1965

Studies of Accelerated Ripening of Ficus Carica Cv. Celeste.

Albin Joseph Langlois
Louisiana State University and Agricultural & Mechanical College

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The Department of Horticulture

by

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ABSTRACT

On three dates in 1963, fruits of the Celeste fig, a variety that exhibits incomplete parthenocarpy, were sprayed and treated manually with a surfactant and three concentrations of roll oil in an attempt to determine the receptive period of fruits and the effect of these materials on the fruit maturation period, number of fruits to mature, percentage drop, size, weight, and soluble solids of fruits.

The main treatment factors (oil concentration, method of oil application, date, and position of fruits on shoots) did not significantly affect the numbers of fruits to ripen in the first two treatments of 1963. Following the third treatment, increasing increments of oil significantly reduced the number of fruits to ripen.

A significantly greater number of treated fruits dropped prematurely following the first two treatments. The main treatment factors did not have a significant effect on premature drop in any of the three treatments.

None of the treatment factors had a significant effect on the number of days to maturity, size or weight of fruits treated on the three dates.

Soluble solids, though not affected by main treatment effects, were generally lower in fruits in the more basal positions.

In 1964 fruits at the three most basal nodes were treated at four-day intervals, beginning May 22 and ending June 11, with olive oil, roll oil, 10% roll oil emulsion in water applied manually to the ostiole, or with 10% roll oil emulsion in water applied as a spray. Maturity was not hastened on any date by any treatment.
On June 11 and 15 the same treatments were applied to fruits at nodes 3, 4, and 5 from the base on a new series of shoots. Only one fruit at the third node, treated manually with olive oil on June 15 responded, ripening in 8 days following treatment. The internal and external characteristics of this fruit was very similar to fruits ripened naturally.

Striking results were obtained from treating all of remaining fruits through position six manually with olive oil, roll oil, and 10% roll oil emulsion on June 25 and 27. Most fruits in the more basal positions ripened in approximately seven days following treatment with any of the three materials whereas untreated fruits required approximately sixteen days to mature. Internal and external characteristics of treated fruits were very similar to naturally ripened fruits.

Size alone was not a good criterion of receptivity. Fruits whose skins were just beginning to turn yellow and whose pulps were beginning to turn pink were effectively stimulated to maturity. These characteristics proved to be a more accurate guide to receptivity than size.

Premature drop, caused by unknown environmental factors, affects fruits before they attain a stage in which they respond to ripening treatments.
INTRODUCTION

Oleification, the practice of applying oil to the ostiole or eye of fig syconia to accelerate ripening, has been a common practice almost since time immemorial. Condit (1947), in his extensive historical researches on figs, notes some early references. He states that Theophrastus mentioned it as a practice in Greece in the third century B.C., and Pliny told of its use by Roman gardeners. In Italy the process is known as "inoliazione," in France as "appreter les figues," and in English-speaking countries as "oleification." Fig growers, using a straw or splinter of wood, apply the oil to the eye of the fig about two weeks before natural maturity of the fruit. In a few days oiled figs begin to increase in size and after several days they reach full color and maturity while untreated fruit remain green and hard.

Minorcan residents of St. Augustine were probably the first to practice oleification in the United States over a century and a half ago (Condit, 1947). A few years later, Clark (1831) and Legare (1831) demonstrated that various oils, when applied at the proper time, were effective in hastening maturity of Lemon figs and that treated figs ripened well in advance of the rainy season. Since then many workers have reported accelerated ripening as a result of treatment with various oils and a number of other substances.

More recently, in addition to accelerating ripening, oleification has been reported to eliminate "staggered" ripening that normally
occurs in nontreated figs and causes several figs on one shoot to ripen simultaneously (Couvillon, 1963).

Accelerated ripening is of particular interest to Louisiana fig growers. In this area, the normal ripening time for the most important variety, Celeste, coincides with heavy rains which makes harvesting practically impossible and promotes conditions ideal for souring of the fruit. If ripening could be advanced by several weeks, this variety would be much better suited for commercial purposes. Furthermore, if staggered ripening could be eliminated, the amount of labor normally required for harvesting could be reduced considerably.

The purpose of this study was to attempt to determine accurately the time at which figs of the Celeste variety are most effectively stimulated by oil applications and to investigate the possibility of effecting accelerated ripening by use of oil sprays rather than by manual application of oil.
A review of the literature provides ample evidence that considerable research has been conducted in the area of cyclic growth of fruit, particularly that of drupaceous fruit. The reports indicate that growth of these fruits is divided into three distinct periods. The first period, immediately after fertilization, is characterized by a rapid rate of growth; the second, during which the kernel is formed and the stone hardens, is evidenced by a depressed growth rate; and the third period, referred to as the period of "final swell," consists of an accelerated growth rate of flesh to maturity. When growth increments for these periods are plotted, a double sigmoid curve is obtained.

Probably the first to report cyclic growth of fruit was Connors (1919), who reported that all of the peach varieties he worked with (Carmen, Hale, Stump, Belle, Elberta) exhibited cyclic growth. He observed that although the length of the three growth stages varied somewhat between varieties, they were still very obvious.

In a more elaborate experiment, Blake (1925) with peaches of the variety Elberta, demonstrated that suture diameter increased rapidly until about forty-five days after blooming. The rate of growth remained relatively unchanged until about eighty days after blooming at which time the rate of increase was once more very rapid.

Since then, a number of other workers have reported on the cyclic nature of fruit growth. Lilleland (1932) observed that most peach varieties seemed to show the three phases regularly year after year.
Dorsey and McMunn (1927) also reported the occurrence of the cyclic growth in the peach variety Elberta; however when growth is measured on a basis of weight or volume rather than suture diameter, the second or "rest stage" is less pronounced. Lott (1932) found that when growth of the Hiley peach is measured on a basis of dry weight, cyclic growth is not evident.

Attempts have been made to explain the occurrence of the various stages of growth. According to Tukey (1933), growth of the pericarp, integuments and nucellus in the peach are parallel during the first period of growth except that the pericarp does not reach maximum size as do the integuments and nucellus. Embryo development was constant through all three stages. Baker and Davis (1951), found development during the first period to be quite complex since profound changes occur. Increases in cell number and cell size of both the pit and the flesh all contribute to the total increase in fruit size.

Growth practically ceases during the second or "rest" period. Connors (1919) stated, "this is a time when the stone becomes hardened and a depressed rate of flesh growth is experienced." To support this statement, he contends that the early clingstones are unlike the late clingstones in that they do not mature their seeds, so as a result they experience a shorter second period. Dorsey and McMunn (1927) agreed with Connors but they suggest that shoot growth, which shows a rapid increase during the second period, may be a factor responsible for that period. Lilleland (1932) disagrees. He maintains that shoot growth does not coincide with the second period of growth. He found no correlation between extent of growth of size of fruit and duration of the
second period, nor did size of the crop affect length of the second period. In addition, he concluded that pit development cannot be considered responsible for cyclic growth either.

In a later paper, Lilleland and Brown (1936), on the basis of results obtained in a girdling experiment, found that fruit of apricot on girdled stems had a shorter second period by ten days and doubled the growth rate of that of ungirdled fruit. This suggests that the cause of second period is due to low concentrations of carbohydrates in the plant.

Tukey (1933) found that stone hardening occurred during the stage of reduced growth and the time of stone hardening, which begins at the distal end, was found to occur at almost the same time for all varieties (Greensboro, Triumph, Carmen, Elberta, and Chili) studied. The earliest maturing varieties, which are more rapid in stone development, showed a high percentage of embryo abortion. From this, the author concluded that the duration of the second stage varied with variety, the earliest ripening varieties having the shortest periods.

The third period of growth, usually designated as "final swell," is considered one of great metabolic activity. Lilleland (1932) reported this period to be one of rapid increase in flesh, adding up to two-thirds of the entire size of the fruit. Fifty per cent of the total soluble solids was accumulated during this period which began only four weeks before harvest in the Elberta variety. The third growth period began immediately after the stone reached its maximum dry weight. In the stone there was an increase of nitrogen until three weeks before harvest, then a decrease. Sugars decreased throughout the period while ash increased for about two weeks, then decreased. Starch
and hemicellulose increased until the stone was near its maximum dry weight than they decreased. Lott (1933) also reported an increase in nitrogen content of Elberta during the second period with a sudden decrease with the onset of "final swell."

Cyclic growth is not confined only to the peach fruit. It has been reported in apricot (Lilleland, 1930), plum (Lilleland, 1934), almond (Brooks, 1940), olive (Hartman, 1949), and cherry (Lilleland and Newsome, 1934).

Cyclic growth in the fig was first reported by Crane (1948) in California. Weekly cross diameter measurements showed that the growth curves of the varieties Mission, Adriatic, Kadota, and Calimyrna, although morphologically different from the drupaceous fruits where no receptacle is present, paralleled the peach growth curves. Although the four varieties differ in regard to growth habit, fruit characteristics, pollination requirements and cultural methods, they are similar in regard to growth of fruit. The rate of growth in the Adriatic variety was greater during the first period but the duration of the third period was longer than that of the other varieties.

Crane and Brown (1950) reported that growth of the Mission variety, a common type fig, when expressed on the basis of moisture content, fresh weight, and dry weight, was markedly cyclic. The first growth period has a duration of five or six weeks accompanied by an increase in diameter and a reduced rate of increase in moisture content and fresh or dry weight. During this period little change in sugar content was evident. The second period lasted about four weeks and was marked by a greatly depressed rate of diameter increase, moisture
content, and fresh weight. The sugar content of the fruit remained at about the same level as it was during the first period. The third growth period was characterized by a rapid increase in diameter, fresh and dry weights, moisture and sugar content. Seventy-two per cent of the total dry weight and eighty-nine per cent of the total sugar content accumulated during this period.

According to Crane and Blondeau (1948), growth of figs of the Calimyrna variety, a Smyrna type requiring the stimulus of pollen to set fruit, is unlike that of drupaceous fruits in that fertilization takes place near the beginning of the period. Growth of the individual fruitlets also occurs in three distinct stages. Growth of the ovary takes place before fertilization and ceases during the period of depressed growth. During the third period, rapid enlargement of the ovary occurs.

Maranto (1959), working with the Celeste variety, a common type fig, studied fruit development as indicated by changes in length, width, and volume, found that its development was of the same cyclic nature as that of other varieties reported by Crane and other workers. The length of the first period became successively shorter in fruit from the most basal to the most apical positions, varying from six to three weeks. The length of the second period was shorter in figs produced later in the season and varied from five to three weeks. The third period did not appear to be shortened by advancing season.

Couvillon (1962), studying the development of the varieties Hunt and Celeste, two common type figs, noted cyclic growth in both. Although Hunt, a naturally later maturing variety than Celeste, ripened
at a later date, the relative length of the three periods of growth was very similar in both varieties.

**Probable Causes of Retarded Development During the Second Growth Period**

A number of hypotheses have been advanced as to why growth is retarded during the second or "rest" period. Connors (1919) maintains that this period of retarded development may be attributed to hardening of the stone. To support this conclusion, he asserts that the early clingstones are unlike the late clingstones in that they do not mature their seeds, and as a result experience a shorter "rest" period. Dorsey and McMunn (1927) agreed in part with Connors but suggested further that shoot growth may also be a factor responsible for the "rest" period since shoot growth shows a rapid increase during this period. Lilleland (1932), on the basis of results he obtained in a study of peach fruit, disagreed with Dorsey and McMunn in that shoot elongation did not coincide with the "rest" period and also with Connors in that pit hardening did not coincide with the second period. Thus he concluded that the coincidence of shoot elongation and pit hardening with the second period of growth does not constitute a suitable explanation for growth suppression.

Later, Lilleland and Brown (1936) reported that girdling branches of Apricots reduced the duration of the second period by ten days and doubled the fruit growth rate. They therefore suggested that suppressed fruit growth during the second period is due to a shortage of carbohydrates.

Tukey (1936), working with three varieties of cherries and six varieties of peaches, in an attempt to find a better explanation
of the influence of seed and embryo formation on the development of
the pericarp during the second stage of growth, used a hand drill to
call the embryo. Results of this experiment showed that destruction
of the embryo during the second stage caused shriveling and eventual
abscission of the fruit. Destruction of the embryo between the second
and third stages resulted in an increased growth of the pericarp,
particularly in the early ripening varieties. From this experiment,
Tukey concluded that rapid growth of the pericarp did not occur until
the embryo "released" it and a balance was obtained between seed parts
and pericarp.

Lott (1942) raised the question as to whether wall thickening
and other changes in the flesh cells were responsible for the retarded
rate of size increase of the flesh and pointed out the need for informa-
tion of the histological behavior during this period of different
varieties during different seasons of ripening.

Measures of growth of several peach varieties, based on dry
weight, showed no clearly defined period of depressed growth rate
(Lott, 1932, 1933, 1942). Lott found that the amount of dry matter,
hemicellulose and lignin in the stone increased rapidly during the
second period while the rate of accumulation of these materials in
the flesh was low. This suggests that dominance of the stone con-
trolled the development of the flesh.

Crane (1948) proposes a somewhat different explanation of
suppressed growth in the Calimyrna fig. He found that the growth
rates during the first period were identical for normally pollinated
and growth regulator induced parthenocarpic Calimyrna fig fruits.
Fruits sprayed on June 24 with an indolebutyric acid (15 ppm) aqueous spray, grew somewhat more rapidly but ceased enlargement in the second period at about the same average diameter as fruits that were naturally pollinated. The difference of about twenty days in the length of time the two types of fruit remained in the second period was attributed to the fact that the parthenocarpic fruits did not mature until about two weeks after maturation of fruits that were pollinated. There was a complete absence in the parthenocarpic fruits of seed, even to the extent that sclerification of the ovary walls was not evident. Because periodicity in growth has been shown to be independent of cultural practices, fluctuations in temperature and moisture, competitive growth processes in other parts of the tree, length of the growing season and dominance of reproductive over vegetative tissues, Crane, in this paper, suggests that it may be due to some physiological factor such as variation in supply or activity of a hormone or an enzyme within the plant or fruit itself.

ACCELERATED RIPENING OF FIG FRUIT

1. Oleification

Probably the oldest known method of accelerating maturity in figs is oleification. This practice has been employed for this purpose by Greek and Roman gardeners since as early as the third century B.C. (Condit, 1947).

Over a century ago, in southeastern United States, experiments on oiling of figs were reported by Clark (1831) and Legare (1831). Clark found Minorcan residents of St. Augustine secretly practicing
oleification and his own experiments demonstrated that the practice would induce ripening before the advent of the rainy season. In July of 1831, Legare read a paper before the Horticultural Society of Charleston, entitled, "Results of Some Experiments to Ascertain the Effect of Oil in Hastening the Maturity of Figs." He found olive oil effective but tallow ineffective in hastening maturity. Legare observed that if oil was applied to any part of the fruit other than the ostiole, abscission followed and also that the fruit should be at least one to one and one-half inches in diameter when the oil is applied. All fruit smaller than this were injured by the oil. This suggests that the fruit should be somewhere in the second stage of growth when oil is applied.

Johnson (1831), in an attempt to explain the action of the oil in hastening maturity, stated, "...if oil, or any other mild application be made to its apperture, so as to include the prespirable fluid, the heat and moisture of which, being thus retained, are thrown back upon the fruit contained within this dilated receptacle, and thus add greatly to facilitate the maturation; but on the other hand, let the oil be applied to the outer surface of the fig, and the arrest of absorption, must prove fatal to the fruit."

In 1863 and 1865, Gasparrini reported his observations on the effects of various agents in promoting the ripening of Italian common type figs. He discovered that a number of oils stimulated the ripening process, but that agents such as vinegar, turpentine, tincture of iodine, and alcohol showed no stimulating effects. Longo (1909) duplicated the experiments of Gasparrini and concluded that oleification was only a traumatic excitation.
Clements and Pentzer (1950) treated figs of the Mission variety manually with olive oil and tartaric acid. Figs treated with olive oil on June 16, 1945 showed appreciable growth and coloring response in four days and were ripe in about six days. In 1946, olive oil gave no response presumably because it was applied too late. The question of application date was investigated in 1948 and the only response of any consequence was obtained on figs treated about ten days prior to full maturity. Olive oil when applied early was ineffective; however, tartaric acid applied on that date gave unusual growth and color response.

Pangacharlu and Sambasiua (1952) treated figs of Kalbatii, a variety of the common type, with linseed and sesamum oil by inserting oil-coated wooden needles into the ostiole. Fruit treated with sesamum oil ripened twenty-two days earlier than untreated fruit and those treated with linseed oil ripened sixty-two days earlier than the checks. All treated fruit were larger in cross diameter and length, weighed more, and seemed to be of better quality than naturally ripened fruit.

Couvillon (1962) studied the effects of olive oil, cottonseed oil, mineral oil, and various fatty acids on figs in various positions on shoots of the varieties Celeste and Hunt. All three oils used gave response in the three most basal positions of both varieties when applied at the proper time. In the variety Celeste, these oils when applied early (May 8), caused considerable dropping, but later applications (June 4), produced striking growth and color responses without heavy dropping and treated figs ripened within six days. In the variety Hunt, which normally ripens about a week after Celeste, early applications (May 8 and June 4), caused a large amount of dropping
but applications on June 21 affected ripening in approximately seven days without severe dropping. Celeste fruits treated with fatty acids (myristic, oleic, linoleic, and palmitic) dissolved in mineral oil, ripened figs in five days after June 4 treatments.

Eynard (1962) treated figs of an unnamed variety on two dates. Materials were applied internally by syringe and on the skin at the apical end by a flock of cotton. Olive oil, 2,4,5-trichlorophenoxyacetic acid, and 2,4,5-trichlorophenoxy propionic acid were used. The internal treatments were more effective than external ones. Internal oil applications on August 15 caused fruit to mature in fifteen days but was ineffective on August 29. The growth substances caused maturity in seventeen and nineteen days, respectively, but only on fruits treated on August 29. These results suggest that certain materials are possibly more effective than others in accelerating maturity on a given date.

2. Applications on Growth Regulators

Research workers, seeking materials which would induce parthenocarpic development of nonparthenocarpic varieties of figs, discovered that certain materials, in addition to inducing parthenocarpic fruit development, would also accelerate ripening.

Among the first to report this phenomenon were Blondeau and Crane (1948), who sprayed unpollinated but pollen receptive synconia of Calimyrna, a variety which requires cross pollination for fruit development, with aqueous solutions of 2,4,5-trichlorophenoxyacetic acid at 25 ppm. The fruit so treated were well filled and palatable in sixty days (fifteen days after treatment) instead of the average one hundred and twenty day period required for maturity in the untreated
fruit. Indolebutyric acid at 1,500 ppm gave similar results but 2,4-dichlorophenoxyacetic acid at 100 ppm was ineffective.

Crane and Blondeau (1949), on a basis of results obtained in the previous season, set up another experiment utilizing nine materials, alone or in combination, applied manually or in spray form, on three dates. Manual applications were considerably more effective and early applications (May 24 and June 5) showed no response. Parthenocarpic development occurred only as a result of the June 12 treatment with indolebutyric acid, at 1,500 and 2,670 ppm and also when mixed with naphthoxyacetic acid. Treated fruit matured in twelve days and were comparable in size and quality to mature pollinated fruit.

Crane and Blondeau (1949a) sprayed unpollinated fruit of the Calimyrna variety with 2,4,5-T and oil emulsion containing the isopropyl ester of 2,4,5-T. These materials in concentrations of 10, 25, 50, 75, and 100 ppm were sprayed thoroughly on the fruit, foliage and shoots. Fruit sprayed with 25 ppm 2,4,5-T on June 30 were mature fifteen days later. The length of the growing season was shortened approximately sixty days. Comparable results were obtained with similar concentrations of the isopropyl ester of 2,4,5-T. Fruit sprayed on July 29 with 25 ppm 2,4,5-T and its ester matured in thirteen days, twenty-nine days before the maturity of pollinated control fruit. Injury was generally encountered on both dates at concentrations of about 25 ppm of both materials.

Crane and Blondeau (1950) found that para-chlorophenoxyacetic acid (PCPA), when sprayed on fruits and foliage during the caprification period, could be used to set Calimyrna figs as a substitute for
caprification. There was no accelerated maturity nor were there observable symptoms of leaf, fruit or shoot injury accompanying even the highest concentration (200 ppm) of PCPA used.

Crane and Campbell (1959) sprayed Calimyrna figs on June 14 with various concentrations (25 to 1,000 ppm) of gibberellin. All levels of gibberellin used were very effective in inducing parthenocarpy and maturity of the treated fruit occurred one week or more earlier than that of caprified figs.

Only a very few references are made in the literature on attempts to accelerate the maturity of common type figs by use of growth regulators. Crane and Blondeau (1949b), accelerated the maturity of the variety Mission by spraying the fruit and foliage with a 20 ppm aqueous solution of 2,4,5-T on August 17. Sprayed fruit matured seventeen days earlier than unsprayed control fruit.

Clements and Pentzer (1950) found indolebutyric acid (1/2 gram in 100 ml of water) and naphthacetic acid (0.25 per cent in 0.01 per cent 4-chlorophenoxyacetic acid as an aerosol in 95 per cent dimethyl ether) to be ineffective in accelerating ripening of the variety Mission. Olive oil applied on the same date (May 28) was also ineffective, presumably because it was too early.

Gibberellin (GA) was applied to fruit of the Mission variety by Crane and Grossi (1960), on two dates, June 11 and July 13. Aqueous solutions of GA at concentrations of 20, 40, and 80 ppm were applied with a hand sprayer to the fruit and foliage. GA generally had a hastening effect on the time at which the fruits began their third growth cycle. The higher the concentration of GA, the earlier the
fruit began the cycle and the earlier they matured. Maturity was advanced by as much as twenty-five days for fruit sprayed with 80 ppm GA to fifteen days for the 20 and 40 ppm treatments.

O'Rourke (1964) sprayed aqueous solution of amine salt 2,4,5-T (2, 5, and 10 ppm) on fruit and foliage of the common fig varieties, Celeste, Reine Blanche, Brown Turkey, Green Ischia, San Piero, Hunt, and Florentine (Dottato) on April 23, 1956 and May 18, 1956. Green Ischia, the latest maturing variety, was treated again on July 17. Foliar injury occurred on all varieties, most severely on Green Ischia, the shoots of which were killed by 10 ppm applied May 18. No acceleration of ripening of any variety was noted. Several Celeste fruits colored and dropped prematurely. Celeste figs on shoots treated with 10 ppm on April 23 ripened on June 20 and 22 and were significantly larger than fruits from untreated shoots. No other responses of fruits to treatments were noted.

The treatments were repeated in 1958 on the varieties Celeste, Florentine, and Green Ischia, but no response occurred.
MATERIALS AND METHODS

1. Location and Description of the Planting

The trees used in this study are located about four miles south of Louisiana State University on the Ben Hur Farm. The trees are of the Celeste variety and were grown from rooted cuttings taken from the same mother tree. They are nine years old and are planted twenty feet apart on twenty-foot rows. The soil in the orchard is classified as Sharkey silt loam.

Through 1963, the orchard was maintained in clean cultivation; in 1964 it was put into sod. The trees were pruned annually and fertilized at the rate of about one pound of 8-8-8 fertilizer per year of age per tree was broadcast beneath them in late winter of each year.

2. Preliminary Experiments

1963

In the absence of any experimental information concerning the tolerance of the Celeste fig plant to the oils proposed to be used, preliminary tests were necessary. The reportedly nonphytotoxic oils, Orchex 796 and Roll oil 3190 (produced by Humble Oil and Refining Corporation), were applied by means of a power mist blower to the foliage and fruits of the Celeste trees on May 17, 1963. A two per cent aqueous emulsion with one per cent Multifilm-L surfactant was selected for the initial treatment concentration, based on the fact that these oils had been used on other plants at that concentration without detrimental effects. Seventy-two hours later a browning of
leaves, stems and fruits was noted on all treated parts. On May 24, 1963, mineral oil (Nujol) in water emulsions of 0.5, 1.0, and 1.5 per cent with three concentrations of Multifilm-L (1.0, 1.5, and 2.0 per cent) were sprayed on branches of adjacent Celeste trees. Similar injury was noted in seventy-two hours. The surfactant Multifilm-L was replaced by Spray-Tac and a third spray treatment was made on May 26, 1963. This treatment consisted of roll oil 3190 at 0.25, 0.5, and 1.0 per cent in water with the surfactant at the same concentration as the oil. No signs of injury were noted.

1964

Because of poor response of the fruit to oil applications in 1963 might have been due to the low levels of oil used, an attempt was made in 1964 to determine the maximum level of roll oil Celeste trees would tolerate. On May 7, 1964, aqueous solutions containing 1, 2, 3, 6, 8, 10, 15, and 20 per cent roll oil and 0.03 per cent Spray-Tac were sprayed on adjacent trees. Only treatments of 15 and 20 per cent oil showed injury.

3. Experimental Design

1963

The preliminary experiments had shown that an oil could be safely applied by means of a mist blower at the time that fruits had been shown to be receptive to manually applied oils. Factors that needed to be investigated included time of application, method of application, concentration of oil and surfactant used, and the effect of the physiological age of the fruit (position on the shoot). A split, split, split plot design was selected.
On each of three treatment dates (May 30, June 7, and June 12), twenty shoots, ten each on opposite quarters of the tree, were tagged for each replication. Ten shoots or one-quarter of the tree received the particular treatment for the tree in spray form and fruits on the shoots on the opposite quarter had the same material applied to them manually. Treatments were replicated four times; however, because of an insufficient number of trees in 1963, check treatments contained only three rather than four trees. Only ten shoots were tagged and measured on check trees. On the second date of application (June 7), fruits on ten shoots on each of four trees were treated manually with olive oil.

1964

In 1964, no provisions were made for statistical analysis since emphasis was being placed on date of application rather than on oil level. Only one oil level, 10 per cent, was used but the number of times of application was increased to seven. On each application date, one-quarter sectors of four trees bearing tagged shoots were sprayed with one liter of ten per cent roll oil emulsion. Fruits on tagged shoots on the opposite quarter of the same tree received the same emulsion applied manually.

Also on each application date, fruits on ten tagged shoots on one quarter of four trees were manually treated with undiluted roll oil and fruits on ten tagged shoots on the opposite quarter were manually treated with undiluted olive oil.

Checks in 1964 for the first five application dates consisted of fruits in positions one through three on ten shoots on each of five
trees located diagonally across the orchard. For treatment dates six and seven, ten additional shoots on these same five trees were tagged but fruits in positions three through five were measured.

4. **Shoot Selection**

1963 and 1964

Just prior to each treatment date, shoots, sufficient in number for that treatment, were selected and tagged. These shoots were selected around the periphery of the tree on the basis of uniformity in size, vigor, exposure, and size and number of fruits. Shoots with barren nodes or misshapen fruits were avoided. Shoots selected for treatment were located at a height where they could easily be reached without the use of a ladder.

Fruits on each shoot were numbered in succession from the base to the apical end of the shoot, the most basal fruit being designated as position one and the others being given successively higher numbers. Each fruit therefore had an individual number consisting of row, tree, shoot, and position number, such as 1-1-1-l for the most basal fruit on shoot one on tree one on row one.

5. **Method of Application of Materials**

1963 and 1964

Identical methods of applying the various materials were employed in both years. One liter of material was applied to quarters of trees designated to receive spray treatments by use of a power mist blower. With this amount it was possible to wet the foliage to a point of slight drip. Materials for the manual treatments were
applied by use of the tip of the index finger, being careful not to get the material on any part of the fruit other than the eye and the area immediately surrounding it.

6. Times of Application of Materials

1963

Previous work (Couvillion 1963) indicated that the Celeste fig is apparently most responsive to oleification about twenty-five days after the fruits enter the second phase of the growth curve. Periodic measurements over several seasons show that this time occurs usually during the first week of June. In an attempt to better define the period of time in which the fruits were in a receptive condition in 1963, one series of treatments was applied when the fruits were about seventeen days into the period of no growth increase. This coincided with the calendar date May 30. A second series of treatments was applied on June 7, about twenty-five days into the second growth period, and a third treatment series was made on June 12, thirty days after the entry of the fruit into the second period.

In addition to the previously described series of treatments applied on June 7, fruits in the three most basal positions on ten shoots of four trees, were treated manually with olive oil. This treatment did not constitute part of the main experiment for that date but was intended for observation purposes only. Cross diameter measurements for these fruits were taken on the treatment date and at three day intervals thereafter until response was determined.

1964

In 1964 seven main treatments were applied, the first on May 22
and one on every fourth day thereafter through June 15. In the first five treatments, fruit in the positions one through three were measured and in the sixth and seventh treatments, fruit in positions three through five were measured since many fruit in the first two positions had already fallen or dropping was imminent.

After the above main treatments appeared to show no ripening effect, daily treatments consisting of manual applications of olive oil and roll oil (ten shoots each) were started on June 5 in an attempt to determine when figs in the various positions could be effectively stimulated to maturity. No measurements were made on these treatments.

By June 24, all daily treatments applied on or after June 18 began exhibiting positive indications of accelerated ripening. On June 25, a separate treatment of manually applied undiluted olive oil and roll oil as well as a treatment of ten per cent roll oil in aqueous solution, were each applied to ten tagged shoots. These materials were applied to any and all fruit still remaining on the tagged shoots in positions one through six. Cross diameter measurements were recorded on the treatment date and on alternate days thereafter. On June 27 a similar group of treatments was applied to an adjacent tree. On both dates, ten shoots were tagged and measured as checks.

Since the fruit remaining in the more basal positions on most trees were beginning to increase significantly in size, indicating that they were entering the third growth stage and would probably not be stimulated by oil applications, additional treatments were not instituted.
7. **Materials Used**

1963 and 1964

In both years the same oil and surfactant (roll oil, oil 3190 and Spray-Tac) were used but in different concentrations. The Olive oil used was the same as that used for culinary purposes.

8. **Measurement of Response to Treatments**

1963

A. **Fruit Size.** The fruits were measured across their maximum diameters with a vernier caliper. Both check and treated fruits were measured on the day they were treated and on every third day thereafter. From these data it was possible to plot growth curves of the fruits. Ripened fruits were bagged individually, marked for identification, and their fresh weights and soluble solids determined.

B. **Soluble Solids Determination.** After weighing, each fruit was blended in a Servall omni-mixer in nine times as many milliliters of water as grams the fig weighed thus giving a dilution factor of ten. A few drops of this material was placed on an American Optical hand refractometer and the value obtained was multiplied by ten to obtain the actual per cent soluble solids. Soluble solids determinations were run to see if any possible detrimental or beneficial effects of treatment appeared coincidental with an early ripening effect.

C. **Maturation Period.** An accurate record was kept on the number of days from the date of treatment to fruit maturity. The practical aim of this work was to see if the number of days normally required to reach maturity could be shortened.
Because of the high percentage of premature fruit drop in 1964, lack of sufficient samples precluded fresh weight and soluble solids determinations. Only maximum cross diameter measurements and the number of days from treatment to maturity were kept on the fruits.
EXPERIMENTAL RESULTS

1. **Growth of Untreated Fruits in 1963**

   During the 1963 season, fruits in the three most basal positions were measured on the first two treatment dates (May 30 and June 7) and on the third treatment date (June 12), fruits in positions four, five, and six were measured.

   The first and second treatments were started approximately fourteen and twenty-three days, respectively, after the onset of the second growth period of the fruits. The third growth period started first in fruits in position one and followed, at a few days interval, in fruits in positions successively higher up the shoots. The length of the third period, about twelve days, was approximately the same for fruits in comparable positions on both dates. There was a definite ripening order for fruits regardless of the date of treatment. Fruit at the first node ripened first followed at approximately three day intervals by fruit in more apical positions.

   Untreated fruits in positions four, five, and six on the third treatment date, although maturing somewhat later than those in positions one, two, and three, previously treated, followed a similar growth pattern. Onset of the third growth period took place about twelve days later than the start of the same period for fruits in positions one, two, and three and lasted about ten days. Once again there was a definite order of ripening; the fruits in the most basal positions ripening about three days earlier than fruit in subsequent positions up the shoots.
Figure 1. The Influence of Oils in Various Concentrations Applied Manually and in Spray Form on May 30, 1963, on the Days Required for Celeste Fig Fruits to Ripen in the Three Most Basal Positions on Shoots.
Figure 2. The Influence of Oils in Various Concentrations Applied Manually and in Spray Form on June 7, 1963 on the Days Required for Celeste Fig Fruits to Ripen in the Three Most Basal Positions on Shoots.
Figure 3. The Influence of Oils in Various Concentrations Applied Manually and in Spray Form on June 12, 1963 on the Days Required for Celeste Fig Fruits to Ripen in Positions Three, Four, and Five on Shoots.
2. **Effect of Oil Applications in 1963**

   **A. Growth of Treated Fruits**

   No striking differences in growth between treated and untreated fruits nor between treatments on a given date occurred. Growth patterns of treated fruits in all three positions on the three treatment dates were very similar to the growth of untreated fruits on a comparable treatment date. The initiation and length of the third growth period and the order of ripening of treated fruits in successive positions for each treatment date were also very similar to those of the untreated fruits on corresponding dates (see Appendix Tables 1, 2, and 3).

   Olive oil applied manually on June 7 had no apparent effect in stimulating the maturity of fruits.

   **B. Number of Fruit to Ripen**

   1. **May 30 and June 7 Treatments.** Analysis of variance demonstrated that the number of untreated fruit to ripen following the second treatment was significantly greater than following the first treatment. Fifty-eight fruit in all three positions of the untreated fruits ripened following the second treatment whereas only twenty-eight ripened following the first treatment. There were no significant differences between positions in the number of fruits to ripen (see Table 5).

   No significant differences in the number of fruit to ripen were found to be due to main effects (date, concentration of oil, method of application, and position) following the first two treatments. A highly significant interaction was found to exist between date and oil.
Table 1. Average* maximum cross diameters (cm) of Celeste fig fruits at the three most basal nodes of shoots treated on May 30, 1963.**

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*Averages of 30 fruits for check treatments and 40 fruits for others.

**Condensed from Appendix Table 1.
Table 2. Average* maximum cross diameters (cm) of Celeste fig fruits at the three most basal nodes of shoots treated on June 7, 1963.**

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* Averages of 30 fruits for check treatments and 40 fruits for others.

** Condensed from Appendix Table 2.
Table 3. Average* maximum cross diameters (cm) of Celeste fig fruits at nodes four, five, and six of shoots treated on June 12, 1963.**

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*Averages of 30 fruits for check treatments and 40 fruits for others.

**Condensed from Appendix Table 3.
2. **June 12 Treatment.** Analysis of variance of the third treatment (see Table 7) showed that there were no significant differences in the number of fruits to ripen between positions of the untreated fruits. A highly significant difference existed among treated fruits between the concentration of oil used but there were no significant differences due to position or to the method of oil application. An increase in concentration of oil generally reduced the number of fruits to ripen. Thirty-four fruits ripened in the surfactant treatment, twenty-four in the 0.25% oil treatment, nineteen in the 0.5% oil treatment, and sixteen in the 1.0% oil treatment.

C. **Number of Fruit to Drop Prematurely**

1. **May 30 and June 7 Treatments.** There was a highly significant difference between the number of treated and untreated fruits to drop prematurely. Eighty-four out of 180, or 53 per cent of the untreated fruits in the first treatment dropped while 58 out of 180 or 66 per cent of untreated fruits dropped following the second treatment (see Table 6). Following the first treatment, 640 out of 960 or 66 per cent of treated fruits dropped prematurely while 529 out of 960 or 55 per cent dropped following the second treatment.

There was a significant difference in the number of untreated fruit to drop prematurely between the two dates but no difference between positions.

Among the treated fruits, there were no differences in the number to drop due to main effects on either date nor were any interactions of significance.
Table 4. Average maximum cross diameters (cm) of all Celeste fig fruits* at three successive positions of shoots treated on three dates in 1963.

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*Averages of fruits in three positions in each treatment of Tables 1, 2, and 3.
Table 5. The influence of oils in various concentrations applied manually and in spray form on May 30 and June 7, 1963 on the number of Celeste fig fruits to ripen in the three most basal positions (nodes) on shoots.

<table>
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<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>Obtained</th>
<th>Required</th>
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<td>Among Treated</td>
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Table 6. The influence of oils in various concentrations applied manually and in spray form on May 30 and June 7, 1963 on the number of Celeste fig fruits to drop prematurely from the three most basal positions (nodes) on shoots.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>&quot;F&quot; Obtained</th>
<th>&quot;F&quot; Required</th>
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Table 7. The influence of oils in various concentrations applied manually and in spray form on June 12, 1963 on the number of Celeste fig fruits to ripen in positions (nodes) four, five, and six on shoots.

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<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>&quot;F&quot;</th>
<th>&quot;F&quot; Required</th>
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Table 8. The influence of oils in various concentrations applied manually and in spray form on June 12, 1963 on the number of Celeste fig fruits to drop prematurely from positions (nodes) four, five, and six on shoots.

<table>
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<th>Source of Variation</th>
<th>Sum of Squares</th>
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<th>Mean Square</th>
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</thead>
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</table>
2. **June 12 Treatment.** No significant differences existed between treated and untreated fruit in the number of fruit which dropped prematurely. Among the treated fruits, there were no significant differences in the number of premature drops due to any of the main effects nor to any interaction of significance (see Table 8).

D. **Days from Treatment Date to Maturity**

The loss of a large number of plots due to premature drop precluded the use of statistical analysis in determining differences between treatments. Observations of remaining fruits were made however.

1. **May 30 Treatment.** No differences were evident between treated and untreated fruits in the number of days required to reach maturity. Untreated fruits ripened in an average of 37 days while treated fruits ripened in an average of 38 days.

Method of oil application had no consistent effect on the number of days required for fruits to mature. Fruits treated manually with 0.25 and 0.5 per cent oils ripened in the same number of days. In the surfactant treatment, sprayed fruits matured on an average of one day earlier than manually treated fruits and in the 1.0% oil treatment, sprayed fruit matured two days earlier than manually treated fruits.

Position had no consistent effect on days to maturity. There was a general trend for fruits in the more basal positions to ripen before those in more apical positions.

Oil concentration had little effect on days to maturity. The 0.25% oil took the longest to ripen followed by 1.0%, 0.5% and the surfactant.
2. **June 7 Treatment.** There were no differences between untreated and treated fruits in the number of days required for fruit to reach maturity. Untreated fruits ripened in an average of 31 days while treated fruits ripened in an average of 32 days.

A definite difference was evident between positions in the number of days required for fruit to mature. In every treatment except the 0.25% manual, the fruit ripened successively up the shoots at a few days interval.

The method of oil application had little effect on the number of days required for fruits to ripen. In the 0.25% oil treatment, fruits treated manually ripened in an average of three days earlier than the sprayed fruit. In all others, fruits in spray treatments took a few days longer to ripen than manual treatments.

Only small differences occurred between oils in the number of days required for fruits to mature. The fruits treated with surfactant matured in 29 days while fruit treated with all other oil concentrations ripened in an average of 33 days.

The ripening period shortened as the season progressed. Untreated fruits in the first treatment ripened in an average of 37 days while those in the second treatment ripened in 31 days. The six day difference being approximately equal to difference in physiological age on their respective treatment dates. Among the treated fruits, the ripening period also shortened as the season progressed but no consistent differences occurred between the various oil concentrations used.

3. **June 12 Treatment.** Untreated fruit ripened in an average of 38 days following treatment. Among the treated fruits, manually applied
oils consistently caused earlier ripening, by one to four days, than oils sprayed on.

In every treatment, except the 0.5% oil spray which ripened in inverse order, fruits consistently ripened successively up the shoots.

E. Size of Fruits

1. May 30 Treatment. The average diameter of untreated fruits was 3.1 centimeters at maturity. No distinct position differences in size were noted.

Among the treated fruits, some differences in size between method of oil application were noted. In the surfactant, 0.25% oil, and 1.0% oil treatments, the average diameter of fruits treated manually or sprayed was 2.90 centimeters. However, in the 0.5% oil, sprayed fruits averaged 2.72 centimeters and manually treated fruits averaged 3.09 centimeters in diameter.

Size differences between position were inconsistent and without any pattern.

The concentration of oil had no effect on fruit size.

2. June 7 Treatment. Untreated fruit showed no positional effect in size and averaged 2.77 centimeters in diameter.

Fruits manually treated and sprayed with the surfactant averaged 2.88 centimeters in diameter. Fruits sprayed with 0.25% and 0.5% oil were slightly larger than manually treated fruits, while fruits sprayed with 1.0% oil were slightly smaller than manually treated fruit.

Oil concentration had no effect on size. All fruits treated with surfactant, 0.5%, 0.25% and 1.0% oil averaged 2.83, 2.93, 2.97, and 2.88 centimeters in diameter, respectively.
3. **June 12 Treatment.** Untreated fruits averaged 2.86 centimeters and showed no positional effect.

The average diameters of treated fruits were similar regardless of oil concentration or method of oil application.

**F. Weight of Fruit**

1. **May 30 Treatment.** The average weight of untreated fruits was 17.17 grams. No positional effect on weight was evident.

The average weight of fruits was not affected by oil concentration nor method of oil application. No differences in weight due to positional effect were noted.

2. **June 7 Treatment.** Untreated fruits averaged 14.95 grams and showed no positional effect.

Among the treated fruits, method of application had little effect on weight of fruits. Fruits sprayed with surfactant and 0.5% oil were larger than those treated manually. Fruits treated manually with 0.25% and 1.0% oil were larger than those sprayed.

The concentration of oil demonstrated no effect on weight of fruits.

3. **June 12 Treatment.** The average weight of untreated fruits was 14.49 grams. This was almost identical to the average weight of treated fruits. A positional effect was not evident.

Among the treated fruits, method of oil application and concentration of oil had no effect on weight.

**C. Per Cent Soluble Solids**

1. **May 30 Treatment.** The average per cent soluble solids for untreated fruits in position one was 12.40 and 17.50 for positions two and three.
Table 9. Observations on ripe Celeste fig fruits at the three most basal nodes of shoots treated on May 30, 1963.*

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<th>Wt. (gm)</th>
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*Averages of 30 fruits for check treatments and 40 fruits for others.
Table 10. Observations on ripe Celeste fig fruits at the three most basal nodes of shoots treated on June 7, 1963.*

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*Averages of 30 fruits for check treatments and 40 fruits for others.
Table 11. Observations on ripe Celeste fig fruits at positions four, five, and six of shoots treated on June 12, 1963.*

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*Averages of 30 fruits for check treatments and 40 fruits for others.
Method of oil application and concentration of oil had little
effect on soluble solids. Positional effects were not evident.

2. **June 7 Treatment.** The average per cent soluble solids for
untreated fruits was 10.25%. Positional effect was not noted.

Generally, the method of oil application had little effect on
soluble solids. The largest differences between methods occurred in
the surfactant treatment in which the sprayed fruits had an average
soluble solids of 12.33% while manually treated fruits had 10.33%
soluble solids.

The concentration of oil used also showed little effect on soluble
solids. The surfactant treatment had the highest average soluble solids
with 11.33%; the 1.0% oil was next with 9.65%; the 0.25% oil followed
with 9.31% and the 0.5% oil treatment had the lowest, 9.27% soluble solids.

3. **June 12 Treatment.** Position, among the untreated fruits, had
a large influence on soluble solids. Fruits in position one averaged
12.56%; position two, 16.14%; and position three, 14.78% soluble solids.

Position, method of application, and concentration of oil had
little or no effect on soluble solids.

3. **Growth of Untreated Fruits in 1964**

   A. **Fruits in Positions One, Two and Three**

Growth of the untreated fruit in these positions did not change
appreciably during the twenty-four day period in which they were
measured. On the last two measurement dates, small increases in
diameter of fruit in each position were evident, indicating that the
fruit were entering the third growth period (see Tables 12 and 13).
Table 12. Growth* of Celeste fig fruits at the three most basal positions (nodes) on shoots treated with two oils applied manually to ostioles of fruits at successive dates.** 1964.

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</table>

*Average maximum cross diameter measurements of 40 fruit in centimeters.

**Measurements were taken at three day intervals and continued for nine days following treatment. If no response was noted, measurements were terminated at this time. Measurements of the untreated fruits were continued until nine days beyond the date of the last application of materials. (See Materials and Methods section.)
Table 13. Growth* of Celeste fig fruits at the three most basal positions (nodes) on shoots treated with ten per cent aqueous emulsions of roll oil applied manually to ostioles of fruits or sprayed on foliage and fruit.** 1964.

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</tbody>
</table>

*Average maximum cross diameter measurements of 40 fruit in centimeters.

**Measurements were taken at three day intervals and continued for nine days following treatment. If no response was noted, measurements were terminated at this time. Measurements of the untreated fruits were continued until nine days beyond the date of the last application of materials. (See Materials and Methods section.)
B. Fruit in Positions Three, Four, and Five

Growth of untreated fruit in these positions did not show an appreciable change until about the last two dates of measurement in which small increases in diameter occurred in fruits in positions four and five (see Table 14).

4. Growth of Treated Fruit in 1964

A. Fruit in Positions One, Two, and Three

Neither treatment nor treatment date had any effect on growth of fruits in these positions. Measurements indicated that fruit diameters were not affected by the applied treatments. Small fluctuations in all treatments were evident but they were consistent with fluctuations which occurred in the untreated fruits (see Tables 12 and 13). Premature drop was not increased by treatment since untreated fruit dropped in about the same numbers as treated fruit.

B. Fruit in Positions Three, Four and Five

No fruit in these positions showed response to treatment or treatment date except one fruit in position three treated manually with olive oil on June 15. This fruit was greatly accelerated to maturity by the oil and ripened in eight days. It was 3.0 centimeters in diameter and was in every way identical to a normally ripened fruit.

Premature drop of fruit in these positions were consistent with premature drop of untreated fruit in the same positions.

5. Other Treatments in 1964

On June 25 and 27, a series of treatments of olive oil, roll oil, and a 10% aqueous emulsion of roll oil were applied manually to all
Table 14. Growth* of Celeste fig fruits at positions (nodes) three, four, and five on shoots treated with roll and olive oil applied manually to ostioles of fruits and ten per cent aqueous emulsions of roll oil applied manually to ostioles of fruits or sprayed on foliage and fruits.** 1964.

<table>
<thead>
<tr>
<th>Treatment Date</th>
<th>Position Number</th>
<th>Olive Oil</th>
<th>Roll Oil</th>
<th>Check</th>
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<td></td>
<td>6/15 6/18 6/21 6/24</td>
<td>Ol</td>
<td>Ol</td>
<td>Ch</td>
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<tr>
<td>6/15</td>
<td>3</td>
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<td>1.9 2.0 1.9 1.9</td>
<td>1.8 1.8 1.8 1.9</td>
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<td></td>
<td>4</td>
<td>2.0 2.0 2.0 2.0</td>
<td>1.8 1.9 1.9 1.9</td>
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</tr>
</tbody>
</table>

*Average maximum cross diameter measurements of 40 fruit in centimeters.

**Measurements taken at three day intervals and continued for nine days following treatment. If no response was noted, measurements were terminated at this time. Measurements of untreated fruits were continued until nine days beyond the date of the last application of materials. (See Materials and Methods section.)
fruits remaining through position six on ten tagged shoots. A similar group of untreated fruits was also measured on each date.

A. June 25 Treatment

Striking results were observed for treatments. In general all materials applied caused accelerated development of fruit in the more basal positions (see Table 15 and Appendix Table 4).

Fruits in positions one and two treated with olive oil ripened in six days whereas untreated fruit in these positions required an average of seventeen days to ripen. Fruits in positions three through six did not show such striking results but ripened in approximately three to four days, on the average, earlier than untreated fruit in comparable positions.

Although some fruit in positions one and two treated with roll oil ripened in six days following treatment, the average days for all fruits in positions one and two to ripen was twelve and fifteen, respectively. Fruit in positions three through five (no fruit ripened in position six) ripened several days earlier, on an average, than untreated fruit in those positions.

Fruit in position one treated with 10% roll oil ripened in an average of seven days following treatment. Some fruit in positions two and three treated with 10% roll oil ripened in as short a period of time but the average number of days required to ripen for fruit in positions two and three was thirteen and eighteen days, respectively. Fruit in positions four and five (no fruit ripened in position six) in this treatment ripened in an average of twenty-three days while untreated fruit in comparable positions required twenty-two days to ripen.
Table 15. Response to three oils applied manually on June 25, 1964 to ostioles of Celeste fig fruits at successive positions (nodes) on shoots.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Number Treated</th>
<th>Number Ripe</th>
<th>Number Dropped</th>
<th>Days From Treatment</th>
<th>Average Size (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olive Oil</td>
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<td>10% Roll Oil</td>
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<td>3</td>
<td>36</td>
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</table>
No fruit dropped prematurely from the first three positions of the check treatment, the first two positions of the 10% roll oil treatment, and the first position of the roll and olive oil treatments. Premature drop in all other positions were consistent with drop in the check treatment except for the three highest positions in the 10% oil treatment which had 70, 75 and 100% drop, respectively, in those positions.

The size, and internal and external features of fruit accelerated to maturity were quite similar to those of untreated fruits.

B. June 27 Treatment

Striking effects of oil applications were also observed in this treatment. All materials generally accelerated ripening of fruit in the more basal positions on shoots (see Table 16 and Appendix Table 5).

Fruits in the three most basal positions treated with olive oil ripened in an average of eight days following treatment while untreated fruit in these positions required eighteen days to ripen. Fruit in positions three through six in the olive oil treatment were not accelerated to maturity and in fact, ripened later than comparable untreated fruit.

Although fruit in positions one through four treated with roll oil required on the average from eleven to eighteen days to ripen following treatment, some fruit in each of those positions ripened in as little as six days. Fruit in position five of this treatment, however, required twenty-seven days to ripen, five days longer than the untreated fruit in that position. Fruit in position six ripened in an average of twenty-nine days (no untreated fruit in this position matured).
Plate I. Effect of various oils applied manually to ostioles of fruits of Celeste fig on June 25, 1964, on the internal and external character of mature fruits.
Table 16. Response to three oils applied manually on June 27, 1964 to ostioles of Celeste fig fruits at successive positions (nodes) on shoots.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Number Treated</th>
<th>Number Ripe</th>
<th>Number Dropped</th>
<th>Days From Treatment</th>
<th>Average Size (cm)</th>
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</tbody>
</table>
Fruit in positions one, two, and three treated with a 10% aqueous emulsion of roll oil ripened in an average of eight, ten, and six days, respectively, but in each of those positions some fruit ripened in as little as six days. Fruit in positions four through six ripened in approximately the same number of days as untreated fruit in those positions.

Some premature dropping was encountered in all treatments except in position two of the roll oil treatment and in positions one and two in the 10% roll oil and untreated treatments. The amount of premature drop generally increased with successive positions up the shoots in all treatments including the untreated plot. Dropping in all positions of all treatments were generally consistent with that of the untreated fruit.

The average size, internal and external characteristics of fruits accelerated to maturity by the various treatments were generally identical to those of untreated fruit (see Plate 1).

6. Possible Morphological and Anatomical Characteristics Indicating Receptivity to Oil Applications

Examination of sections of fruits collected on each of the main treatment dates in 1964 failed to reveal any characteristics which could be used as a guide to receptivity to oil. Size alone proved not to be suitable.

More was discernible from fruits collected on June 25, however. Fruit in positions one and two collected on that date were beginning to lose much of their green external color and took on a slightly yellow color. At this time the veins in the skin of the fruits became quite prominent and pulp turned pink in color (see Plate 2). Fruits higher on shoots did not have such an appearance.
Plate II. Internal and external characteristics indicating receptivity to oils.
DISCUSSION

Celeste, the variety of fig used in this study, belongs to the common type of fig, which normally bears fruit parthenocarpically. However, in some seasons, Celeste drops fruits prematurely from several nodes near the bases of shoots. These fruits usually attain only about one-third to one-half the size of mature fruits and show some actual loss of size prior to abscission from the tree. A change in color from green to yellow often precedes this premature drop. Dropping of fruits in Celeste appears to indicate that the variety is not fully parthenocarpic and in certain seasons some factor which is normally present, is either absent or present in insufficient quantities for normal development of fruits.

When fruits of Celeste are artificially pollinated they adhere strongly and mature when unpollinated fruits may drop heavily from like positions on other shoots on the same tree or from other nodes on the same shoot. This indicates that the factor responsible for normal growth of the seedless fruits may be hormonal in nature, the fruits dropping in the absence of such a hormone. The environmental factors governing the supply of such a hormone are not evident.

Drought has often been postulated as the cause of the premature drop of Celeste fruits. This seems doubtful. When scions of some other varieties are grafted to a common rootstock with Celeste scions, Celeste fruits drop in some seasons while fruits of the other varieties are ripened normally. Mulching and supplemental irrigation seem to have little effect on premature drop of Celeste fruits. The experimental
planting was irrigated in 1963, a year of low spring rainfall, and in 1964, when rainfall was not deficient, and drop of fruits was severe in both years.

No relationship between temperature and premature drop is obvious, although it is conceivable that a carefully planned study may detect some such relationship.

Treatment effects in 1963 and in the early season of 1964 were largely overcome by the effect of premature drop. The growth, size, weight, the numbers to ripen and drop, and the length of the maturation period of remaining treated fruits so closely paralleled those of untreated fruits that it seems that the effects of treatment were almost completely masked by the premature dropping of fruits that would have perhaps responded to treatments. The effectiveness of the later treatments in 1964 seems to bear this out. Fruits were in some way "conditioned to drop" early in the season and were not responsive to treatments. The later response to the same treatments on fruits of the same physiological age seems to be evidence that this "conditioning" influence was not present later in the season.

Results obtained in the 1963 season and in the early part of the 1964 season indicate that "conditioned" fruits dropped regardless of treatment. Fruits treated later in the season in 1964, located at more apical nodes than earlier treated fruits, but of about the same physiological age, were stimulated to early ripening by certain treatments. Premature dropping of check fruits was less from the more apical positions (later in the season).

Fruits sampled from more basal positions on shoots in 1963
contained less total soluble solids than fruits located more apically on the shoots. These fruits corresponded in positions to fruits that dropped heavily. This change in the normal pattern of increasing soluble solids with maturity may be an indicator of incipient drop. The present study cannot offer any conclusive evidence on this possibility, however.

Regardless of the unforeseen effects of fruit drop certain results deserve notice. In 1963 experiments, the mineral oil "Nujol" in water emulsions with Multifilm-L surfactant caused leaf injury when applied as a spray at concentrations of 0.5, 1.0, and 1.5 per cent oil. The phytobland oils Orchex 796 and Roll oil 3190 also caused injury when applied as emulsions with 1.0 per cent Multifilm-L and 2.0 per cent oil concentration. The combination of Roll oil 3190 with the surfactant Spray-tac, however, caused no injury when applied at concentrations of up to 1.0 per cent oil and 1.0 surfactant. This showed that an oil could be applied safely with a mist blower at the responsive time of the fig fruits. It remained to be seen if the oil sprays would accelerate ripening. Results in 1963 were confounded by the fruit drop, and little was learned about such matters as the proper time to apply the oil and the correct concentration of oil to use, but oil applied by the spray method did not seem to be particularly detrimental, except in the very early season when fruit drop was at its worst. Later in the season little difference was noted between manually applied oil and sprayed oil.

In 1964, one concentration of oil was used (10% roll oil and 0.03% Spray-tac) and the emphasis was placed on attempting to determine the time that the fruits would be responsive to the oil. The coincident manual applications were intended as checks on responsiveness,
and the fruit samples collected for examination were intended to show any apparent changes that could be used to determine the responsive stage. When one disregards the early season failure to respond (probably due to the incipient drop) the responsive time of the fruits coincides fairly well with that described by Couvillon (1963). This stage, about three weeks after the fruits have attained the "plateau" in the growth curve characteristic of the variety, is one at which the individual flowers are past pollen receptivity. The ovary walls show considerable sclerification. One might speculate that if the continued development of this parthenocarpic fruit depends upon a hormone similar to that produced by the developing seed, or upon seed-produced hormones in pollinated specimens, the production would necessarily lag behind the stage at which stigmas were receptive because of the necessary time required for growth of the embryo to be underway.

Little outward differences occur in fruits that are responsive to the oil treatments and those that are not. The size may be the same. There is some fading of the grass-green color to a more yellow green. A striking change in the appearance of the pulp to the naked eye seems to be associated with the responsive time, however. The pulp, which is pure white at the time of stigma receptivity, begins to take on a pink, then a reddish coloration. Such coloration occurs in caprified, or pollinated fruits of many varieties of figs that normally have pale pulp. The manual application of pure Roll oil 3190 seemed to cause a particularly intense reddish coloration of the pulp in ripe fruits (Plate 1). How long the fruits remain responsive was not accurately determined, but in many cases three fruits at successive nodes can be
ripened with one application of oil. Since these fruits represent a span of some six or seven days in age it may be assumed that the period could persist for about that long. In a normal season in the Baton Rouge area this period for figs at basal nodes would occur from about May 30 to June 7, based on observations made by O'Rourke (1964).
SUMMARY

In the 1963 season, fig fruits of the Celeste variety were sprayed and treated manually with a surfactant and three concentrations of Roll oil 3190, a nonphytotoxic oil produced by Humble Oil and Refining Company, on May 30, June 7, and June 12, in an attempt to determine the receptive period of fruits to oleification and the oil concentration which would stimulate fruits to maturity as well as the effect of the oil on the number of fruits to ripen, percentage drop, size, weight, and soluble solids of fruits.

A high percentage of fruits dropped prematurely among both the treated and untreated fruits. This premature dropping could possibly have been attributed to moisture stress since the Spring of 1963 was unusually dry, or to the fact that the variety Celeste is not completely parthenocarpic and drops a large number of fruits due to a lack of pollination.

The number of fruits to ripen following treatment on the first two dates was not significantly affected by any of the main experimental effects (date, oil concentration, method of treatment, and position of fruits on shoots). Following treatment of the third date, the only treatment to have a significant influence on numbers of fruits to ripen was the oil, which reduced the numbers of fruits to ripen with additional increments of oil. This appeared not to be due to injury by the oil but merely to immaturity of the fruits.

Following the first two treatments a significantly greater number of fruit dropped prematurely from treated shoots. No other treatment
had a significant influence on premature drop. Following the third treatment, there were no significant differences in drop between treated and untreated fruits nor were there significant differences due to other factors, such as concentration, etc.

No differences in the number of days required for fruit to mature occurred between treated and untreated fruits. Untreated fruits and fruits treated on May 30 required about seven days less to ripen following treatment than those treated on June 7. This seven day difference was about equal to the difference in physiological age of fruits on the two treatment dates.

None of the main treatment factors showed an influence on the number of days required for fruits to mature in any of the three treatments. Fruits generally ripened successively up the shoots at two-day intervals. Fruits treated manually with olive oil on June 7 were not effectively stimulated to early maturity.

The main treatment factors did not have any influence on the size and weight of fruits treated on any of the three dates. The size and weight of untreated fruits were almost identical to the size and weight of treated fruits.

Soluble solids, particularly of untreated fruits in the May 30 treatment, were generally lower for fruits at more basal positions on shoots. This suggests that fruits about to drop either lost or did not accumulate soluble solids. The main treatment factors did not influence soluble solids of fruits in any of the treatments.

During the 1964 season, five treatments, starting on May 22 and at four day intervals thereafter, of olive oil, roll oil, and a
10% emulsion of roll oil, were applied manually and in spray form to the three most basal fruits on shoots of Celeste fig trees. On June 11 and 15, the same materials were sprayed and applied manually to fruits at the third, fourth, and fifth nodes from the shoot bases.

Again in 1964 heavy premature dropping was encountered. Oil applications in the first five treatments failed to accelerate maturity of fruits. Only one fruit, in position three (third node) and treated manually with olive oil on June 15, was accelerated to maturity. This fruit ripened in eight days after being treated and was in every way identical to naturally ripened fruits.

Since heavy premature drop had largely nullified treatment effects on the first seven dates of application, two additional series of treatments, one on June 25 and another on June 27, were applied to Celeste fig fruits. These consisted of applying separately, olive oil, roll oil, and a 10% emulsion of roll oil to any and all fruits in positions one through six remaining on ten shoots.

Striking results were noted on both dates. All three materials generally accelerated maturity of fruits in one through three. Treated fruits ripened in approximately sixteen days. Fruits so stimulated to maturity were in every way identical to those which ripened naturally.

These results strongly suggest that all of the materials, including the 10% roll oil emulsion, were capable of accelerating maturity when applied at a receptive period. This receptive period is apparently a function of physiological maturity and occurred at a later calendar date than that suggested by Couvillon (1963). This was undoubtedly due to lack of response in fruits "conditioned" in some way to absciss.
Size alone proved to be a poor criterion of receptivity. External and internal color of fruit appeared to be a better guide. Fruits with a pale green skin and pink pulp were effectively stimulated to maturity. It is postulated then, that if oils are applied when fruits in the first and second positions have such an appearance, it would be possible to accelerate them and possibly fruits in positions three and four to maturity. In seasons when premature drop occurs, fruits near the bases of shoots do not attain the receptive stage.
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Appendix Table I. Average* maximum cross diameters (cm) of Celeste fig fruits at the three most basal positions (nodes) of shoots treated on May 30, 1963. Measurements were made at three-day intervals.

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| "                  | 2    | 1.9 | 1.9 | 1.9 | 1.9  | 2.0  | 2.0  | 2.0  | 2.0  | 2.3  | 2.7  | 2.8 | 3.1 |     |     |      |      |
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| **Manual**          |      |     |     |     |      |      |      |      |      |      |      |     |     |     |      |      |
| Position 1          | 1.8  | 1.8 | 1.7 | 1.8 | 1.8  | 1.8  | 1.8  | 1.9  | 2.1  | 2.4  | 2.6  | 2.8 | 2.8 |    |     |      |      |
| "                  | 2    | 1.9 | 1.8 | 1.8 | 1.8  | 1.9  | 1.9  | 1.9  | 2.0  | 2.3  | 2.5  | 2.8 | 2.9 |    |     |      |      |
| "                  | 3    | 1.8 | 1.8 | 1.8 | 1.8  | 1.8  | 1.9  | 1.9  | 2.0  | 2.2  | 2.5  | 2.9 |    |    |    |      |      |

| **0.25% Oil Spray** |      |     |     |     |      |      |      |      |      |      |      |     |     |     |      |      |
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| "                  | 3    | 1.8 | 1.8 | 1.7 | 1.8  | 1.8  | 1.8  | 1.9  | 2.0  | 2.1  | 2.3  | 2.3 | 2.5 | 2.8 | 2.9 |    |      |

| **Manual**          |      |     |     |     |      |      |      |      |      |      |      |     |     |     |      |      |
| Position 1          | 1.8  | 1.8 | 1.8 | 1.8 | 1.8  | 1.8  | 1.8  | 1.7  | 1.8  | 2.2  | 2.4  | 2.6 | 2.8 |    |     |      |      |
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| "                  | 3    | 1.8 | 1.8 | 1.9 | 1.9  | 1.8  | 1.8  | 1.8  | 1.8  | 1.9  | 2.1  | 2.5 | 2.8 | 2.8 |    |      |
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* Average of forty fruits for treated shoots and thirty fruits for check shoots.
Appendix Table II. Average* maximum cross diameter (cm) of Celeste fig fruits at the three most basal positions (nodes) of shoots treated on June 7, 1963. Measurements were made at three-day intervals.

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*Average of forty fruits for treated shoots and thirty fruits for check shoots.*
Table III. Average* maximum cross diameters (cm) of Celeste fig fruits at positions (nodes) four, five, and six of shoots treated on June 12, 1963. Measurements were made at three-day intervals.

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* Average of forty fruits for treated shoots and thirty fruits for check shoots.*
Appendix Table IV. Average* maximum cross diameters (cm) of Celeste fig fruits at successive positions (nodes) of shoots treated on June 25, 1964.

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*Average of all remaining fruits on shoots.
Table V. Average* maximum cross diameters (cm) of Celeste fig fruits at successive positions (nodes) of shoots treated on June 27, 1964.

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*Average of all remaining fruits on shoots.
VITA

Albin Joseph Langlois was born near New Roads, Louisiana on March 16, 1934. He attended both elementary and high school at Poydras High School in New Roads. In September, 1952, he entered Louisiana State University and in August, 1956 he received a Bachelor of Science degree from that institution with a major in Horticulture. He spent the next two years in the United States Army and after his release from duty in September, 1958, he re-entered Louisiana State University and was awarded a Master of Science degree in June, 1960. The following year he served as Instructor of Agriculture at Francis T. Nicholls State College in Thibodaux, Louisiana.

In September, 1961, he entered the University of Illinois and studied there three semesters. In February, 1963 he returned to Louisiana State University and studied there until accepting a position on the faculty of Arkansas State College in September, 1964.

He is presently a candidate for the Doctor of Philosophy degree.
Candidate: Albin J. Langlois

Major Field: Horticulture

Title of Thesis: Studies of Accelerated Ripening of Ficus Carica C. V. Celeste

Approved:

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

Date of Examination:

December 22, 1964