

manure-treated plots, and additional treble superphosphate broadcast where the light rate had been broadcast initially.

This second test was located at the Fink Ranch on the west side of the Antelope Valley. Each plot was one-third acre in size and there were four replications of each treatment. Results the first season showed slightly higher yields from the high rate of treble superphosphate than from the dairy manure. However, as the experiment continued, yields from the animal manure treatments improved, particularly at the higher rate (19 tons) of broadcast application. Results over a four-year period (see table 3) indicate that about 80 lbs of hay were produced from each pound of fertilizer phosphorus applied from the dairy manure. An equivalent yield was possible where broadcast applications of phosphorus (from treble superphosphate) had been made. The heavy initial application of superphosphate worked into the soil was not quite as effective as the experiment continued.

Results of these two alfalfa fertilizer tests in the Antelope Valley indicate that animal manures and poultry manures can be used in alfalfa production and that they give continued phosphorus responses equal to, or slightly better than, those obtained from commercial phosphorus materials. No attempt is made in this study to evaluate costs. Nothing in the data suggests that application of manure justifies an appreciably higher price per unit of phosphorus than would be paid for superphosphates.

Manures in this study did at least as well as commercial phosphorus and appear to have a definite place in phosphorus-deficient areas. If manures can be transported and applied to the land at favorable costs it would seem worthwhile to explore the possibility of utilizing the large resources of manures from poultry farms and dairy or beef feed lots in southern California as a means of building up some of the phosphorus-deficient soils in nearby valleys. It would also seem possible that grass crops such as sudan or sorghum might precede the alfalfa to allow some return for the large amounts of nitrogen which come with the phosphorus in the initial manure applications—and let the residual build-up of soil phosphorus help alfalfa crops which could then follow.

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GIBBERELLIN RESEARCH WITH CITRUS

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Gibberellic acid is registered and recommended in California for certain uses (particularly in delaying rind and fruit maturity) on navel oranges and lemons. Favorable responses have also been obtained on limes and mandarins, but our present knowledge is insufficient to warrant registration or recommendation for use on these fruits. So far, we do not know how to take advantage of the delayed softening and aging of Valencia orange and grapefruit rind tissue without obtaining considerable regreening. The influence of GA₃ on retention of young fruit has potential value, but no practical method has yet been devised to avoid phytotoxic responses.

GIBBERELIC ACID (GA₃) is the commercially available member of a family of naturally occurring compounds. Very low concentrations of these compounds possess biological activity capable of regulating plant growth. The influence of GA₃ on citrus has been the subject of extensive field and laboratory research in California during the past eight years. When GA₃ is applied to nearly mature green-colored citrus fruit there is a considerable delay in loss of green chlorophyll pigment from the rind. In lemons and limes, this reflects a delay in fruit maturity, but for grapefruit, mandarins, and both navel and Valencia oranges, the effect appears to result from a delay in certain aging processes of the rind.

Lemons and limes

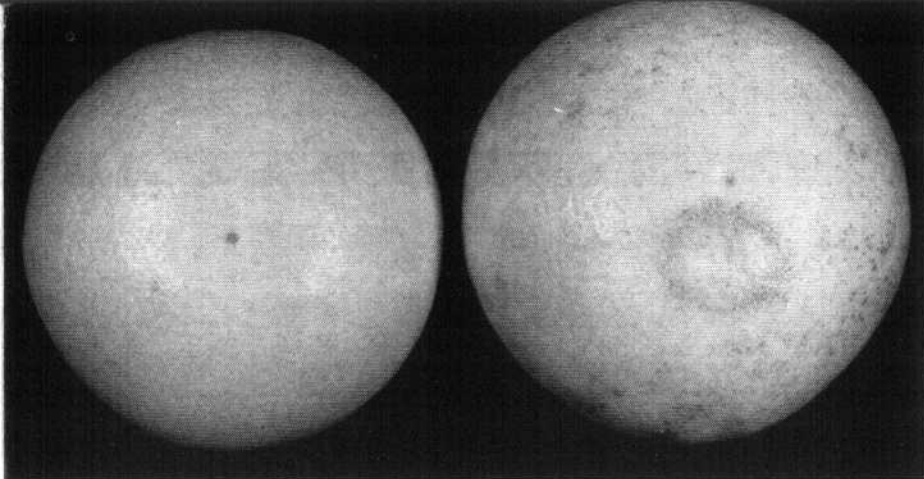
Preliminary trial applications of GA₃ to lemons and limes in 1956 indicated that it might be effective in increasing fruit set or retention in these and other varieties of citrus. Although increased retention occurs when GA₃ is applied to branches, to individual flower clusters, or to small fruit, phytotoxic effects occur when GA₃ is applied to entire trees during bloom.

The natural pattern of lemon and lime

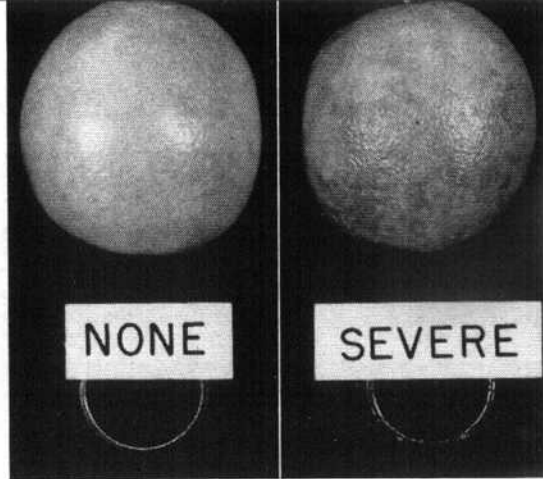
fruit maturity is for much of the fruit to color and ripen prior to the demand for fresh fruit that develops during hot summer weather. GA₃ sprays delay the maturity of lemon and lime fruits—providing greater flexibility in harvesting and marketing. In some trials, this delay in fruit maturity has eliminated the early harvest, which is predominately undesirable, small, tree-ripe fruit. GA₃ has been registered and recommended for use on lemons since November 1963, but registration has not yet been obtained for limes.

Mandarins

Poor fruit set is a problem in the Clementine (Algerian) mandarin wherever it is grown. In previous trials (1958), applications of GA₃ at 1,000 ppm to flowers in full bloom on Clementine trees resulted in increased fruit set. The GA₃-treated fruits were significantly smaller—probably because they were also seedless. Since the self-incompatibility of this variety can be somewhat overcome by interplanting other citrus varieties, and since spraying entire trees during the flowering season has phytotoxic results, very little additional research has been performed. The potential of GA₃ to



Red Ruby Blush grapefruit from Hemet. The fruit on the left was not treated. Fruit on the right had been dipped in 500 ppm GA₃ four months previously. A green ring on the bottom and brownish speckles persisted on treated fruits until harvest.



Washington navel oranges from Tulare County. Fruit seen on the right shows evidence of severe rind staining.

delay softening in mandarins has not been tested enough to determine possible use.

Valencias and grapefruit

If GA₃ is applied to Valencia orange or grapefruit trees when the fruits are fully colored, regreening of the rind increases. In some trials, this regreening has caused a considerable reduction in crop value.

In 1958, relatively high concentrations of GA₃ sprays on Marsh grapefruit trees in San Bernardino County caused severe leaf drop and twig die-back when treatments were applied just after full bloom. Mature fruits on the trees at time of spray, regreened, lost turgor and shriveled. Although drop of mature fruit was decreased by GA₃, production on treated trees was reduced.

Subsequent GA₃ fruit dip trials on Red Ruby Blush grapefruit at Hemet resulted in less yellow and blush color development, a green ring on the bottom of each treated fruit, and brownish speckles (see photo). Additional research is planned to determine whether lower concentrations or different times of application will produce the beneficial effects and minimize the undesirable responses.

Navel oranges

The navel orange fresh fruit market is an important segment of the California citrus industry. To promote orderly marketing, it is often necessary to store the crop on the tree and harvest it over a period of four to six months after it reaches legal maturity. Later in the season a number of rind disorders appear—especially in the Central Valley citrus areas.

One serious problem in navel oranges is "rind staining." Symptoms vary from brownish discolorations on the surface to breakdown and shallow pits in the rind

(see photo). This disorder results from the rind becoming soft and susceptible to mechanical abrasion. During the past five years a reduction in rind staining has been obtained from pre-harvest application of GA₃. When navel oranges age on the tree, the rind surface occasionally becomes sticky to the touch. This condition was also markedly reduced by GA₃ applications.

Spray oil

Pesticide spray oil has been an important insect control material for many years, but oil sprays increase the susceptibility of navel oranges to water spot. However, the addition of GA₃ to oil spray for pest control in August or September did not remedy this condition. In subsequent trials, it was found that application of GA₃ later in the season—as soon as the fruit reached full or marketable orange color—gave protection from water spot to Washington navel oranges previously treated with oil spray in late summer.

Other benefits of GA₃ sprays to navel oranges include maintenance of the rind in a condition of greater resistance to puncture, and a reduced susceptibility to rupture of the rind under pressure (see photo). Fruit size, fruit shape, rind thickness and juice quality factors have not been affected by treatments. GA₃ is registered and recommended in California for certain uses on navel oranges and it is estimated that approximately 10,000 acres were treated during the 1965-66 season.

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Penetrometer used to measure the resistance of orange surface to rupture.

