Gibberellin Tested on Citrus

fruit set on Bearss lime, Eureka lemon, and Washington navel orange increased by treatments in preliminary investigations

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Light fruit set of navel oranges and—to a lesser degree—of Valencia oranges often occurs and growth regulators tested in California in the past have failed to increase the set. However, certain gibberellin treatments—in preliminary experiments—have increased fruit set on lime, lemon, and orange trees.

In one experiment—with Bearss lime—initiated in October 1956, fruit 3/8″ in average diameter were tagged and painted with either 100 ppm—parts per million—or 1,000 ppm concentration of gibberellic acid—GA—dissolved in 95% ethyl alcohol. Twenty groups of three fruit were tagged on each of five trees. One tagged fruit in each group was a control. Approximately three months after treatment the remaining fruit were counted and measured. The count showed 58% of the control fruit, 86% of the 100 ppm GA treated, and 79% of the 1,000 ppm GA treated fruit remained. Statistical evaluation of the data showed that both GA treatments were significantly different from the control at the 1% level. The treated fruit were normal in appearance and when harvested on March 26, 1957, no differences were found in fruit size or in per cent acid, soluble solids, or juice.

In a second experiment—started on December 28, 1956—30 flowering terminals on each of 10 Eureka lemon trees were thinned to a single bloom and tagged. Three treatments were applied to 10 groups of matched terminals on each tree. In each group of three, one flower was painted with 100 ppm GA, another with 1,000 ppm GA, and the third was left untreated as the control. Gibberellic acid dissolved in 95% ethyl alcohol was used. Approximately three months later a count of fruit set showed 1.4 fruit set for the control, 1.8 for the 100 ppm GA treatment, and 3.0 for the 1,000 ppm GA treatment. The improved fruit set at the high concentration of GA was statistically significant at the 1% level when compared to the control.

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Washington navel oranges three weeks after a 250 ppm gibberellin spray was applied over flowers. The persistent styles on the fruit illustrate a typical growth regulator effect.

CITRUS

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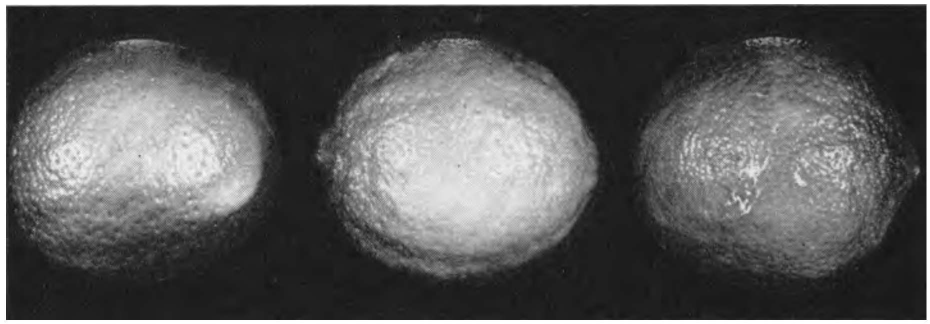
In one experiment in the Edison area near Bakersfield, mist sprays of one gallon per tree of the potassium salt of gibberellic acid—KGA—at 10 ppm and 100 ppm concentrations were applied. Single-tree plots were replicated four times and included an unsprayed control. The sprays were applied on May 2, 1957, when the young fruit averaged 3/16″ in diameter. The fruit on all treatments were normal in appearance and in fruit quality factors as determined by analysis of fruit samples obtained on October 18, 1957, and again on December 11, 1957. Because of a harvesting error, production records were not obtained.

In another experiment on 20 Washington navel orange trees at Riverside, drenching sprays were applied to eight individual branches per tree. Each of the eight branches received a different KGA spray treatment as follows: 1 ppm single spray, 1 ppm repeat spray, 10 ppm single spray, 10 ppm repeat spray, 100 ppm repeat spray, 250 ppm single spray and 1,000 ppm single spray. The wetting agent was Dynawet at 0.06%. The initial spray application was made on May 3, 1957, when the trees were in the latter part of the bloom period, and the repeat sprays were applied after bloom on May

Washington Navel Oranges Mist Sprayed with 1 Gallon Gibberellic Acid on May 2, 1957
Edison

Fruit quality factors	Treatments		
	Control	10 ppm spray	100 ppm spray
Oct. 18, sample 18 fruit/tree			
Acid mg/10 ml juice	94.9	92.4	94.4
% soluble solids	11.0	11.2	11.3
% juice	45.0	46.0	45.0
Ascorbic acid mg/100 ml juice	69.0	69.0	66.8
Rind color rating[1]	3.7	3.4	3.3
Dec. 11, sample 20 fruit/tree			
Acid mg/10 ml juice	51.3	52.1	52.1
% soluble solids	14.1	14.0	14.2
% juice	47.0	49.0	48.0
Rind thickness mm	5.0	4.5	4.9

[1] An arbitrary scale with 1 indicating good orange color, 2, 3 and 4 progressively more green, and 5 indicating 50% or more green color on the rind.



Mature Bearss lime fruit seven months after young fruit had been painted with gibberellin at—*Center*—100 ppm—*Right*—1,000 ppm, or—*Left*—untreated control. Fruit set was increased by the gibberellin while size and maturity were not influenced.

Fruit Count and Size on December 10, 1957
Drenching sprays of potassium salt of gibberellic acid applied on May 3, 1957
Washington Navel Oranges—Riverside

Treatments	Dates sprayed	No. of fruit/branch	Av. fruit diam. mm
Control	No spray	2.0	63.1
1 ppm	5–3–57	1.5	65.6
1 ppm	5–3–57, 5–29–57	2.1	66.3
10 ppm	5–3–57	2.2	64.7
10 ppm	5–3–57, 5–29–57	2.1	64.4
100 ppm	5–3–57, 5–29–57	2.7	63.5
250 ppm	5–3–57	3.9**	61.9
1,000 ppm	5–3–57	4.0**	62.5
Significance level:	5% D	1.3	NS
	1% D	1.7	

** Indicates significance at the 1% level of probability.

Composite Fruit Sample, January 22, 1958
Drenching sprays of potassium salt of gibberellic acid applied on May 3, 1957
Washington Navel Oranges—Riverside

Fruit quality factors	Treatments		
	Control	250 ppm spray	1,000 ppm spray
Acid mg/10 ml juice	129.8	143.9	136.2
% soluble solids	10.3	10.3	10.4
% juice	47.0	47.0	46.0
Ascorbic acid mg/100 ml juice	75.0	74.7	69.3
% fruit showing abortive seeds	14.0	36.0	33.0

Washington navel oranges—Riverside experiment. On the left fruit from 20 control branches harvested on January 22, 1958. Fruit from similar branches sprayed with 250 ppm KGA on May 3, 1957, at the right.

29, 1957, but before the severe period of June drop. The control branches received no spray.

A count of the fruit set per branch on July 12, 1957, showed that there was an average of 8.3 fruit set on the 250 ppm treatment and 10.0 fruit set on the 1,000 ppm treatment as compared with the control which had 5.4 fruit set. The increase in fruit set due to KGA treatments was significant at the 1% level. This difference was maintained until the fruit were harvested on December 10, 1957, when the 250 ppm treated branches averaged 3.9 fruit, the 1,000 ppm branches 4.0 fruit, and the control branches 2.0 fruit. None of the other treatments caused significant differences in numbers of fruit set.

There was no significant effect of any of the treatments on fruit size. Pooled samples for each of the two highest KGA concentrations were similar to the controls in fruit quality as measured by acid and soluble solids in the juice and per cent juice.

The numbers of small abortive seeds of about ⅛″ in length were only counted for the 250 and 1,000 ppm concentrations. These treatments caused a twofold increase in tiny undeveloped seeds.

Large-scale field experiments are now in progress to further evaluate the influence of gibberellins on fruit set and other tree responses.

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OLIVES

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to bloom if maintained in the greenhouse during the entire winter with a minimum temperature of 55°F.

It is apparent that olive trees—at least the Mission and Barouni varieties—require a period of winter chilling before they will bloom.

Flower Production

The degree of flower production and consequent fruitfulness is proportional—within limits—to the amount of winter chilling. A similar situation—with an important difference—exists in deciduous fruits, such as pears, peaches, and apricots, in which a winter chilling period of sufficient duration and intensity is essential for satisfactory fruit production.

In the deciduous fruits, flower initiation occurs the previous summer; the low winter temperatures serve to break the rest period of the buds, allowing them subsequently to develop normally rather than absciss or fail to open.

In the olive, the first microscopic evidence of flower initiation does not appear until about March 15, following the usual winter-chilling period. It is quite probable that the low-temperature winter period is responsible for the subsequent initiation of floral parts, because a lack of a low-temperature period results in the failure of flowers to be initiated, and the longer the period of winter chilling the greater is the production of flowers.

Varietal Experiments

On October 1, 1954, 3-year-old trees of seven different varieties—Rubra, Azapa, Mission, Manzanillo, Barouni, Ascolano, and Sevillano—grown in 3-gallon cans, were divided into four groups of three trees each.

Group *A* was placed in the greenhouse October 1, and received no chilling throughout the winter. The temperature in the greenhouse was thermostatically controlled with a minimum of 60°F. Trees in Group *B* remained outdoors until December 15, when they were brought into the greenhouse. They received 578 hours below 45°F. Group *C* remained outdoors until January 15, receiving 1,212 hours below 45°F. Group *D* was outdoors the entire winter, receiving 2,143 hours below 45°F.

Shortly after each group was brought into the greenhouse, vegetative growth activity resumed and after 3–4 weeks under greenhouse temperatures inflorescences began to appear. At full bloom, the total number of inflorescences per tree, the average number of flowers per inflorescence, and the per cent perfect flowers were determined. After fruit setting was complete, the number of fruits per tree was counted. The top table on page 6 shows the effects on fruitfulness of the differential winter chilling.

In the winter of 1956–57, the same trees were used again in further tests. In addition, trees of the Criolla variety were included. The tests were conducted in essentially the same manner as in the 1954–55 studies. The trees of each variety were divided into four groups of three trees.

Group *A* was taken into the greenhouse on October 3, after four hours below 45°F. Group *B* was brought in on December 18, after 613 hours below 45°F. Group *C* was taken into the greenhouse on February 1, after 1,326 hours below 45°F. Group *D* remained outdoors the entire winter, receiving 1,657 hours below 45°F.

In the absence of winter chilling, no inflorescences were produced on any tree of any variety. With all varieties—except Rubra and Azapa—maximum inflorescence and fruit production per tree were obtained with the maximum amount of chilling in 1956–57 as in 1954–55.

The results were somewhat erratic for the trees given the intermediate amounts of chilling. In several cases, trees in Group *B* produced more inflorescences and fruits than those in Group *C*, even though Group *C* had a greater amount of chilling. In general, however, trees receiving an intermediate amount of chilling produced intermediate numbers of inflorescences and fruits.

Response Evident

A varietal response in inflorescence production to the differential chilling was evident. Varieties Ascolano and Sevillano seem to require the maximum amount of chilling given in these tests before appreciable numbers of inflorescences are produced. Therefore such varieties should be planted only in areas characterized by relatively large accumulations of hours below 45°F during the winter months.

Varieties Mission, Criolla, Barouni, and Manzanillo produce some inflorescences with only a slight amount of winter chilling but, generally, far below the numbers possible when greater amounts of chilling are given.

In the 1954–55 experiments, varieties Rubra and Azapa behaved like Mission, Criolla, Barouni, and Manzanillo, but in the 1956–57 tests, Rubra and Azapa flowered as well with low chilling as with complete chilling. Rubra produced 227 inflorescences per tree after 613 hours at 45°F and 187 inflorescences after 1,657 hours at 45°F. Azapa produced 41 inflorescences per tree after 613 hours at 45°F and 54 after 1,657 hours. Although the results were not consistent for both years, the 1956–57 experiment indicates that it is possible for only a slight amount of chilling to induce considerable inflorescence production in these two varieties.

The varying fruit bearing characteristics of olives in certain areas may possibly be explained on the basis of sufficient or insufficient winter chilling. For example, it is difficult to obtain the high yields from olives in southern California that can be produced in the interior Central Valley. The mean January temperatures in southern California olive districts range from 54°F at Riverside to 55°F at San Diego, whereas in each of the three leading olive sections in the Interior Valley the mean January temperature is 45°F.

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