

# Growth of Olive Fruit

follows three-period growth pattern of other stone fruits

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The olive fruit has, in general, the same growth pattern of the other stone fruits, such as the peach, plum, apricot, and cherry.

Fruits of this type make a fairly rapid growth during the first period which occurs early in the season. Later, during the second period, which coincides with the hardening of the pit, very little increase in size is made. Finally there is a third period, the period of final swell, coming just before harvest in which there is a large increase in size.

In connection with a general research program on the culture of the olive in California an investigation of the growth of the developing olive fruit—a stone fruit—was made during the 1946 and 1947 seasons.

The Manzanillo variety was used in the 1946 tests with fruit samples picked at approximately two-week intervals from one tree about 40 years old growing at Davis. Collections were made from July 1 to December 1 with 100 fruits obtained on each sampling date.

Each fruit was measured with a vernier caliper at the point of greatest width of the cross diameter. The volume of the fruits also was obtained by displacement of water.

At the time of each sampling another lot of approximately 100 fruits was picked which was used for making the oil content determinations.

Due to the very large number of fruits borne on an olive tree in full production the number of fruits sampled was proportionately so small that their removal is not believed to have affected the growth rate of the remaining fruits.

The Mission variety was used for the 1947 tests and as in the 1946 work, 100 fruits per sample were used with collections made at two-week intervals from June 13 to January 12. Cross diameter measurements at the point of greatest width were made and the volume of the fruits also was obtained by displacement of water.

In addition the fresh weight and the dry weight of the fruit was determined and from this the moisture content was calculated.

As in 1946, a second lot of approximately 100 fruits was obtained at each sampling date for use in the oil content determinations. The oil content was calculated both as a percentage of the fresh weight and of the dry weight.

The trees used had adequate water throughout the growing season.

## Growth Pattern

The Manzanillo olive fruit exhibited the periodic growth behavior which is typical of stone fruits. The first rapid size increase of the fruit terminated at Davis in 1946 about August 15. This coincided with the beginning of hardening of the pit. After a period lasting about three weeks rapid increase in volume was again resumed and continued until about the first of November at which time further size increase was not made, at least until December 1 at which time measurements were discontinued.

Coloring of the fruit—development of a cherry-red color—coincided approximately with the end of the last period of rapid growth.

The oil content determinations of Manzanillo fruits during 1946 show that there is very little synthesis of oil until about August 1 at which time oil production is initiated at a fairly uniform rate until about the first part of November, at which time further increase in oil content in this variety failed to appear.

In the 1947 results with the Mission variety periodic growth was again evident in the plotted curve for fresh weight.

The curve for moisture also showed a marked cyclic behavior following somewhat the pattern for the curve of the fresh weight of the fruit. During November, December, and January there was a gradual decrease in moisture. This was nullified by a steady increase in dry weight other than oil and a sharp rise in oil content during December and January.

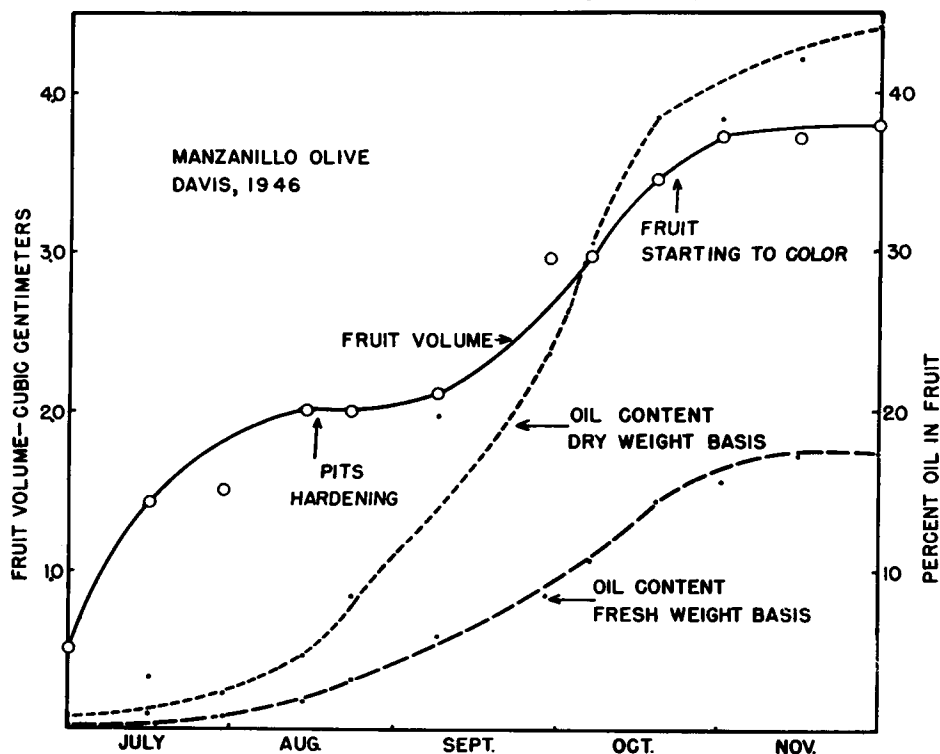
As with the Manzanillo variety in 1946, oil production started about August 1. In the Mission it increased in amount at a fairly steady rate until December and January at which time there was an accelerated rise in oil content.

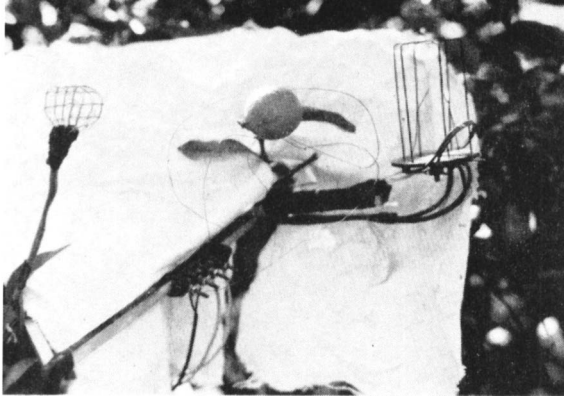
The profitable production of olives for pickles in California is dependent to a great extent on obtaining large size fruit. From this study it is apparent that it would be to the grower's benefit to delay harvest until the fruit had completed the sharp increase in size which occurs just before the fruit starts to color.

This pronounced size increase was completed in the Manzanillo variety at Davis in 1946 by October 15. It was com-

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Fruit volume and oil content of the Manzanillo olive during the 1946 growing season at Davis.





Thermocouples and hot-wire anemometer used to record transient temperatures during the passage of air blast in observation of heat radiation by lemon.

## FROST

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but largely by thermal radiation of heat from earth to the slightly colder foliage; it is this heat transfer that keeps the air from being chilled excessively.

To reduce frost hazard under this complicated system of heat transfer it is desirable—and important—to promote heat flow into ground by day and heat out-flow by night. Hence it is advantageous to maintain the thermal conductivity of the soil at a maximum. This can be done by keeping the soil moisture up nearly to field capacity and not disturbing settled ground.

A cover crop usually increases frost hazard. A dry mulch on the surface is wrong for frost protection because in the sun it will have a hotter air surface than solid ground and thus more of the solar energy will go up in air convection and be lost than if good soil conditions had carried the heat into the ground. The dry mulch is also worse for frost than solid ground at night because with its greater thermal resistance the heat flow upward cannot match the radiation demand until the surface cools further to get a greater temperature difference from deep soil. Dry peat soil is a natural bad example. Over duntrodden grain near Davis a thermograph in July recorded a daylight temperature cycle of 98° F to 28° F.

## Limitations

There has been no major freeze in southern California in the past 10 years and it is probable that when one does occur a large number of the approximately 1,000 wind machines now in use will prove to be inadequate. The observed failures of wind machines seem mainly due to too fast an indrift of cold air. Furthermore there is no expectation that wind machines will afford protection when there is a freeze with cold daytime conditions, cold soil, and no relatively warm air overhead on a clear, cold night. Since the machines do not add appreciable heat it is a mistake to start them long before needing the gain due to air mixing or

forced convection. Some improvement in machine protection can be gained by lighting border heaters on the upwind side of an orchard.

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## OLIVE

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pleted in the Mission variety at Davis in 1947 by the third week in October. The Mission fruits at Davis in 1947 increased in size during the first two weeks in October as much as they had during the preceding two months.

The usual harvest period for pickling olives in California occurs generally from the first of October until mid-November depending upon the variety. Undoubtedly much of the fruit is harvested after this period of final swell. Growers who make a practice of early harvesting may not be obtaining the maximum size from their fruit which is possible.

There are other factors than fruit size, of course, which may determine the optimum time to harvest the crop. These are largely the processing characteristics of the variety which necessitates harvesting at certain stages of maturity in order to make a satisfactory product.

The sharp increase in the Mission fruit size just prior to fruit coloring in October is accounted for largely by increased

moisture in the fruit. There is no particularly large increase in oil or dry weight other than oil at the time of the pre-coloring increase in fruit size.

For the grower to obtain the full benefit of this size increase it would appear necessary to keep the trees supplied with sufficient water during this period. In fact other research workers have found in the olive that when the soil moisture drops to the permanent wilting percentage it is reflected in a reduced rate of size increase, resulting in a smaller size fruit at maturation even though subsequent irrigations are given.

The Mission is the leading olive variety in California for the production of olive oil. The data obtained in the studies for oil content in this variety agree with the experience of olive growers, in that the oil content increases steadily into mid-winter. As seen in the accompanying graph concerning Mission olives, in which the oil content is expressed in grams of oil per fruit, there is an actual pronounced increase in the oil content of the fruit during December and January. In addition, during this same time there is a decrease in the moisture content of the fruit. Very few olives are harvested for oil in California before the middle of December and probably the bulk of the oil olives are picked during January.

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## COLOR

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to react with the breakdown products of the sugars, giving rise to dark-colored polymers of the type rather inadequately described as humins.

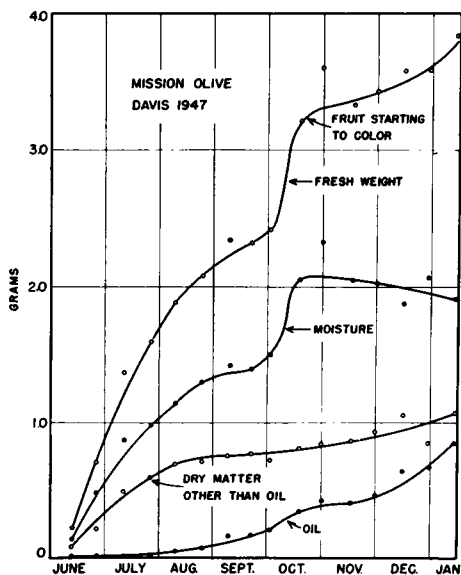
## Control is Complex

The control of this type of deterioration is no simple matter as yet. If the product is kept at the lowest practicable temperature, this is still the most effective means of retarding the damage and the most effective supplementary treatment is the well-known long-established use of sulfur dioxide.

Research in these various fields is slowly bringing about a better understanding of the behavior of the compounds involved and will determine procedures to be used in controlling undesirable changes.

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Fresh weight, moisture, oil and dry matter other than oil of Mission olives during the 1947 growing season at Davis. Weight per fruit, based on average of 100 fruits.