Project Number: 83-O3 (Part 1)

ANNUAL REPORT TO THE ALMOND BOARD OF CALIFORNIA

December 30, 1983

Tree and Crop Research on Freeze Protection - Irrigation

by

R. L. Snyder

Objectives:

1. Characterize the energy budget within an almond orchard under freezing conditions.

2. Introduce the operation of under-tree sprinklers into the energy budget model to determine the theoretical effects of various application rates, starting and stopping conditions, and sprinkler spray differences on the microclimate in an orchard.

3. Field test the energy budget and sprinkler operation models to verify accuracy.

4. Determine what under-tree sprinkler management will afford the greatest freeze proection under various environmental conditions.

5. Investigate the interactive benefits of the combination of sprinklers and control of ice-nucleating bacteria on freeze protection.

Interpretive Summary:

Weather stations were set up near Camino during December 1982, and January, 1983, to study the effects of sprinkler application rates (0.08, 0.12, and 0.16 in/hr) on the microclimate during freezing conditions. The site near Camino was selected because it is historically a very cold region. There was only one night, however, when temperatures were cold enough for data to be gathered. On that night sprinkler operation raised the soil surface temperature from 27.3 to 31.6 degrees Fahrenheit where it stabilized. After one hour of operation the air temperature was fluctuating around 32 degrees Fahrenheit. Temperatures were not cold enough to discern any differences between sprinkler application rates.

During February, March and April, 1983, the weather stations were moved to an almond orchard north of Chico and one additional station was added to increase the number of treatments to five. Treatments were: (1) control; (2) 0.08 in/hr Toro low volume; (3) 0.08 in/hr impact sprinklers; (4) 0.12 in/hr impact sprinklers; and (5) 0.10 in/hr microjet sprinklers. No results were obtained because of excessive rainfall and no freezing temperatures.

Experimental Procedure:

A hand-move sprinkler system was set up in an open field near Camino to test the effects of application rate on the microclimate under freezing conditions. Four automatic weather stations were set up in the field. One of the weather stations was used as a control and the other three were placed in the sprinkler operation area. Water was applied at rates of 0.08, 0.12, and 0.16 in/hr to the area around each of the three weather stations. Measurements included net radiation, air temperature, humidity, soil surface temperature, soil temperature at 5 inches, air temperature at 2.5 feet, and air temperature at 10 feet. Wind speed was measured at the control station.

A solid-set sprinkler system was modified to provide the four sprinkler application rate treatments in the orchard near Chico. Each of the automatic stations measured net radiation, air temperature, humidity, soil surface temperature, soil temperature at 2 inches, air temperature at 2.5 feet, and air temperature at 10 feet. Wind speed was measured at the control station.

Results:

The only data gathered were from the Camino experiment on one night when temperatures dropped below 32 degrees Fahrenheit. No differences between treatments were observed, but the lack of observable effects were most likely due to the relatively mild freezing conditions. The soil surface temperature was observed to increase to near the melting temperature and that effect raised the radiation of heat from the surface. The increase in radiated heat will be partly intercepted by the trees in an orchard and provides some of the protection observed when under-tree sprinklers are used for freeze protection.

Discussion:

Results from this year's experiments tend to support results from previous years but much remains to be confirmed. The experiment must be conducted under colder conditions to differentiate between application rate effects and to determine how much protection can be afforded by the different rates.

Because cold temperatures have been rather limited in the areas where these experiments have been performed, a shift in direction has been made from previous efforts. A computer model to simulate the energy budget in an almond orchard will be written and tested under freezing and near freezing conditions. Once completed the operation of sprinklers will be introduced into the model to determine the theoretical effects of various sprinkler management schemes on the energy budget. Further studies on the interactive benefits of combining under-tree sprinklers and control of ice-nucleating bacteria on freeze protection will continue.

Project Number: 83-O3 (Part 2)

ANNUAL REPORT TO THE ALMOND BOARD OF CALIFORNIA

December 30, 1983

Nitrogen on Drip Irrigated Almonds

by

Roland D. Meyer

Objectives:

To evaluate the effect that nitrogen rates at two water application levels have on growth, nutrient concentrations of leaves and twigs, and nut yields of almonds.

Interpretive Summary:

Growers and agricultural advisors have long been interested in what the nitrogen requirements of new almond plantings are under drip irrigation. The first few years of tree growth with less than complete canopy cover result in less water use with drip irrigation due to the reduced evaporation from the bare soil surface. Past research with other crops has shown that fertilizer materials applied by drip are distributed differently in the soil than when broadcast on the soil surface. Multiple fertilizer applications throughout the growing season are possible with drip systems which should result in greater efficiency of nitrogen use. Nitrogen applied in conjunction with water may result in greater uptake when plants are actively growing. The high concentrations of some fertilizers, such as the ammonium form of nitrogen, may result in an undesirable plant root environment. The low pH created may bring into soil solution sufficient levels of manganese and aluminum to reach toxic proportions. Monitoring the nitrogen status of trees has been difficult because of the decline in nitrogen concentrations in the leaves during the growing season, thus it seemed desirable to investigate the use of other plant parts for diagnostic purposes.

Leaf analysis in 1982 revealed total nitrogen content declined from approximately 4.5% in April to 2.0% in October. Although chemical analyses have not been completed on all samples collected, early season results indicate a similar trend exists in 1983. The unassimilated nitrogen fractions, nitrate and ammonium show the same trend. Little if any difference between water levels or nitrogen rates appeared until the August 4, 1982 sample date. At that time the total nitrogen in the leaves increased with increasing water and nitrogen application rates. These relationships were not as apparent in later samplings as was shown for the August sampling. Analyses of the 1983 season samples shows a similar but much more progressive trend of increasing nitrogen concentration associated with higher application rates but little if any difference between water levels. Visual observation of the orchard confirms the range in nitrogen concentration indicated by the chemical analysis with the trees receiving the zero and lower rates of nitrogen showing the yellow-green leaf color as opposed to the dark green with higher rates.

During the dormant periods, January 1982 and January 1983, tree trunk diameters have been recorded and the increase in cross-sectional areas for the five trees per plot calculated. There is a trend for trunk size to show an increase with increasing water and nitrogen application rates. Twig samples

taken during the dormant period (December 1982-January 1983) following the first season of treatment application show a trend for higher nitrogen concentrations with increasing rates of applied nitrogen. The lower level of applied water (0.6 ET) however, shows a trend of having greater total nitrogen concentrations.

Experimental Procedure:

The experiment was established on the Nickels Estate beginning in the second year after the three almond varieties-Butte, Carmel and Nonpareil were planted. Five-5 tree plots were selected from each of the four-28 tree rows of each variety to which the two replications of the ten treatments were assigned. The ten treatments included two water levels-0.6 and 1.0 of evapotranspiration (ET) each with five nitrogen rates-0, 0.5, 1.0, 1.5 and 2.0 in 1982 and 0, 0.8, 1.7, 3.5 and 7.0 oz per tree in 1983. Urea was used as the nitrogen fertilizer source. The lower two nitrogen rates were split into thirds and applied three times during the season (60 day intervals) while the two higher rates were split into fourths and applied four times during the season (40 day intervals). Both application regimes began on April 1st and ended on August 1st. Leaf samples were taken from each of the 60 individual plots each month beginning April 1st and ending October 1st. Twig samples were taken once during the December 1981-January 1982 period and three times during the December 1982-January 1983 period. Only moderate pruning was carried out after the first growing season with much more severe pruning at the completion of the second season (Dec 1982-Jan 1983). Leaf and twig samples were analyzed for total, nitrate, and ammonium nitrogen, total phosphorus, potassium, calcium, and magnesium and selected sample dates were chosen for micronutrients zinc and boron. Tree trunk diameters were recorded during January of 1982 and 1983 to calculate the change in cross-sectional area for the five tree plots.

Results:

Visual observation of the orchard indicated that the zero and two lower nitrogen rate treatments showed yellow-green leaf color while the two higher rates had very dark green color. The difference in color between nitrogen treatments was more dramatic in 1983 than 1982. This would be expected with the higher rates of nitrogen applied and the second year for treatments receiving no nitrogen. Treatments receiving the 0.6 ET water level showed some leaf wilt indicating plant moisture stress during the latter part of both growing seasons.

Results of leaf analyses show the previously well documented decline in total nitrogen concentration throughout the growing season. This is illustrated in Figure 1 with the 4.5% nitrogen concentration on April 6 which decreases to under 2% by October 7, 1982. Although chemical analyses have not been completed on all samples collected, early season results indicate a similar trend exists in 1983. The unassimilated nitrogen fractions, nitrate and ammonium show the same pattern. Total nitrogen concentrations indicated no difference between water or nitrogen treatments until the August 4, 1982 sampling when the total nitrogen increased with increasing water and nitrogen applications (Figure 2). These relationships were not as apparent in later samplings in 1982. Unassimilated nitrate and ammonium concentrations were not effected by nitrogen or water treatments. Figure 3 illustrates the near constant nitrogen concentration across all treatments beginning with the April 7, 1983 sampling. Throughout the 1983 season the nitrogen concentration for the two water levels remained the same but progressively increased with an increase in applied nitrogen (Figure 4).

Twig samples taken during the dormant period (December 1982-January 1983) following the first season of treatment application show a trend for higher nitrogen concentrations with increasing rates of applied nitrogen. The lower level of applied water (0.6 ET) however, indicated a trend of having greater total nitrogen concentrations.

During the dormant periods, January 1982 and January 1983, tree trunk diameters have been recorded and cross-sectional areas for the five trees per plot calculated. Since the January 1982 samples were taken prior to the establishment of any treatments, cross-sectional areas for the five trees per plots were not expected to be nor were they different. The January 1983 measurements indicated both water and nitrogen rates increased the growth of trees to such an extent that the increase between 1982 and 1983 is dramatic (Figure 5).

Nut yields were recorded after the third season of growth (1983) but they were small and erratic as might be expected.

Discussion:

It appears that the first three years growth (second and third with treatments applied) of the experimental orchard has been normal to slightly better than expected. Nitrogen concentrations in plant tissues have been in the range desired with low applied nitrogen rates falling below and higher applied rates remaining above adequate levels. If any nitrogen rates were to be suggested from the study for the early years of growth they would be in the range of 1 to 3 oz per tree during the first and second years and 3 to 6 oz per tree the third year.

Publications:

Thus far the preliminary results have been published in the University of California Cooperative Extension Soil and Water newsletter, No. 55, Summer 1983.

Figure 1.

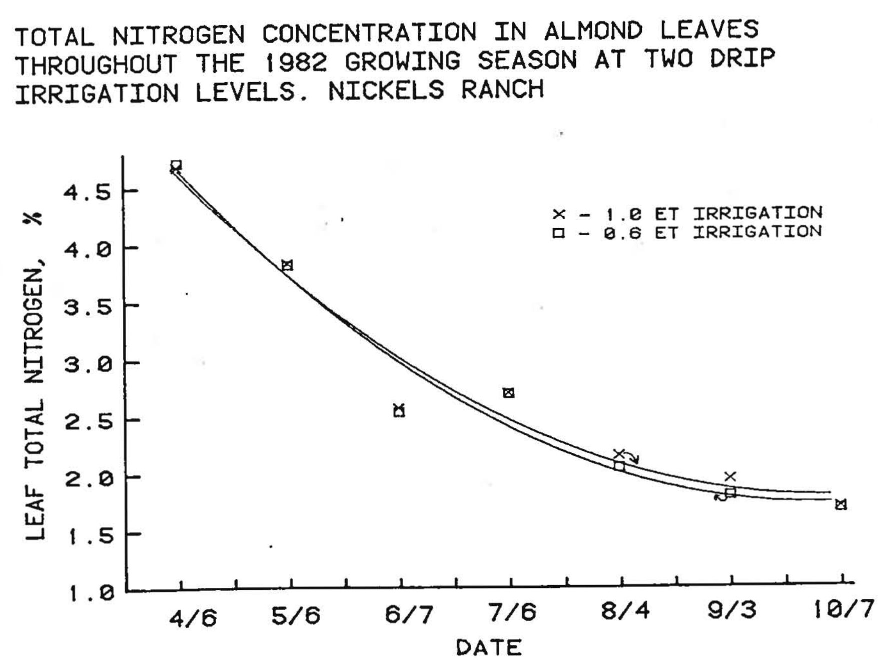


Figure 2

TOTAL NITROGEN CONCENTRATION IN ALMOND LEAVES ON AUGUST 4, 1982 AS INFLUENCED BY NITROGEN RATE AND WATER APPLIED THROUGH DRIP SYSTEM. NICKELS RANCH.

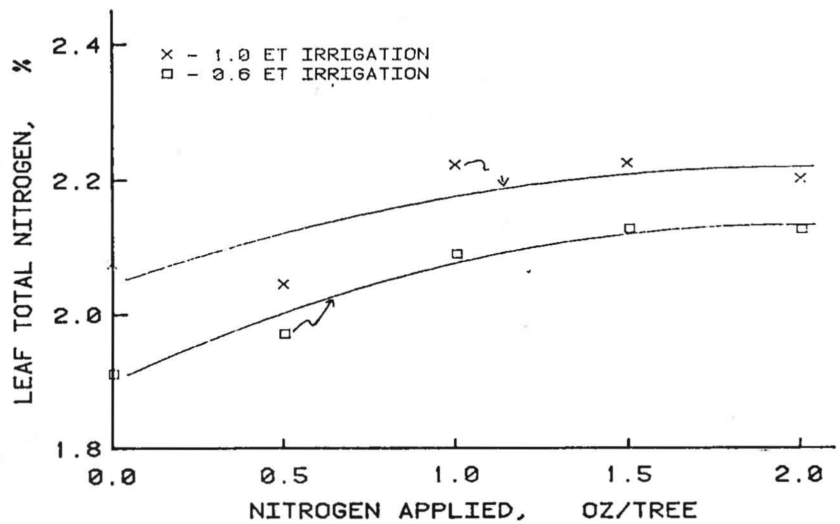


Figure 3

TOTAL NITROGEN CONCENTRATION IN ALMOND LEAVES ON APRIL 7, 1983 AS INFLUENCED BY NITROGEN RATE AND WATER APPLIED THROUGH DRIP SYSTEM. NICKELS RANCH

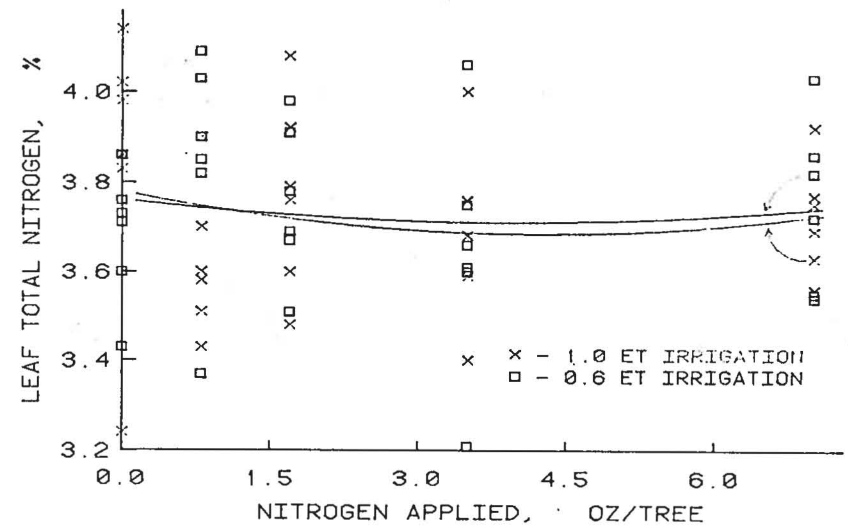


Figure 4

TOTAL NITROGEN CONCENTRATION IN ALMOND LEAVES ON SEPTEMBER 2, 1983 AS INFLUENCED BY NITROGEN RATE AND WATER APPLIED THROUGH DRIP SYSTEM. NICKELS RANCH

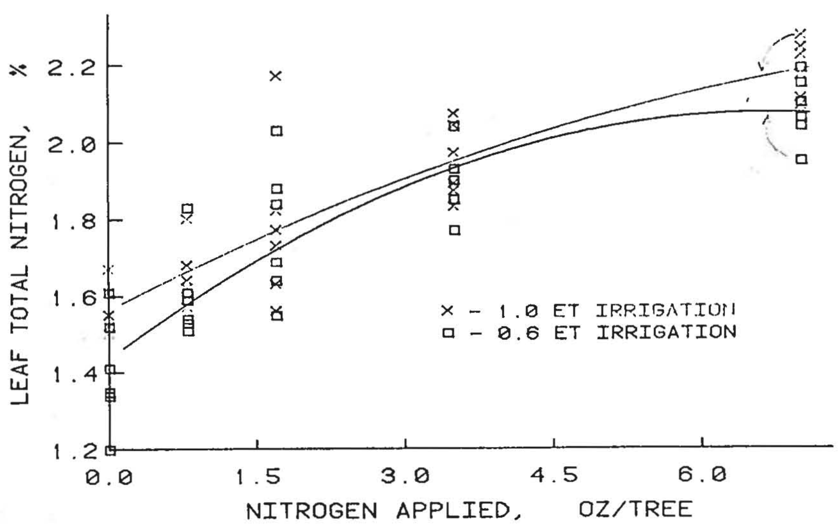
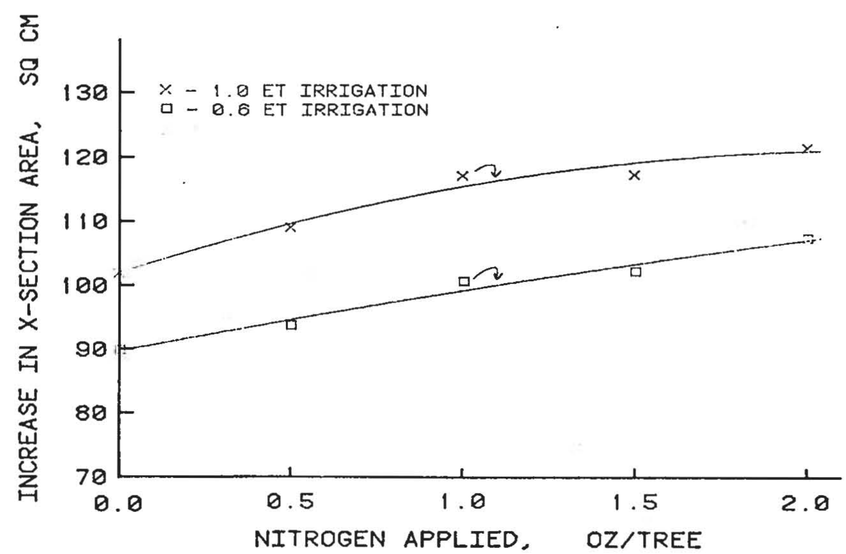


Figure 5

INCREASE IN TRUNK CROSS-SECTIONAL AREA (TOTAL OF 5 TREES/PLOT) FROM 1982 TO 1983. NICKELS RANCH.



COOPERATIVE EXTENSION
UNIVERSITY OF CALIFORNIA

DAVIS, CALIFORNIA 95616

REPLY TO: Land, Air & Water Resources
129 Hoagland Hall

January 3, 1984

RECEIVED
JAN 5 1984
ALMOND BOARD

Robert K. Curtiss
Associate Director of Research
Almond Board of California
Post Office Box 15920
Sacramento, California 95852

Dear Bob:

Enclosed are two copies of our 1983 annual report on Project 83-03, "Tree and Crop Research, Part II - Nitrogen on Drip Irrigated Almonds."

Please feel free to get in touch if you have any questions.

Sincerely,

Roland D. Meyer

Roland D. Meyer
Extension Soils Specialist

RDM:rr
Encls.
cc: Herbert Schulbach
Thomas Aldrich
Warren Micke