

thought there should be a price premium for mechanically harvested grapes because the product delivered to the winery had fewer stems and leaves, as compared with hand-harvested grapes. They were thus delivering more grapes per ton of delivered product to the winery. However, growers mentioned that not all varieties were picked as easily as Thompson Seedless (the main variety picked in these tests). Certain varieties were harder to shake from the vine, causing juicing which brought on early fermentation. This problem is of greater concern among growers of varieties, which bring a much higher return. A device for field crushing may aid in solving this problem.

Although field modifications were few among the growers interviewed, many had to raise stake height to raise the fruit zone, and five-ft stakes were commonly replaced by 6-ft to 7-ft stakes. A consequence of mechanization was that growers were forced to observe better management in maintaining stakes and wires, in pruning vines so as to remove obstructing arms, and in preparing low, narrow and clean berms.

Independence

Growers liked the machine because they felt it gave them independence from many of the problems encountered in hand harvest. They liked feeling more in control of the farm. A few also mentioned cost savings. Complaints about the machine were concerned with the long hours of work, repair costs, and the high initial cost of the machine and supporting equipment. However, the tone of growers was favorable towards the machine.

Since the harvester is specialized, it is idle between harvests. The manufacturers and some enterprising growers are developing additional uses for the machine. Some intended uses are as a spray rig, a cultivator and a pruning aid, all uses still concerned with grapes.

The estimated acreage needed to justify the purchase of a machine is being calculated and will be presented in a full report later this year. The report will also include comparisons of hand and machine harvest costs and problems, and implications for adjustments by growers.

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POTASSIUM NUTRITION AND DEFICIENCY IN CITRUS

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POTASSIUM DEFICIENCY OF CITRUS in California had not been recognized prior to about 1960. Since then, experimental work has led to a greater understanding of potassium nutrition and the effects of potassium levels (as determined by leaf analysis) on yield and fruit quality of oranges, lemons and grapefruit.

Leaf symptoms

Symptoms of potassium deficiency on orange, lemon, and grapefruit are shown in the photos. Yellow to yellow-bronze chlorotic patterns develop on older leaves, along with a cork-screw type of curling toward the lower leaf surface, particularly on the lemon. Similar leaf curling often occurs on healthy lemon trees, but the leaves do not become chlorotic. The intensity of the curling and chlorosis on lemon leaves increases as the severity of the deficiency increases. Potassium deficient orange and grapefruit trees usually do not exhibit this particular kind of leaf curl. On orange and grapefruit the chlorosis develops primarily on leaves behind fruit, and may not be easily recognized even when the deficiency is severe. The symptoms on lemon are more conspicuous, allowing easy visual diagnosis. Visual diagnosis should be confirmed by leaf analysis.

Leaf analysis

The potassium concentration in citrus leaves decreases with increasing leaf age. Leaf analysis guides are based on 5- to

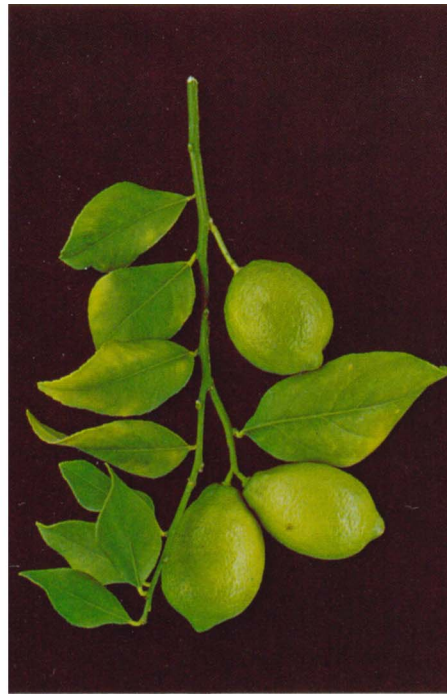
7-month-old leaves. Obtaining a leaf of this age from orange and grapefruit is not difficult. In lemons, however, a 3-month-old leaf may look the same as a 7-month-old leaf. In some earlier research, potassium deficiency of lemon often went undetected because young leaves in the samples had high concentrations of potassium. For correct diagnosis, it is essential to avoid leaves younger than 5 months.

Experience with citrus shows that after leaf potassium drops into the deficiency range (below 0.7%), increasing it to the adequate range is difficult—even with several years of either soil or foliar potassium applications. Consequently, the potassium leaf concentration should not be permitted to drop below 0.7% in 5- to 7-month-old spring-cycle leaves from non-fruiting terminals. Leaves should be sampled and analyzed by competent personnel.

For most effective use of citrus leaf analysis, a record of annual leaf analyses and amounts of fertilizer applied should be kept for each leaf sampling unit. This information can help in making a decision on the proper use of potassium fertilizer.

Yield and fruit size

The influence of the percentage of potassium in leaves on yield, fruit size, and quality for orange and lemon are shown in graphs 1 and 2. Preliminary information indicates that the potassium



Potassium deficiency symptoms (left to right) on orange, lemon, and grapefruit show up in yellow-bronze chlorotic patterns on leaves, as well as cork screw type curling toward lower leaf surface, particularly on lemon.

effects for grapefruit are similar to those for orange.

The number of fruit per tree on orange, lemon, and grapefruit is likely to be reduced if leaf potassium drops below 0.7%. For these three kinds of citrus fruit, and probably others, fruit size increases up to about 1.2 or 1.3% leaf potassium. While increases of potassium above this range may result in a slight size increase, it is of little practical value. Volume yield (boxes of fruit per tree)

is related to both numbers and size of fruit.

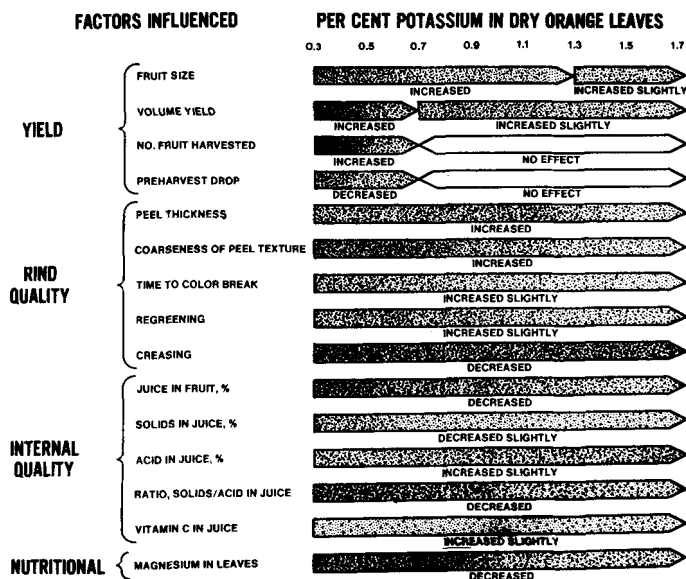
Fruit quality

Many of the effects of increasing potassium levels on the quality of orange, lemon, and grapefruit are similar, but the economic impact has not been the same. For example, a delay in time-to-color-break (loss of green color) of the orange or grapefruit may not be desirable, or may be of little consequence.

However, a delay in time-to-color-break of lemon permits the fruit to remain on the tree longer and attain a larger size before harvest, since harvesting of the lemon fruit is determined by both size and color.

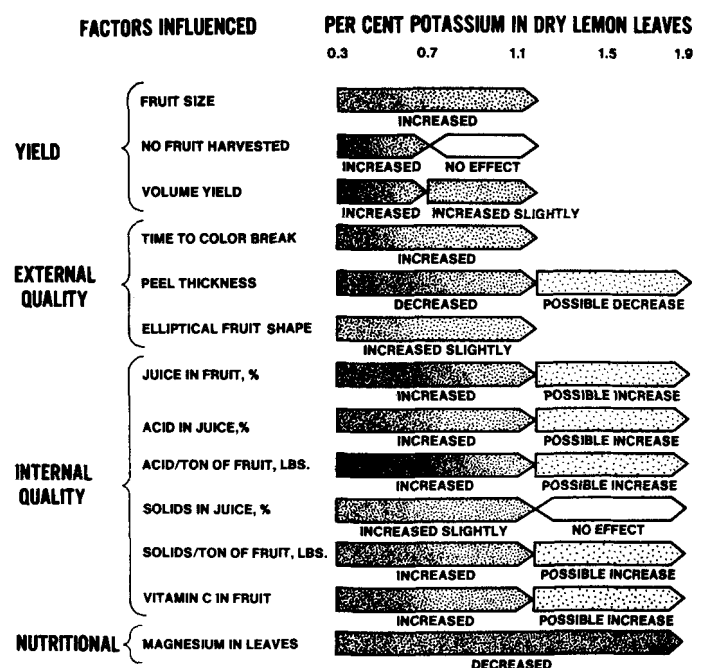
Also, an increase in the acid concentration in lemon juice is usually desirable, particularly for products fruit. In oranges, an increase in acid concentration delays the time to reach legal maturity—which may be of some advan-

GRAPH 1. INFLUENCE ON YIELD, QUALITY AND MAGNESIUM NUTRITION RESULTING FROM CHANGES IN PERCENTAGE OF POTASSIUM IN 5- TO 7-MONTH-OLD, SPRING-CYCLE ORANGE-LEAVES.*



*Degree of shading indicates amount of effect on factor indicated.

GRAPH 2. INFLUENCE ON YIELD, QUALITY AND MAGNESIUM NUTRITION RESULTING FROM CHANGES IN PERCENTAGE OF POTASSIUM IN 5- TO 7-MONTH-OLD, SPRING-CYCLE LEMON LEAVES (NO ARROW MEANS NO VALID DATA)*



tage to the internal quality of late-harvested oranges.

An increase in potassium affects some quality factors differently in oranges than in lemons. A higher potassium level increases orange peel thickness and reduces the percentage of orange juice, but decreases lemon peel thickness and increases the percentage of lemon juice. The increase in the percentage of lemon juice, in conjunction with an increase in the acid concentration in the juice (both of which are associated with an elevated potassium level), results in a marked increase in pounds of acid per ton of fresh lemon fruit. This is a particular advantage in lemon fruit used for processing.

Creasing of oranges can be reduced by increasing the potassium level, regardless of the initial level. There are, however, no leaf analysis guides that can be used to predict the incidence of creasing.

Potassium application

Potassium fertilizer should not be applied indiscriminately either as a foliar spray or soil application. Leaf values below 0.7% would in most cases indicate a need for potassium. With leaf values above 0.7%, potassium fertilization can be of value where creasing of oranges or small fruit sizes are problems. As indicated in the charts, other factors are also

influenced and should be considered before potassium is applied when leaf levels are above 0.7%.

Suggested rates for foliar applications are 30 lbs of potassium nitrate per 100 gallons of spray (in water only). For a mild deficiency one annual spray suffices, but for a moderate to severe deficiency, two annual sprays are required. Although applications at all times of the year have been effective, somewhat better results have occurred from applications shortly after expansion of the major growth flush of the year.

The nitrogen in the potassium nitrate sprays supplies some nitrogen to the tree, so that the amounts of nitrogen applied in the normal nitrogen program can be reduced.

Unfortunately, soil applications of potassium are sometimes ineffective on California citrus, even several years after a massive application of fertilizer. Five to 10 lbs of potassium sulfate (sulfate of potash) applied in a band around the dripline of each tree, for two consecutive years is sometimes effective, and if so, is likely to remain effective for several years. Leaf analysis can indicate need for repeat applications. On poorly-drained soils, salinity problems have occurred with applications of potassium sulfate greater than 10 lbs per tree.

Although not evaluated experimentally on citrus, potassium nitrate could be applied to the soil instead of potassium sulfate. Potassium nitrate could supply the total amount of nitrogen required since 7.4 lbs of potassium nitrate contains 1 lb of nitrogen, and 2.7 lbs of potassium (which is equivalent to the potassium in 6.1 lbs of potassium sulfate). Where soil applications have been effective, the only difference in response between soil- and foliar-applied potassium has been a more rapid response to the foliar-applied material. Potassium chloride (muriate of potash) should not be used on citrus in California because of the damaging effects that have been encountered from use of this material.

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GLYCEROPHOSPHATE

as a phosphate fertilizer

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Commonly available commercial phosphate fertilizers move very little from point of contact with the soil—resulting in inefficient utilization of surface-applied materials. An organic phosphate compound, glycerophosphate, has been shown to move through the soil with applied irrigation water. Potential utilization advantages of glycerophosphate as a fertilizer include: possible correction of deficiencies in mid-season; application with the water in sprinkler or drip irrigation systems; and proper placement, and timing of surface applications.

ALTHOUGH THE USE OF inorganic phosphates as a means of supplying phosphorus to plants is well known, much difficulty is encountered in the topical application of these materials as fertilizers. After 60 years of scientific investigation, with several sources of inorganic phosphate, there is little doubt that phosphorus moves very little from point of contact with the soil. Commonly available commercial phosphate fertilizers hydrolyze chemically (on contact with the soil solution) to the orthophosphate ion and are adsorbed or precipitated almost immediately. The situation is especially serious for irrigated agriculture in arid areas of the world inasmuch as the surface 2 to 10 cm (0.8 to 4 inches) of soil dries rapidly, resulting in no active roots in that region of the soil profile. There-

fore, there is inefficient utilization (commonly 5% to 10%) of surface-applied phosphate fertilizers.

A partial solution to the inefficiency of surface-applied phosphate fertilizer has been banding and mechanical placement in the root zone. However, in permanent crops such as alfalfa, orchards, and turf, subsurface applications are seldom used because of damage inflicted upon the root system and the stand of the plants. Also, where irrigation is accomplished by permanent installations such as drip and solid set sprinkler systems, it is physically impractical and economically not feasible to inject phosphorus below the soil surface. Consequently, it seems essential that a fertilizer without the undesirable characteristics of presently available phosphate fertilizers be developed.