# Fruitfulness in the Olive

## winter chilling may explain higher yields of orchards in the interior Central Valley than of those in southern California

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**Olive trees** will not survive winter temperatures below 10°F–12°F, but they require relatively cold winters to produce satisfactory commercial crops.

The principal olive districts in California's Central Valley have a mean January temperature of 45°F. Other areas of the world where olives produce satisfactory crops have similar relatively cold winters, such as Seville, Spain, with a mean January temperature of 49.6°F; Rome, Italy, 45°F; and Athens, Greece, 47.6°F.

In regions with relatively warm winters the olive will grow very well—vegetatively—but in general, the trees are not fruitful where the mean January temperature is much above 50°F or at latitudes much below 30°.

At Homestead, Florida—25° north latitude and a mean January temperature of 66.8°F—healthy, vigorous olive trees have been grown but they never bloomed. Efforts for the past 20 years near Brownsville in southern Texas—26° north latitude, mean January temperature 59.8°F—have failed to induce olive trees to set fruit.

**Effect of Winter Chilling on Fruitfulness of Seven Olive Varieties**
**Average of three trees per treatment. 1954–55**

| Variety | Average number inflorescences per tree | | | | Average number flowers per inflorescence | | | | Average percentage of perfect flowers | | | | Average number of fruits per tree | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *A | B | C | D | *A | B | C | D | *A | B | C | D | *A | B | C | D |
| Rubra | 0 | 43 | 11 | 314 | .. | 19 | 18 | 16 | .. | 61 | 87 | 53 | .. | 0 | 0 | 108 |
| Azapa | 0 | 30 | 8 | 240 | .. | .. | 10 | 10 | .. | .. | 29 | 50 | .. | .. | 0 | 14 |
| Mission | 0 | 29 | 31 | 336 | .. | 5 | 10 | 14 | .. | 15 | 20 | 20 | .. | 1 | 2 | 37 |
| Manzanillo | 0 | 0 | 6 | 249 | .. | .. | 4 | 9 | .. | .. | 2 | 38 | .. | 0 | 0 | 14 |
| Barouni | 0 | 27 | 22 | 189 | .. | 5 | 8 | 8 | .. | 43 | 61 | 74 | .. | 11 | 2 | 67 |
| Ascolano | 0 | 0 | 0 | 152 | .. | .. | .. | 11 | .. | .. | .. | 25 | .. | .. | .. | 3 |
| Sevillano | 0 | 9 | 2 | 198 | .. | 7 | 10 | 8 | .. | 41 | 1 | 23 | .. | 4 | 0 | 22 |

* Group A—0 hours below 45°F. Group B—578 hours below 45°F. Group C—1212 hours below 45°F. Group D—2143 hours below 45°F.

**Effect of Winter Chilling on Fruitfulness of Eight Olive Varieties.**
**Average of three trees per treatment. 1956–57**

| Variety | Average number inflorescences per tree | | | | Average number flowers per inflorescence | | | | Average percentage of perfect flowers | | | | Average number of fruits per tree | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *A | B | C | D | *A | B | C | D | *A | B | C | D | *A | B | C | D |
| Ruba | 0 | 227 | 40 | 187 | .. | 16 | 10 | 16 | .. | 94 | 67 | 62 | .. | 18 | 1 | 68 |
| Azapa | 0 | 41 | 59 | 54 | .. | 14 | 11 | 14 | .. | 80 | 86 | 85 | .. | 2 | 3 | 8 |
| Mission | 0 | 8 | 111 | 328 | .. | 10 | 8 | 14 | .. | 76 | 18 | 32 | .. | 1 | 5 | 74 |
| Manzanillo | 0 | 14 | 40 | 132 | .. | 8 | 8 | 11 | .. | 71 | 39 | 51 | .. | 0 | 14 | 18 |
| Barouni | 0 | 2 | 21 | 88 | .. | 8 | 8 | 11 | .. | 88 | 78 | 48 | .. | 0 | 21 | 62 |
| Criolla | 0 | 0 | 41 | 132 | .. | .. | 15 | .. | .. | .. | 72 | .. | .. | .. | 7 | 7 |
| Ascolano | 0 | 0 | 1 | 289 | .. | .. | 7 | 14 | .. | .. | 28 | 10 | .. | .. | 0 | 6 |
| Sevillano | 0 | 0 | 1 | 57 | .. | .. | 10 | .. | .. | .. | 63 | .. | .. | .. | 0 | 3 |

* Group A—4 hours below 45°F. Group B—613 hours below 45°F. Group C—1326 hours below 45°F. Group D—1657 hours below 45°F.

**Effect of the Amount of Winter Chilling on Fruitfulness of Mission and Barouni Olives**

| Treatment | No. of hours below 45°F | No. of inflorescences /tree | No. of flowers /tree | No. of perfect flowers /tree | Perfect flowers % | No. of fruits /tree | No. of fruits /100 inflorescences |
|---|---|---|---|---|---|---|---|
| *Mission variety—1950–51 (average of 12 trees per treatment)* | | | | | | | |
| No chilling. Trees moved into greenhouse Oct. 1 | 0 | 0 | .. | .. | .. | .. | .. |
| Trees out-of-doors entire winter | 966 | 32 | 250 | 60 | 24 | .. | .. |
| *Barouni variety—1951–52 (average of 5 trees per treatment)* | | | | | | | |
| No chilling. Trees moved into greenhouse Oct. 23 | 0 | 0 | .. | .. | .. | .. | .. |
| Trees moved into greenhouse Dec. 5 | 417 | 17 | 176 | 91 | 52 | 3 | 18 |
| Trees moved into greenhouse Feb. 1 | 1094 | 80 | 909 | 418 | 46 | 24 | 30 |
| Trees out-of-doors entire winter | 1682 | 362 | 4400 | 743 | 17 | 183 | 51 |

## Experiments Initiated

To determine whether winter chilling is conducive to fruit production in the olive—but not essential for vegetative growth—a long-term study on the effect of the amount of winter chilling on fruitfulness was initiated during the winter of 1950–51.

A group of 12 4-year-old bearing Mission variety trees—growing in 5-gallon containers—was maintained from October to April in a greenhouse with a minimum temperature of 55°F. Another group of 12 similar trees was maintained outdoors for the same period. The trees exposed to the natural low winter temperatures at Davis—966 hours below 45°F—bloomed normally but the greenhouse trees failed to produce a single flower.

During the winter of 1951–52, a similar experiment was conducted with the Barouni variety. Four groups of trees were used with five trees in each group.

Group *1* was maintained in the greenhouse the entire winter. Group *2* was taken into the greenhouse on December 15 after being exposed to 417 hours below 45°F. Group *3* was moved into the greenhouse on February 1 after 1,094 hours below 45°F. The trees in Group *4* remained outdoors the entire winter and were exposed to 1,682 hours of temperatures below 45°F.

Counts were made of the number of inflorescences produced per tree, the total number of flowers, the number of perfect flowers per tree—the olive normally produces perfect and staminate types of flowers—and fruit set was recorded. Flower and fruit production in the trees was directly proportional to the amount of winter chilling. Trees completely failed

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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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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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