important to know whether initial wetting is sufficient, or if a long-term residual effect is needed. In general, if initial wetting is required to prevent erosion and increase infiltration, the most efficient nonionic would be one of the ether group. If long-term efficiency is required, the ester group would be better. There are many requirements between these limits and the selection of the wetting agent will depend on which is the most important.

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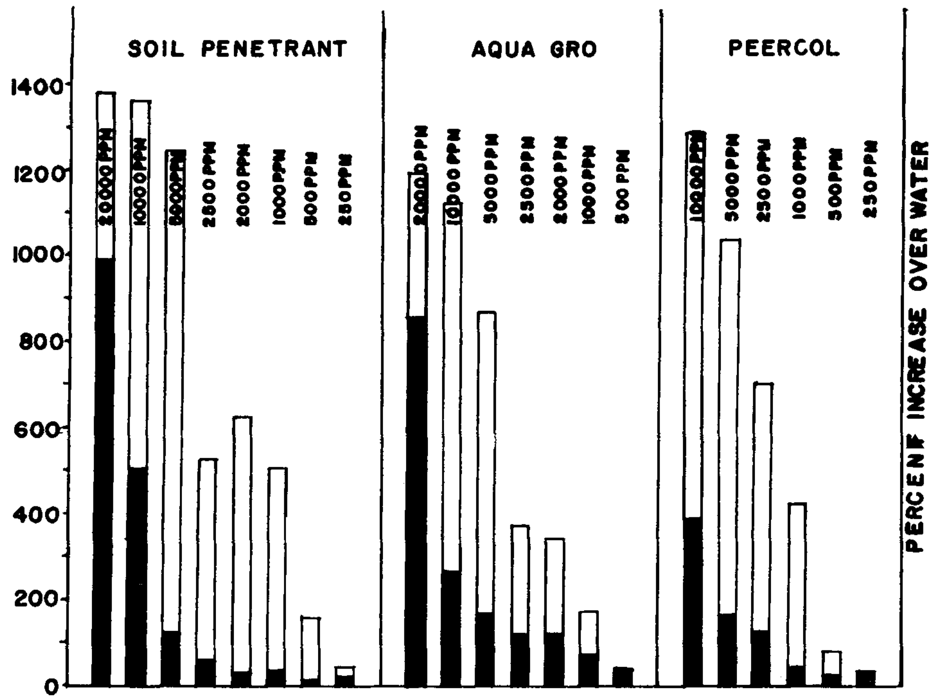
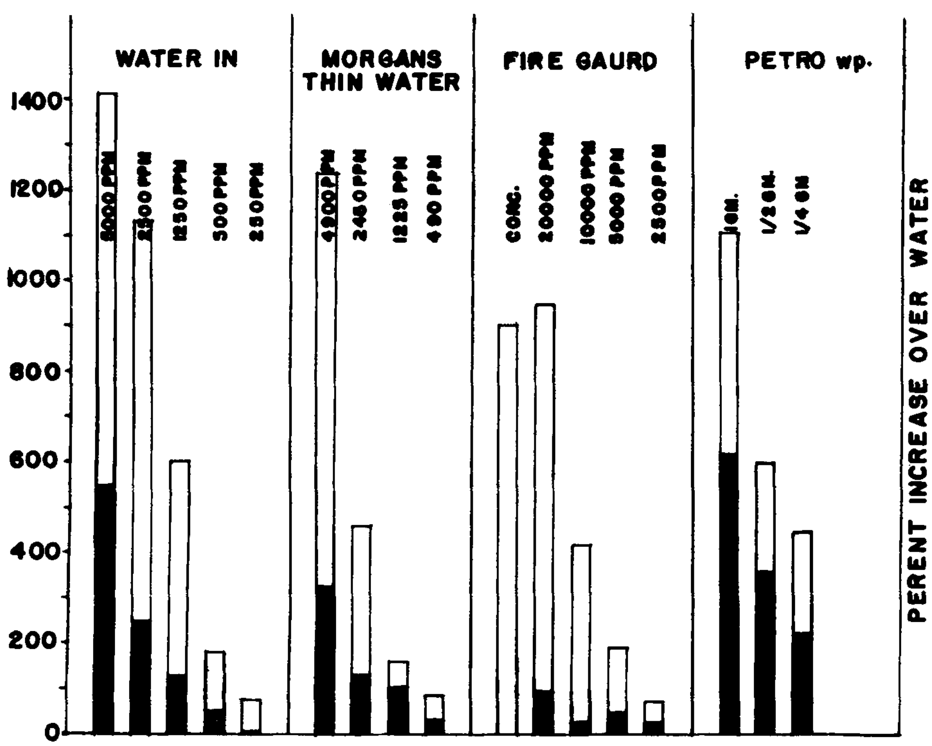
GRAPH 2. WETTING EFFICIENCY OF VARIOUS WETTING AGENTS. HOLLOW BAR REPRESENTS THE EFFICIENCY FOR FIRST TEST PERIOD. SOLID BAR REPRESENTS THE EFFICIENCY AT THE END OF THE THREE YEAR PERIOD.



GRAPH. 3. WETTING EFFICIENCY OF VARIOUS WETTING AGENTS. HOLLOW BAR REPRESENTS THE EFFICIENCY FOR FIRST TEST PERIOD. SOLID BAR REPRESENTS THE EFFICIENCY AT THE END OF THE THREE YEAR PERIOD.



Effects o

K. URIU

P. E. MARTIN

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Trunk growth studies of almonds at Davis have given new information about the need for spring irrigation. A lever-type dendrometer developed at the University of Idaho was used to follow trunk growth patterns for four consecutive years under widely varying conditions of soil, water, and crop density. The study has shown that the need for early irrigation increases when there is a heavy crop. In the spring, trunk growth rates were increased by irrigation even when as much as 40 per cent available water still remained in the top 4 ft of soil. After mid-season, trunk growth rates were not increased by irrigation unless the soil water content had dropped to the plant wilting percentage before irrigation. These studies also showed that trunk growth rates were reduced as the crop density increased.

THIS IRRIGATION study began in the spring of 1963 and was conducted for four seasons in a 20-year-old almond orchard at University of California, at Davis. Lever-type dendrometers were installed, one instrument per tree, in four differentially irrigated rows. End trees were not instrumented, leaving eight instrumented trees per row. Two guard rows separated the irrigation treatments.

Dendrometers always show maximum trunk expansion attained since the last

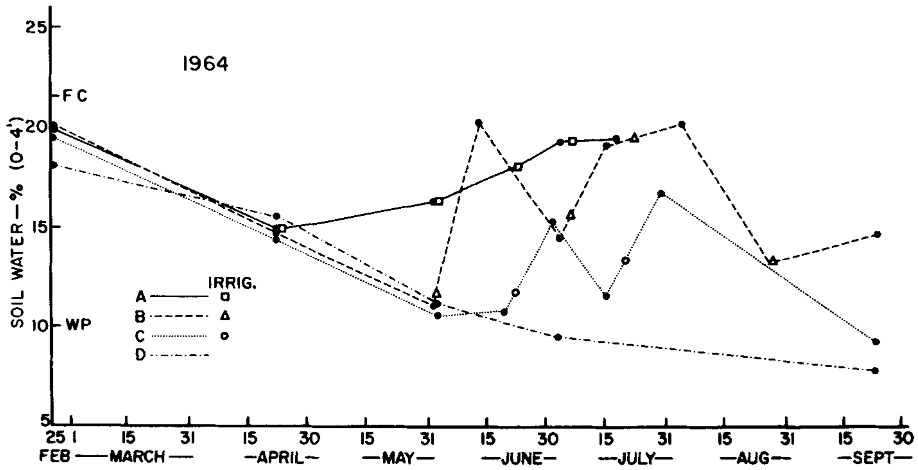
IRRIGATION, CROP DENSITY ON ALMOND TRUNK GROWTH

reading. As the trunk expands (generally between night and early morning), the lever of the dendrometer is pushed outward. When expansion stops, the lever remains stationary and does not retract with trunk shrinkage. Readings were taken every two days. The data from trees in each treatment row were averaged.

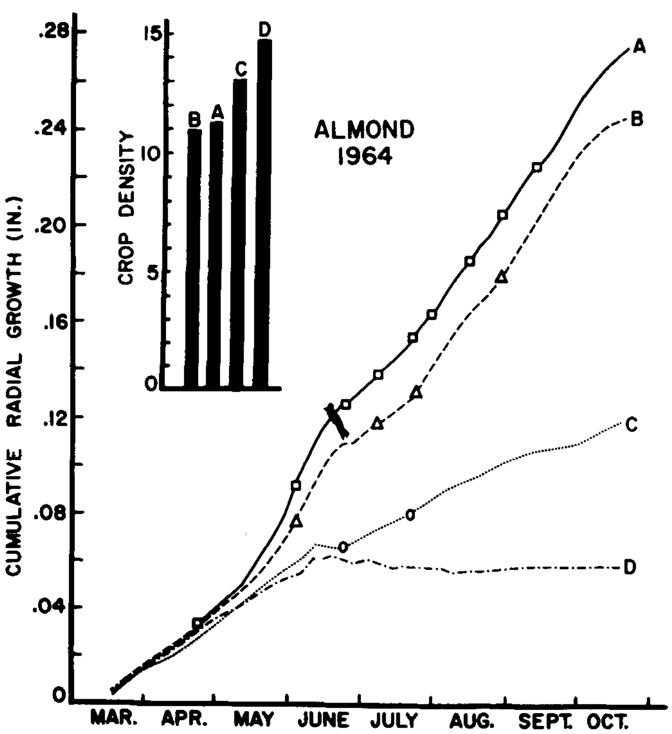
Four treatments

There were four irrigation treatments: (A) trees irrigated every two weeks during the growing season (approximately nine irrigations); (B) trees irrigated when the water content average of the top 3 feet of soil was still about 3 per cent above the wilting point (WP)

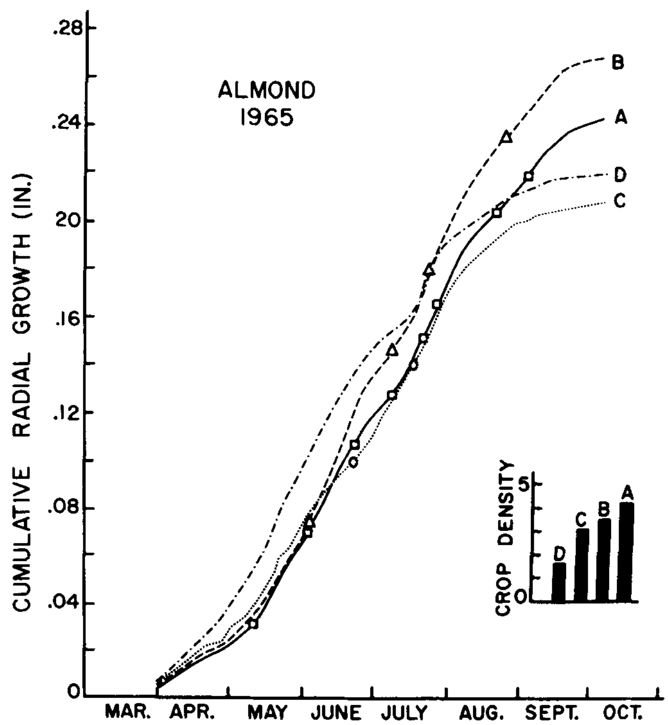
GRAPH 2. AVERAGE SOIL WATER CONTENT (0 TO 4 FEET), 1964. (TREATMENT A WAS NOT SAMPLED BEYOND MID-JULY; THEREFORE IRRIGATIONS AFTER THIS DATE ARE NOT SHOWN.)



GRAPH 1. CUMULATIVE RADIAL TRUNK GROWTH (IN.) AND CROP DENSITY (NUMBER OF NUTS PER CM^2 OF TRUNK CROSS-SECTIONAL AREA) FOR 1964. TREATMENT A HAD NINE IRRIGATIONS DURING THE SEASON; TREATMENTS B, FOUR; C, TWO; AND D, NONE. SYMBOLS ON CURVES INDICATE IRRIGATION DATES.



GRAPH 3. CUMULATIVE RADIAL TRUNK GROWTH (INCHES) AND CROP DENSITY (NUMBER OF NUTS PER CM^2 OF TRUNK CROSS-SECTIONAL AREA) FOR 1965. TREATMENT A HAD NINE IRRIGATIONS DURING THE SEASON; TREATMENTS B, FOUR; C, TWO; AND D, NONE. SYMBOLS ON CURVES INDICATE IRRIGATION DATES.



—four irrigations; (C) trees irrigated when the average water content in the top 3 feet of soil reached WP—(two irrigations); and (D) trees that were not irrigated.

Rectangles

Irrigation water was applied in rectangles enclosing two trees each. Water was applied to a depth calculated to return the soil moisture to field capacity throughout the root zone. Samples for gravimetric determination of soil water were obtained in foot increments down to 6 ft before each irrigation, and once a month in the unirrigated plot. Soil water percentages from the top 4 ft were averaged and plotted.

Yields per tree, and nut sizes, were determined at harvest, and an estimate of the total number of nuts per tree was calculated. Trunk circumference was measured at the end of each year, trunk cross-sectional area calculated, and a crop density figure obtained (number of nuts per cm^2 of cross-sectional area of the trunk).

Growth patterns

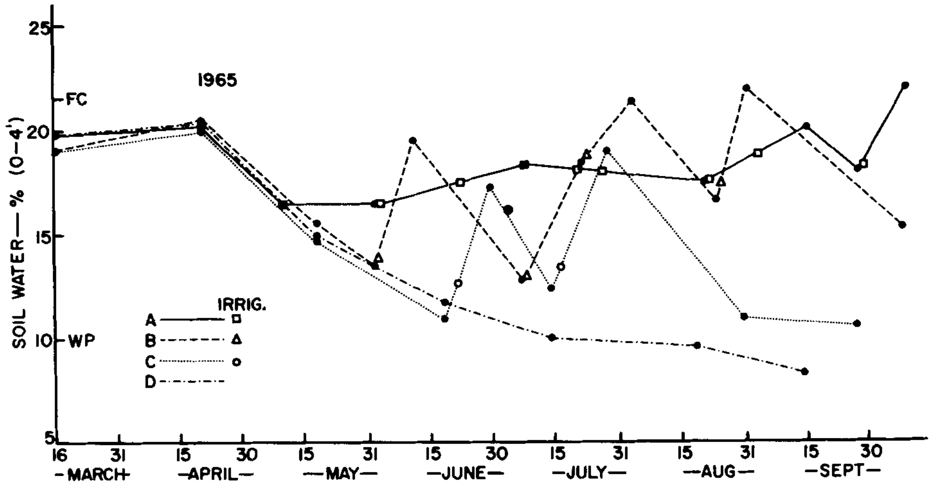
The tendency of almonds to bear in alternate years was quite evident during the four years of this study; 1963 was a moderately light crop year, 1964 heavy, 1965 very light, and 1966 again heavy. Also, preseason winter rainfall was above normal prior to the 1963 and 1965 seasons and below normal for 1964 and 1966. Thus, rainfall and crop conditions and subsequent trunk growth results were very similar in alternate years. Trunk growth curves for 1964 are therefore used to illustrate both the 1964 and 1966 results, and 1965 curves to illustrate 1963 and 1965 results.

In the winter and spring of 1963–64 there was about 11 inches of rainfall. This resulted in a relatively low reserve of soil water in the spring. In the dry plot (D) the soil was wet to a depth of only 4 ft, and the soil below was at the wilting point.

The crop load was heavy, ranging from 11 to 15 nuts per cm^2 of trunk cross-sectional area. The average crop for this orchard is about six to 10 nuts per cm^2.

The total cumulative radial trunk growth at the end of the season (graph 1) was greatest in treatment A. Treatment B had slightly less growth even though the crop load was slightly less than in A. Treatment C, with a higher crop density, had considerably less growth than in A or B. Treatment D, with the highest crop density, had the least growth.

GRAPH 4. AVERAGE SOIL WATER CONTENT (0 TO 4 FEET), 1965.



Beginning season

In the beginning of the season, treatments A and B, with practically the same crop density, were growing at about the same rate until A was irrigated in late April. Then the growth rate of A exceeded that of B even though the soil water was well above the wilting point in both treatments (graph 2). Around mid-May, the growth rate was considerably higher in B than in C although the soil water level at this time was the same in both treatments. Neither had been irrigated yet. The crop density, however, was considerably higher in the C plot. Since the soil water conditions were the same in both, it can be assumed that the growth rate was lower in C than in B because of the heavier crop. Likewise, the growth rate was the lowest in treatment D which had the highest crop density.

In June, growth was suddenly reduced in both treatments C and D when the soil water content neared the wilting point. Growth resumed in the C plot when an irrigation was applied in late June, but it did not resume in the unirrigated D treatment.

The first irrigation of the season in treatment A was followed by a growth response, although at the time of irrigation 30 to 40 per cent available water still remained within the top 4 ft of soil. Irrigations later in the season did not further increase the rate of growth. Also, the rate of growth in A, from late June on, was no greater than in B even though A was given twice as many irrigations as B. In C, the last irrigation (late July) did not bring about an increase in growth rate although soil water content was close to the wilting point.

Unlike in 1964, the preseason rainfall in 1965 was approximately 19 inches. Average rainfall for the area is about 16 inches. Therefore, soil water was abundant down to 6 ft in all plots prior to spring growth. The crop was extremely light—only two to four nuts per cm^2 of trunk area.

Light crop

With a very light crop and adequate soil water, trunk growth did not differ much between treatments until late in the season (graph 3). As treatments D and C approached WP in mid-July and late August, respectively (graph 4), trunk growth rates were markedly reduced. Treatments A and B, in contrast, had sufficient irrigations so that growth was not restricted by soil water deficits.

Total growth in B was greater than in A although B had fewer irrigations. However, crop density was higher in A, indicating that the heavier crop suppressed trunk growth. Even in the water-deficient plots (C and D), the plot with the lower crop density (D) had the greater total trunk growth. Also in the early part of the season, when all plots had abundant soil water, trunk growth rate correlated inversely with crop density: growth rates decreased in order from treatments D to A, while the crop loads increased.

After irrigations were started, however, this order was not maintained. Thus, treatment A, whose early growth was the slowest (because it had the largest crop density), by mid-June (after two irrigations) was growing as fast as the unirrigated treatment D, which had initially been growing twice as rapidly. Later, as the soil water content in D decreased and approached the wilting point, growth in D slowed while A maintained its rate. A temporary increase in growth rate of D in late July was associated with a period of unseasonably cool weather which diminished the effect of the soil water deficit on the water balance in the tree. However, with the return of higher temperatures the growth rate in D was again markedly reduced.

Conclusions

In each of the four years of the study, both the soil water supply and crop load, whether in a high crop or a low crop year, influenced rate of trunk growth and total seasonal growth.

Trunk growth was primarily influenced by soil water and secondarily by crop load. This was apparent in the low-rainfall years of 1964 and 1966, during which C and D reached the wilting point in mid-season. Trunk growth was stopped and resumed only after irrigation of treatment C in late June. Even then growth in C never equaled the rate in plots A and B which were irrigated much earlier in the season. This indicates that irrigations applied late in mid-season have much less effect on current rates of trunk growth than those applied early in the irrigation season.

Early irrigations

In all four years, early irrigations (in May and June) increased trunk growth rate in treatments A and B, even though the average soil water content through the top 4 ft of soil was well above the wilting point (30 to 40 per cent available water remained) at time of irrigation. Later irrigations in plots A and B, whether at intervals of two or four weeks, did not increase growth rate further, but merely maintained the rate established earlier.

This study indicates that high crop density in almonds increases the need for irrigation, especially early in the season. During years of low crop density, trunk growth rates may be maintained with a schedule of less frequent irrigations.

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HONEY BEE POLLINATION OF ALFALFA SEED

improved by supplemental feeding

BOB SHEESLEY • BERNARD PODUSKA

Results of these Fresno County experiments indicate possible advantages to both alfalfa seed growers and beekeepers from the use of supplemental feeding, and requeening of bee colonies used in alfalfa pollination.

ALFALFA SEED GROWERS in Fresno County produced 22 per cent of the United States' alfalfa seed on 10 per cent of its seed acreage in 1967. Pollination of this crop in Fresno County requires 150,000 honey bee colonies during the three-month period of June, July, and August.

Seed growers are continually looking for practical management procedures to improve seed yields. Pollination during the 10-to-12-week alfalfa seed setting period depends upon a continuing supply of new bees to replace worn out or dead field workers. Colonies entering seed alfalfa for pollination need actively laying queens with brood of all stages and enough workers to serve the colony and to pollinate the alfalfa flowers.

Recent tests have demonstrated that a January feeding of natural pollen mixed with drivert sugar mixed with 1 per cent natural pollen stimulated egg laying. This food supplement was fed before natural pollen was available, and resulted in larger bee populations in time for almond pollination.

Another experiment was conducted recently in Fresno County to explore answers to the following questions: (1) can pollination of alfalfa blossoms be increased by feeding honey bees prior to bloom or during bloom?; and (2) what happens to the strength of brood, and pollen collecting abilities of honey bee colonies while in seed alfalfa?

Results reported here are from this single experiment conducted under one set of conditions. The consistency of results does suggest they are valid for this set of conditions. However, there are many variables in field experiments of this type. For this reason it is unlikely that the same results will be obtained with extremely different bee populations, or different environmental and pesticide situations.

Sixty colonies of bees were divided into four test treatment groups of 15 colonies each. Each test group included five strong colonies, five of medium strength, and five weaker colonies. These original strength ratings were based on actual brood area measurements on May 28, two weeks before they were moved to the alfalfa seed field. Natural pollen had been available to all colonies since January 13. The colonies were further assigned to five equal replications to determine any pollen collection differences due to the effect of physical locations in the alfalfa seed field.

The four treatment groups in the experiment were: (1) the control group of bees, receiving no food; (2) those receiving 1½ lbs. of drivert sugar with 1 per cent pollen fed dry on May 29, two weeks before they entered the alfalfa seed field; (3) those receiving the same