseases which affect the leaves, twigs and fruit at certain seasons. Neutral copper in sufficient quantities to supply 1 pound of copper per 100 gallons is used in combination with wettable sulfur as a postbloom, early spring treatment for the control of melanose, greasy spot, rust mites and spider mites. Neutral zinc sometimes is added to this postbloom spray to correct little leaf or mottle leaf of orange trees. A summer application of zineb, in combination with the oil emulsion spray used for the control of scale insects and spider mites, will give longtime control of greasy spot and rust mites.

Chlorosis may be a symptom of a nutritional deficiency, or the yellowing of the leaves may be caused by salt accumulation. Deficiencies of iron, zinc and manganese cause definite patterns in the leaves which can be recognized. These trace mineral deficiencies are corrected most effectively and economically through the use of neutral compounds of the deficient elements as foliage sprays—usually in combination with wettable sulfur and neutral copper fungicide.

Tristeza disease may be controlled by using tolerant understocks adapted to local conditions. Fruit diseases largely are problems for the handlers and shippers of citrus fruits.

MARKETING

Grapefruit, oranges and tangerines are grown in the Lower Rio Grande Valley primarily for sale as fresh fruit through retail channels. This places special emphasis on appearance, size, keeping and eating quality and other factors which affect dealer and consumer acceptance of the fruit.

Early maturity also is important in merchandizing a crop of fruit, since prices usually are highest at the start of the new fruit harvest. Growers also are anxious to move as much of their fruit crop as possible before the freeze-danger period begins. This creates a marketing problem, because some growers are willing to accept lower prices for their fruit rather than take the risk of having it frozen.

Certain varieties ripen earlier than others, but these hereditary characteristics may be altered by the environment in which the fruit develops. The orchardist can change the environment in which the trees grow to a limited extent, but not the climate, and it is impracticable to change orchard soil to any marked degree. However, soil management during the early part of the fall may have an effect on the size of the fruit, rind thickness, juice content and sugar to acid ratio of the juice.

The ripening and sizing of the fruit act as natural deterrants to dumping all of the crop on the market early in the season. Grapefruit and oranges which reach marketable size and meet the legal requirements for maturity early in the fall encounter less competition in the markets of the country than those that ripen and mature later. Most varieties meet the legal requirements for maturity by December 1, but large quantities of fruit never reach sufficient size to be marketed as fresh fruit. This small fruit problem indicates a need for a more remunerative outlet for good, but small, Valley oranges and grapefruit.

Most Valley citrus fruits are sold to cash buyers who bid for the fruit on the trees; the buyer pays all harvesting costs, loading and hauling the fruit to the packing plant. Some fruit is sold on a "clean the trees" basis, while most grapefruit is "sold on size" or is "ring picked." Under such a contract, the harvest crews only pick the fruit which meets minimum size requirements. The smaller fruits are left on the trees in the hope that they will increase in size so that they will be saleable as fresh fruit.

An appreciable amount of citrus fruits are harvested, packed and sold by cooperative associations of citrus growers. The co-op member receives a price for his fruit based on the "pooled returns" for lots of fruit to which he contributed.

The trend toward using small film bags for packing oranges and grapefruit should help solve the Valley's small fruit problem, since large quantities are marketed in consumer packages.

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