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Influence of Transpiration Suppressants, Sprinkler Irrigation and Moisture Levels on Transpiration and Evapotranspiration

C.J. Gerard

Texas Water Resources Institute

Texas A&M University

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INFLUENCE OF TRANSPIRATION SUPPRESSANTS, SPRINKLER IRRIGATION AND MOISTURE LEVELS ON TRANSPIRATION AND EVAPOTRANSPIRATION

Principal Investigator
C. J. Gerard

Other Investigator
B. W. Hipp

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SUMMARY

In 1968 and 1969, moisture level treatments were applied to tomatoes and citrus. Light sprinkler applications and white acrylic paint were applied to leaf canopies of tomatoes and citrus. Moisture use and yields as influenced by treatments were determined. Microclimatic data as influenced by treatments were determined. Estimates of influences of treatments on transpiration were evaluated with thermoelectric sensors. Tomato and citrus plant parts were analyzed for certain chemical properties. Diurnal changes in citrus tree trunks and fruits were monitored with linear variable displacement transducers.

Moisture Use and Yield

The effects of treatments on tomatoes were influenced by years. In 1968, the effects of treatments on water use were small and inconclusive. The white reflective treatment reduced water use by tomatoes by 10%, but reduced yields by 30% in 1969. Evaporative cooling increased yields of tomatoes in 1968 and 1969.

Water use by citrus was significantly increased by sprinkler treatment in 1968, but not in 1969. In 1968, evaporative cooling increased total citrus yields and increased the tonnage of fruits which could be sold to fresh market. Evaporative cooling was effective in influencing fruit quality and size, and offers the promises of increasing the yield of quality produce and of making more efficient use of our diminishing water supply.

Microclimatic Data

Canopy, leaf and soil temperatures, humidity, and net radiation data for tomatoes and citrus indicated that evaporative cooling and reflective treatment modified plant stress conditions in canopies of tomatoes and citrus. However, the differences due to treatments on tomatoes were small in 1968, and the differences on citrus were small in 1968 and 1969. Climatic conditions in canopy and net radiation data indicated that reflective treatment on tomatoes was effective in reflecting the incoming solar radiation in 1969.

Thermoelectric Data

Sap flow as influenced by treatments and climatic conditions was evaluated with a thermoelectric method. Sap flow was highest by tomatoes grown on the sprinkler treatment, and least by tomatoes grown on the dry treatment. Moisture contents of tomato stems were influenced by time and treatments.

Sap flow in citrus as influenced by treatments and time was ill-defined, possibly due to open structure of citrus. One of the greatest problems with the use of the thermoelectric method for evaluating sap flow for tomatoes and citrus in the field was plant variability.

Chemical Analyses

Evaporative cooling and reflective treatments increased the Ca content and lowered the K:Ca ratio of tomato fruits. Previous research has shown that these chemical properties are associated with lower plant water stress. The lower Ca content of citrus leaves and lower Brix^{o} and acid content of grapefruits indicate that citrus treated with sprinkler applications was under lower plant-water stress than citrus on the control treatment. Sprinkler applications increased the Cl concentration of leaves causing moderate to severe defoliation in 1968 and 1969. Defoliation may have confounded the potential results or trends.

Plant-Water Stress

Diurnal changes in citrus tree trunks and fruits were effectively monitored by linear variable displacement transducers (LVDT). These data suggest that the diurnal changes in tree trunks and fruits were indices of plant-water stress. Sprinkler treatment reduced daily fruit shrinkage and enhanced fruit enlargement in 1969.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

METHODS AND MATERIALS

Tomatoes

Description of Site and Experiment

Tomato irrigation experiments were conducted in 1968 and 1969 on Harlingen clay soil located about one mile north of Progreso, Texas. The Harlingen clay soils are important soils in the Lower Rio Grande Valley. They have poor surface and internal drainage, and range in bulk density from 1.4 to 1.6 gm/cc. This soil has about 2% sand, 30% silt and 60% clay, holding about 1.5 inches of available water per foot of soil.

The experimental area was fertilized with 60 pounds of P_2O_5 per acre on February 12, 1968 and 1969. The land was treated with 7 and 4 pounds per acre of Prefar for weed control in 1968 and 1969, respectively. Chico, a pear-shaped tomato, was planted and irrigated February 29, 1968 and February 11, 1969.

The experimental treatments are described in Table 1. Treatments A, B, and C were in a randomized block design consisting of 4 replications. Each plot was 76 by 100 feet in length. Treatment D was a strip along side the other treatments. The influence of sprinkler irrigation on other treatments was minimized by: (1) having a border of about 40 feet between the two plot areas, and (2) being north of the other treatments (the wind during the blooming period is from the southeast over 90% of the time). The sprinklers were automated to come on for 30 minutes during peak water use periods, applying about 0.10 inches of water every other day.

Tomatoes on treatment C were sprayed three times in 1968 and 1969 with white acrylic paint. In 1968, the dates of applications were May 15, 23 and June 10; in 1969, the spray applications were on April 25 and May 8 and 19. Three sprayings were necessary to maintain a relatively white surface.

The treatments were irrigated according to the description in Table 1. The water was measured onto plots and conducted to the plots with gated aluminum pipe. Tomatoes on treatments B, C, and D were irrigated on May 9 and June 3 in 1968, and April 21, May 2 and May 30 in 1969. Tomatoes were thinned to 12 inches between plants.

Moisture Use and Yield

An access tube per plot was installed to a depth of 5 feet or a total of 4 access tubes per treatment. These were installed in the row between tomato plants. In 1969, the moisture depletion in the furrow was also evaluated. Soil moisture at 6, 12, 18, 30, 42, and 54 inch depths was generally evaluated at weekly intervals. Soil moisture was evaluated 24 to 48 hours prior to and 24 to 48 hours after an irrigation. Soil moisture use was evaluated by moisture depletion techniques. Yield data were obtained and statistically analyzed for significance.

Microclimatic Analyses

Climatic parameters in plant canopy as influenced by treatments were determined at weekly intervals. Leaf, canopy, soil temperatures at 1 and 3 inch depths, and humidity conditions in the canopy were determined. Soil temperature data were evaluated with copper-constantan thermocouples and multi-point indicator type recorders. Each evaluation was an average of determinations from at least 2 sensors. Leaf temperatures were also evaluated with a Model IT-3 Barnes radiation thermometer.1/ Canopy temperatures were evaluated with shielded thermocouples. Humidity in the plant canopy was evaluated with small psychrometer.2/ Three miniature Model 601 net radiometers3/ were installed 3 feet above the soil surface in 1968 and 1969. The net radiation data were determined for treatments B, C, and D in 1968 and A, C and D in 1969.

Thermoelectric Analyses

Evaluation of the influence of climatic and treatment conditions on transpiration was attempted using the thermoelectric method described by Bloodworth, et. al. (3), modified by Closs (7), and defined by Marshall (14). In late 1968 and in 1969, the procedure described by Closs (7) and Marshall (14) was used to attempt to quantitatively measure total sap flow.

Chemical Analyses

In 1968, tomato fruits were dry ashed according to the method of Chapman and Pratt (6) and cation concentrations determined with an atomic absorption spectrophotometer. Basal and distal fruit parts were analyzed for Ca and K on June 6 and 20, 1968.

1/ Barnes Engineering Co., Stanford, Connecticut
2/ Atkins Technical Incorp., Gainesville, Florida
3/ C. W. Thornwaite Associates, Route 1, Centerton, Elmer, New Jersey.
Use of trade names and company names does not imply endorsement of product.

Citrus

Description of Site and Experiment

An experiment using Red Blush grapefruit trees was conducted at the Lower Rio Grande Valley Research and Extension Center, Weslaco, Texas. The grove of 15 year old trees was irrigated by border irrigation (2). The soil is a Willacy loam type having good surface and average to poor subsurface drainage. The bulk density of this soil ranges from 1.4 to 1.6. This soil holds 1.5 to 1.75 inches of available water per foot. Tile was installed at a depth of 6 feet to help drain a water table which developed as a result of Hurricane Beulah and subsequent rains. A strip of black plastic 12 feet wide was put under the trees to control weeds. The treatment descriptions are shown in Table 2. The light sprinkler applications were automated to come on every other day at 1:00 to 1:30 p.m. The water used contained about 900 ppm total salt and 275 to 300 ppm chloride. The white acrylic paint was applied on May 3, 1968. Sprinkler applications were initiated on May 22 in 1968, and applied every other day through October 4. However, daily sprinkler applications were applied during the interval of August 10 through 26. In 1969, the white acrylic paint was applied on April 25. Sprinkler applications were initiated on May 15, and applied every other day through October 3, 1969. These applications of white acrylic paint maintained a relatively white surface during their respective years.

Moisture Use and Yield

Access tubes were installed to a depth of 5 feet in the border midway between trees. The distance between trees was 20 feet wide.

Soil moisture at 6, 12, 18, 30, 42, and 54 inch soil depths was evaluated using the neutron scattering technique. Moisture data for each treatment were an average of 3 replications. Moisture use was determined by the soil depletion technique. Moisture measurements were evaluated 24 to 48 hours prior, and 24 to 48 hours after an irrigation, and generally at weekly intervals until the next irrigation. Yield of citrus as influenced by treatments were determined and statistically analyzed. Yields were expressed as total yield, and as yield of fruit larger than 96 mm in diameter; which is the size required by the fresh market. Fruit growth was determined by measuring with a micrometer the diameter of 10 fruits per treatment every week in 1968 and 1969. Volume of fruits as influenced by treatments was estimated.

Microclimatic Analyses

The influences of treatments on soil, canopy and leaf temperatures were determined with copper-constantan thermocouples and multi-point indicator recorders. The average temperatures of these parameters were estimated from at least 2 locations on each treatment. Humidity in plant canopies as influenced by treatments was determined using small psychrometers and wet and dry Atkins thermistor thermometers. Leaf temperatures were also evaluated with a Barnes radiation thermometer. However, during the 1968 experiment this instrument had to be sent in for repairs.

Thermoelectric Analyses

The influence of treatments on transpiration was evaluated with the thermoelectric method described under tomatoes. In 1968, rate of sap flow to the external branches was evaluated. Branches were selected for uniformity with respect to size, leaves, location, and height on trees. The flow was an average of 4 determinations per treatment. Earlier in the experiment, evaluations were made at different times during the day; but, finally estimates of sap flow were made between the hours of 10:30 a.m. and 12:00 or from 1:30 to 2:30 p.m. In 1969, quantitative evaluation of sap flow was determined according to the procedure described by Closs (7).

Chemical Analyses

In 1968 and 1969, citrus fruit juice as influenced by treatments was analyzed as to Brix° with a polarimeter. Acid content was determined by titrating the juice with 0.1 N NAOH solution. The average juice yield per fruit was also determined. In 1968 and 1969, the citrus leaves were dry ashed according to the method of Chapman and Pratt (6) and cation concentrations determined with an atomic absorption spectrophotometer. Leaves were analyzed for K, Mg, Ca, Zn, Fe, and Mn in 1968; in 1969, leaves were analyzed for Mg, Ca, Zn, and Fe. In 1968, the P concentration of leaves was determined photometrically. The influences of Cl concentration of leaves and leaf drop were evaluated in 1969.

Plant-Water Stress

Daytronic[4/] linear variable displacement transducers (LVDT) model DS 100 and 201 C transducer demodulator were used to continuously monitor the cyclic expansion and contraction of Red Blush grapefruit

4/ Instrument manufactured by Daytronic Corp., 2875 Culver Ave., Dayton (Kettering) 29, Ohio.

trees and fruit. The instrument is the same as described by Namken, et. al. (15), and is similar to the instrumentation described by Tukey (25). For the tree trunk, the system provided an output of 1 mv per 0.0254 mm (0.001 inch); for the fruit, the system provided an output of 10 mv per 0.0254 mm (0.001 inch). In June and July, one and two transducers were attached to trees which were receiving no treatment, light sprinkler applications to leaf surfaces from 1:00 to 1:30 p.m., and white acrylic treatment to leaf surfaces. The desired output for the fruit would vary depending on the stage of fruit development. These evaluations were made during August and early September, 1969, when the fruits were relatively large and making very little growth. The holder attachments for trunks and fruits are shown in Figures 1A and 1B, respectively.

RESULTS AND DISCUSSION

Tomatoes

Moisture Use and Yield

Moisture use by tomatoes as influenced by treatments is reported in Tables 3,4, and 5. Moisture use ranged from less than 0.05 to more than 0.25 inches per day in 1968 and 1969. In 1968, tomatoes grown on treatments B, C, and D used about the same amount of water; which was significantly more water than used by tomatoes on treatment A. In 1969, as shown in Table 3, water use by tomatoes was influenced by treatments; tomatoes grown on treatments B and D used significantly more water than tomatoes grown on treatment C; and, tomatoes grown under treatment C used more water than tomatoes grown under treatment A.

The moisture use data in 1969 are considerably different from the results in 1968. The reflective treatment (C) reduced water use in 1969, but not in 1968. The yield data in Table 6 show that the reflective treatment reduced yields about 30% in 1969, while water use was only reduced by 10% (comparison between treatments B and C). The climatic conditions during growing seasons in 1968 and 1969 were considerably different. Almost 3 times more rain in 1968 than in 1969 meant that plant-water stress of tomatoes grown in 1968 was probably less than for tomatoes grown in 1969. Yields were 3 times higher in 1969 than in 1968 as shown in Table 6. The reflective treatment reduced yields by about 30% in 1969, and about 20% in 1968.

Data in Table 6 show that average yield on treatment B was 10.1 tons per acre in 1969 as compared to 3.4 tons in 1968. Tomatoes treated with reflective coating produced 7.0 tons per acre in 1969, but only 2.7 tons in 1968. Treatment B was the most efficient treatment with respect to production per inch of water. This was also true in 1968. The least efficient treatment was A followed by C and D, respectively.

Moisture use on top of the bed and furrow by tomatoes in 1969 is shown in Table 5. These data show that during the period of May and June the use of water by tomatoes from the furrow was slightly less than on top of the bed. The exception was the use of water by tomatoes from June 2 through June 18, 1969.

Moisture depletion at different depths as influenced by treatments is shown in Figures 2A and 2B, 3A and 3B, 4A and 4B, and 5A and 5B. Moisture depletion was largely restricted to the top 2 feet of soil on treatments B, C, and D. Depletion from the third foot did not occur until late in the growing season even by tomatoes under treatment A.

Microclimatic Analyses

Canopy temperatures as influenced by treatments in 1968 and 1969 are shown in Tables 7 and 8. The average influences of treatments for May and June, 1969, are shown in Figures 6 and 7. Temperatures in the canopy of tomatoes treated with sprinkler and reflective treatments were slightly lower than other treatments. Canopy temperatures of tomatoes under dry treatment (A) often were several degrees higher than canopy temperatures under treatments B, C, and D. Reflective treatment (C) reduced canopy temperatures by 1 to 4^{o}F. Evaporative cooling reduced canopy temperatures an average of 1 to 5^{o}F.

Leaf temperatures of tomatoes are indicated in Tables 9 and 10. In 1968 and 1969, leaf temperatures of dry treatment were higher than leaf temperatures of tomatoes grown on treatments B, C, and D. Leaf temperatures of tomatoes grown under treatments B, C, and D were not markedly different in 1968. The reflective treatment reduced leaf temperatures about 4°F in June, 1969. Evaporative cooling reduced leaf temperatures an average of 4 to 6°F. These trends are shown in Figures 8 and 9. Temperatures of top and bottom of leaves were not different.

Soil temperatures at 1 and 3 inches as influenced by treatments in 1968 and reported in Table 11 indicate that the dry treatment (A) increased soil temperatures, and sprinkler treatment (D) reduced soil temperatures. The dry treatment (A) in 1969 as shown in Table 12 has higher soil temperatures at 1 and 3 inches. Soil temperatures under reflective and sprinkler treatments were lower in 1969 as indicated in Table 12, and Figures 10, 11, 12, and 13. Soil temperatures under moisture stressed tomatoes (A) were often 5 to 10°F higher at 1 inch depth than soil tmeperatures under the other treatments. Reflective treatment in 1969 reduced soil temperatures 3 to 5°F and 0 to 2°F at 1 and 3 inch soil depths, respectively. In 1969, most of the climatic data was taken on the days when the sprinklers were not in operation. Despite this fact, soil temperatures under treatment D were 1 to 2°F lower at soil depths of 1 inch and 3 inches than soil temperatures under treatment B.

Climatic stress in the canopy as influenced by treatments in 1968 and 1969 are shown in Tables 13 and 14. Evaporative potential was greater in the canopy of tomatoes grown under treatment A and was least under the sprinkler irrigation treatment. The reflective treatment (C) as shown in Figures 14 and 15 appeared to reduce evaporative conditions in the canopy in 1969.

The influences of treatments B, C, and D in 1968, and A, C, and D in 1969 on absorption of solar radiation are shown in Tables 15 and 16. The 1968 data in Table 15 are averages for the period from June 1 through July 8, 1968. Treatments did not seem to influence the net radiation data in 1968. The typical net radiation data during the day for May and June in 1969 were considerably different. Cloudy conditions during the afternoon may have caused the energy absorption peak in May. In 1969, as indicated in Table 16 and Figures 16 and 17, the reflective treatment reduced the absorption of solar radiation by canopy, particularly during the late part of the day in June. This may also indicate that the reflective treatment caused some loss in vigor which no doubt would influence the absorption of solar energy by plants.

Thermoelectric Analyses

The rates of moisture flow as influenced by treatments in 1968 are shown in Table 17. Trends are not apparent from these data. In 1969, moisture flow as influenced by treatments and time is shown in Figure 18. Moisture content of tomato stem (oven dry basis) is shown in Figure 19. The highest moisture flow occurred in mid-May. Comparative sap flow by tomatoes was highest under treatment D and least under treatment A. Sap flow ranged from a low of 7 to a high of 69 $cc/cm^2/hr$. One of the greatest problems with the use of the thermoelectric method is plant variability. The trends may be ill-defined because of plant variability and because the treatment effects were not greatly different.

The moisture contents of stems which are shown in Figure 19 were markedly influenced by treatments. Sap flow and moisture content of stems appear to be linear when stems were relatively dry. This occurred when available soil moisture was low and the tomato plant was stressed. When the stem had 500% moisture or higher, climatic stress was probably the factor which controlled sap flow. A linear decrease in stem moisture with time was found for tomatoes grown under treatment A. Tomatoes grown under sprinkler treatment maintained higher moisture content than the other treatments. Further studies of relationships between moisture content of stem and soil moisture might prove fruitful.

Chemical Analyses

Influences of treatments on Ca and K content and K:Ca ratio of basal and distal parts of Chico tomato fruits in 1968 are shown in Table 18. Tomato fruits are low in Ca especially the distal end of fruit and high in K. The K:Ca ratios of basal portion of fruits were 20 to 25, but the K:Ca ratios of distal portion of fruit ranged from a low of 30 to a high of almost 90. Tomatoes from reflective treatment had higher Ca content on June 28. Carolus (5), and Gerard and Hipp (13) have reported that high Ca content and lower K:Ca ratios of fruit are associated with lower plant-water stress.

Citrus

Moisture Use and Yield

Comparative moisture use by citrus in 1968 and 1969 as influenced by treatments is reported in Tables 19 and 20. The total water use by citrus on the sprinkler treatment was significantly higher than citrus grown under A and C in 1968, but not in 1969. The moisture use in inches per day by citrus for different intervals is reported in Tables 21 and 22. Moisture use ranged from 0.05 to 0.4 of an inch per day. The citrus treated with reflective material appeared to use less water during the period of June through November, 1969. The lower moisture use by sprinklers in early and late 1969 was probably due to the loss of evaporative surfaces (defoliation) caused by the chloride ion. The influence of reflective treatment with respect to water use was not very great and certainly not of economical importance.

Trees on sprinkler treatment produced higher yields in 1968. However, only 21 to 26% of fruits, as indicated in Table 23, attained the size required for shipment to fresh market. The yield data in Table 23 show that trees under sprinkler treatment produced larger fruits in 1969; 81% of the fruits attained the size required for shipment to fresh market. The level of significance is shown in Table 24. The reflective and control treatments tended to produce smaller fruits. The lower total yield under sprinkler treatment was due to the lower fruit set in 1969, caused by defoliation by the chloride ion in 1968. The larger fruits on trees treated with sprinkler application in 1969 were probably because this treatment reduced the daily shrinkage of fruits during high evaporative conditions; and, in part, possibly due to flush of new leaves and less fruits on the trees. This will be discussed later in the report.

Volume increases in fruit with time during the period of May through part of December are reported in Figures 20 (1968) and 21 (1969). These data show that fruits were small in 1968, which may have been due to a number of factors such as the heavy fruit set and high evaporative conditions in late summer and fall. The small fruit under sprinkler treatment may have been caused by severe defoliation in 1968. This may have been partly due to daily sprinkler applications of 0.1 inch of water during the short interval of August 10 through 26. In 1969, as shown in Figure 21, the sprinkler treatment increased fruit size; the reflective treatment decreased fruit size. The latter may have been caused by applying acrylic paint to the trees treated in 1968 again in 1969.

Microclimatic Analyses

Temperature data for 1968 and 1969 in canopy as influenced by treatments are shown in Tables 24 and 25. Canopy temperatures under reflective treatment were often 1 to 2°F lower than canopy temperatures of control treatment. Evaporative cooling lowered canopy temperatures by 4 to 5°F. On days when sprinklers were not in operation, canopy temperatures under sprinkler treatment were sometimes higher than canopy temperatures of control treatment (A). This was probably due to defoliation caused by sprinkler applications. Defoliation probably confounded climatic conditions in the canopy.

Leaf temperature data for 1968 and 1969 as influenced by treatments are reported in Tables 26, 27, and 28. On the days sprinklers were in operation evaporative cooling reduced leaf temperatures from a few degrees to over 10°F. Leaf temperatures under sprinkler treatment on days when sprinklers were not operating were sometimes higher than leaf temperatures under control treatment. The influence of reflective treatment on leaf temperatures was not definitive.

Influences of treatments on soil temperatures at 1 and 3 inch soil depths are shown in Tables 29 and 30. Sprinkler treatments reduced soil temperatures at 1 and 3 inch soil depths. Soil temperatures under reflective and control treatments were not markedly different.

Vapor pressure deficit conditions in the canopies as influenced by treatments are shown in Table 31 and Figures 22, 23, 24, and 25. Evaporative cooling on the days sprinklers were in operation reduced for a short time the climatic stress in the canopy, but vapor pressure deficit conditions in canopies were not greatly influenced by treatments. The open structure of citrus and the defoliation and regrowth on certain treatments modified the microclimate in the canopy; and no doubt contributed to the variability in canopy, leaf and soil temperatures, and vapor pressure deficit conditions in citrus canopies.

Thermoelectric Analyses

Moisture flow as influenced by treatments in 1968 is shown in Table 32. The qualitative data show that moisture flow ranged from 14 to about 75 cm/hr. Citrus treated with reflective material did tend to show lower flow velocities. The quantitative evaluations of sap flow in 1969 reported in Table 33 do not show any significant trends.

However, citrus on the reflective treatment tended to have lower sap flow immediately following an irrigation. The sap flow in $cc/cm^2/hr$ ranged from less than one to more than four. The flow in perennials such as citrus was considerably lower than in annuals such as tomatoes. Moisture content of stems was not influenced by treatments. Variability in sap flow was high and trends were ill-defined possibly because of the open structure of citrus.

Chemical Analyses

The influences of treatments on citrus juice quality in 1968 and 1969 are shown in Table 34. These data indicate that the trees receiving sprinkler application were under less stress as shown by the lower Brix° and acid contents in 1968 and 1969. The ion concentrations of leaves in 1968 and 1969 are shown in Table 35. In 1968, the lower Ca contents of leaves suggest that sprinkler and reflective treatments reduced transpiration. The trend is not clear for the reflective treatment in 1969. The ion concentration of reflective material applied to surfaces in 1968 and again in 1969 may have contributed to the variability shown in Table 35.

The Cl concentration of leaves receiving sprinkler applications, reported in Table 36, shows that this type of treatment would be best evaluated if applied inside the canopy of leaves. The value of such a practice needs evaluation. The high concentration of Cl was no doubt responsible for severe defoliation on this treatment. A small amount of leaf drop may have been caused by reflective treatment. Defoliation may have confounded the potential results or trends.

Plant-Water Stress

Typical diurnal changes in citrus tree trunks as influenced by soil and climatic stress are represented in Figure 26. These conditions occurred on June 26, 27, and 28. The difference between curves A and B (June 26 and 27) is due to an irrigation and to 0.1 inch sprinkler application between 1 and 1:30 p.m. The irrigation reduced the shrinkage during high evaporative conditions; the sprinkler application reduced the stress on plants for 2 to 3 hours. The difference between curves A and B and curve C is due to rainfall (approximately 1.00 inch) immediately after noon on June 28. The vapor pressure deficit conditions for June 26 and 28 are shown in Figure 27. The influence of an irrigation on maximum shrinkage of tree trunks is shown in Figure 28. Diurnal changes in the trunk, as evaluated with LVDT, are highly related to soil moisture conditions.

The influences of evaporative conditions on maximum radial change in citrus fruits during the day for control, sprinkler and reflective treatments are shown in Figures 29, 30, and 31, respectively. This reports the difference between the maximum change in the fruit during any one day. During the period of study, the maximum range of the 50 mv recorder was 0.127 mm. This was a period of very little fruit growth (August to September 13, 1969). During periods of rapid growth, the setting used on the trunk would be preferable. The high inverse relationships between the change in fruit during the day and climatic stress are noted. The lower r value in the case of the control treatment was probably due to cloudy conditions and erratic climatic stress conditions which prevailed during the period of evaluation. A high inverse relationship between maximum shrinkage and climatic stress was also found. It should be mentioned that available soil moisture was high when the above fruit measurements were made. Fruit growth during August and September was dependent upon a low evaporative condition which was associated with rainfall.

The relationships between maximum daily fruit shrinkage on control and reflective treatments and sprinkler treatments are shown in Figures 32 and 33, respectively. These data suggest that the daily shrinkage during August and September approaches zero when vapor pressure deficit (VPD) conditions are less than 10 mm of Hg. The sprinkler treatment modified the stress on the fruit as indicated in Figure 33. The relationship between daily shrinkage or contraction of radii and climatic stress was hyperbolic. Again the rapid growth in the fruit occurred when VPD conditions were less than 10 mm of Hg. This is probably why fruit growth during this period is often associated with rainfall.

These data suggest that the diurnal changes in tree trunks and fruits as evaluated with LVDT are indicative of soil and climatic stress. Preliminary results indicate that diurnal changes in tree trunks are associated with soil moisture stress. Diurnal changes were effectively monitored with LVDT. The diurnal changes in the fruit were inversely related with climatic stress.

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TABLES

Table 1. Description of moisture levels, transpiration suppressants, and sprinkler irrigation treatments.

Treatments	Percent of moisture at maximum allowable stress
Before the bloom stage, tomatoes in all treatments were irrigated when the moisture content of the top 2 feet of soil was depleted to 25 percent of the available moisture. Moisture treatments B, C, and D were initiated after the bloom stage.	
A. No water was applied after the bloom stage.	
B. Irrigation brought to field capacity the top 5 feet of soil when the average moisture content of the top 2 feet approached 25 percent of available moisture.	23
C. Irrigated according to treatment B. Application of white acrylic paint biweekly intervals beginning at or slightly prior to blooming.	23
D. Irrigated according to treatment B. Light sprinkler irrigations were applied every other day during high evaporative conditions, during blooming and fruiting period.	23

Table 2. Description of moisture level, reflective and sprinkler irrigation treatments applied to citrus.

Treatments
A. Irrigation brought to field capacity the top 4 feet when the average moisture content of the top 2 feet approached 25 to 0% available water.
B. Irrigation brought to field capacity the top 4 feet when the average moisture content of the top 2 feet approached 25 to 0% available water. Light sprinkler irrigations were applied every other day during high evaporative conditions. The sprinkler irrigation applications were applied at high pressure primarily for the purpose of modifying the environment in the citrus tree canopy.
C. Irrigated according to treatment A and applied reflective coating to tree canopy.

Table 3. Water use by Chico tomatoes as influenced by treatments in 1968 and 1969.

Year	Treatments (inches)			
	A	B	C	D
1968				
Soil moisture depletion	1.65	4.95	5.41	3.92
Rainfall	5.73	5.73	5.73	5.73
Total sprinkler application	-	-	-	1.62
Total water use	7.38	10.68	11.14	11.27
1969				
Soil moisture depletion	5.09	7.05	5.94	7.87
Rainfall	1.96	1.96	1.96	1.96
Total sprinkler application	-	-	-	1.30
Total water use	7.05	9.01	7.90	11.13

Table 4. Soil moisture use by tomatoes under different moisture levels, sprinkler and transpiration suppressant treatments in 1968.

Sampling Interval	Treatments (inches/day)			
	A	B	C	D
4/16/68 to 4/22/68	0.022	0.082	0.055	0.055
4/22/68 to 4/30/68	0.039	0.039	0.036	0.065
4/30/68 to 5/8/68	0.106	0.115	0.110	0.065
5/8/68 to 5/23/68	0.089	-	-	-
5/10/68 to 5/23/68	-	0.135	0.192	0.153 (0.190)[1/]
5/23/68 to 5/30/68	0.160	0.201	0.214	0.164 (0.206)[1/]
5/30/68 to 6/4/68	0.102	-	-	- -
6/4/68 to 6/12/68	0.115	0.259	0.255	0.189 (0.236)[1/]
6/12/68 to 6/19/68	0.139	0.099	0.143	0.163 (0.204)[1/]
6/19/68 to 7/1/68	0.073	0.219	0.183	0.173 (0.189)[1/]

1/ Numbers in parentheses include the amount put on by sprinklers.

Table 5. Soil moisture use by tomatoes under different moisture levels, sprinkler and transpiration suppressants treatments in 1969.

Sampling Interval	Treatments (inches/day)			
	A	B	C	D
			Top of Furrow	
4/9/69-4/15/69	0.039	0.040	0.038	0.030
4/22/69-5/1/69	0.123	0.159	0.112	0.176
5/1/69-5/15/69	0.167	0.158	0.174	0.190 (0.238)*
5/15/69-5/23/69	0.179	0.250	0.201	0.226 (0.263)
5/23/69-5/28/69	0.132	0.230	1.200	0.170 (0.208)
6/2/69-6/18/69	0.060	0.134	0.122	0.173 (0.221)
			Bottom of Furrow	
5/1/69-5/15/69	0.123	0.143	0.147	0.150 (0.198)
5/15/69-5/23/69	0.178	0.236	0.194	0.220 (0.280)
5/23/69-5/28/69	0.098	0.168	0.162	0.170 (0.228)
6/2/69-6/18/69	0.064	0.164	0.115	0.104 (0.146)

* Values in parentheses include sprinkler applications.

Table 6. Yields of Chico tomatoes and yield per acre inch of water under different treatments in 1968 and 1969.

Treatment	Tons/A	Pounds/Acre-inch of water
1968		
A	1.2	325
B	3.4	637
C	2.7	485
D	3.5	621
1969		
A	2.3	660
B	10.1	2240
C	7.0	1785
D	10.5	1885

Table 7. Temperature in canopy in Chico tomatoes as influenced by different treatments in 1968.

Treatment	Time of Day (^oF)			
5/30/68	9:00 a.m.	11:00 a.m.	2:00 p.m.	4:00 p.m.
A	83	90	97	93
B	83	91	98	94
C	83	92	96	93
D	82	90	91	93
6/6/68	9:00 a.m.	1:00 p.m.	3:00 p.m.	
A	83	91	93	
B	81	90	88	
C	81	90	86	
D	81	90	91	
6/12/68	9:00 a.m.	11:00 a.m.	1:30 p.m.	
A	89	92	105	
B	87	92	101	
C	83	91	94	
D	85	90	97	
6/18/68	9:00 a.m.	1:00 p.m.		
A	77	91		
B	76	89		
C	77	90		
D	77	88		

Table 8. Influence of treatments on canopy temperatures (^{o}F) in Chico tomatoes in May and June, 1969.

Treatment	Time of Day (^{o}F)		
	8:30 a.m.	11:00 a.m.	2:00 p.m.
5/6/69			
A	80	88	91
B	78	85	86
C	80	85	87
D	80	85	88
5/16/69			
A	81	85	86
B	79	83	83
C	78	82	83
D	78	82	82
5/22/69			
A	77	87	93
B	76	83	92
C	71	81	88
D	72	81	87
5/29/69			
A	81	89	98
B	79	88	100
C	78	89	85
D	76	85	81
6/6/69			
A	86	99	97
B	80	86	96
C	87	93	91
D	78	84	88
6/13/69			
A	80	95	99
B	76	93	105
C	82	96	97
D	78	87	93

Table 9. Leaf temperature of Chico tomatoes as influenced by different treatments in 1968.

Treatment	Time of Day (°F)								
5/30/68	9:00 a.m.			11:00 a.m.			2:00 p.m.		4:00 p.m.
A	83			90			97		91
B	83			92			98		94
C	84			87			95		97
D	81			91			93		92
6/6/68	9:00 a.m.			1:00 p.m.			3:00 p.m.		
A	82			92			95		
B	82			91			89		
C	81			92			88		
D	81			92			92		
6/12/68	9:00 a.m.			11:00 a.m.			1:30 p.m.		
	1/	2/	3/	1/	2/	3/	1/	2/	3/
A	84	93	91	94	92	91	104	100	99
B	81	88	85	93	93	91	101	98	98
C	83	83	79	93	92	91	97	102	93
D	83	88	87	97	88	89	101	97	93
6/18/68	9:00 a.m.			1:00 p.m.					
	1/	2/	3/	1/	2/	3/			
A	74	78	77	91	91	91			
B	75	76	77	93	88	89			
C	77	77	78	89	89	88			
D	76	77	77	94	89	90			

1/ Thermocouple evaluation of leaf temperature (under the leaf surface).

2/ Temperature of top of leaf (evaluated with Barnes radiation thermometer).

3/ Temperature of bottom of leaf (evaluated with Barnes radiation thermometer).

Table 10. Leaf temperatures of Chico tomatoes as evaluated with a Barnes radiation thermometer and as influenced by different treatments in 1969.

Treatment	Time of Day (°F)					
	8:30 a.m.		11:00 a.m.		2:00 p.m.	
	Top of leaf	Bottom of leaf	Top of leaf	Bottom of leaf	Top of leaf	Bottom of leaf
5/6/69						
A	80	80	82	81	91	88
B	78	78	81	80	88	86
C	78	78	81	81	88	85
D	78	78	81	81	87	86
5/16/69						
A	80	80	84	84	85	85
B	79	79	83	83	81	81
C	78	79	82	82	82	82
D	78	78	82	82	81	81
5/22/69						
A	78	77	86	86	92	92
B	74	74	81	81	87	89
C	76	76	85	84	91	91
D	76	74	85	85	82	81
5/29/69						
A	81	81	87	87	89	89
B	79	79	82	81	93	94
C	78	80	85	85	90	90
D	78	78	84	83	87	85
6/6/69						
A	83	81	85	88	88	89
B	82	79	80	80	89	90
C	82	79	80	83	84	83
D	84	80	79	83	83	82
6/13/69						
A	83	81	96	96	95	96
B	80	80	90	89	100	99
C	82	81	90	90	97	98
D	80	80	90	90	94	93

Table 11. Soil temperatures as influenced by treatments in 1968.

Treatment	Time of Day (°F)							
5/30/68	9:00 a.m.		11:00 a.m.		2:00 p.m.		4:00 p.m.	
	1 inch	3 inch	1 inch	3 inch	1 inch	3 inch	1 inch	3 inch
A	81	79	86	82	105	87	97	88
B	79	79	86	81	88	84	91	85
C	81	81	84	84	89	87	89	88
D	80	80	86	80	89	82	89	83
6/6/68	9:00 a.m.		1:00 p.m.		3:00 p.m.			
	1 inch	3 inch	1 inch	3 inch	1 inch	3 inch		
A	78	78	93	84	93	84		
B	76	77	83	81	81	81		
C	79	79	84	86	85	86		
D	73	73	87	82	86	83		
6/12/68	9:00 a.m.		11:00 a.m.		1:30 p.m.			
	1 inch	3 inch	1 inch	3 inch	1 inch	3 inch		
A	81	81	86	84	106	88		
B	79	79	84	81	93	86		
C	81	81	89	85	94	89		
D	80	80	90	83	104	87		
6/18/68	9:00 a.m.		1:00 p.m.					
	1 inch	3 inch	1 inch	3 inch				
A	79	81	91	84				
B	79	80	88	84				
C	81	79	89	84				
D	79	80	-	87				

Table 12. Soil temperature as influenced by treatments in 1969.

Treatment	Time of Day (°F)					
	8:30 a.m.		11:00 a.m.		2:00 p.m.	
	Depth in Soil		Depth in Soil		Depth in Soil	
	1 inch	3 inches	1 inch	3 inches	1 inch	3 inches
5/6/69						
A	80	80	83	81	87	83
B	76	76	78	78	81	79
C	78	78	78	78	80	79
D	79	78	81	78	84	79
5/16/69						
A	78	78	80	79	84	81
B	78	78	79	78	81	80
C	77	78	78	78	79	79
D	78	78	79	77	80	79
5/22/69						
A	74	76	78	79	86	82
B	73	74	76	76	81	79
C	71	73	74	74	78	78
D	70	72	75	73	81	77
5/29/69						
A	78	78	81	80	88	82
B	77	77	80	78	87	83
C	75	76	77	78	81	82
D	73	74	79	77	85	79
6/6/69						
A	80	77	83	79	88	83
B	75	75	77	77	82	81
C	73	74	76	76	80	78
D	73	73	76	75	81	78
6/13/69						
A	81	81	87	84	97	90
B	77	77	84	81	91	87
C	78	78	79	79	84	86
D	78	77	86	77	91	81

Table 13. Influence of treatment on vapor pressure deficit in plant canopy in 1968.

Treatment		Time of Day (mm of Hg)		
5/30/68	9:00 a.m.	11:00 a.m.	2:00 p.m.	4:00 p.m.
A	4.6	11.9	18.9	14.4
B	4.2	9.8	17.3	12.5
C	3.9	10.3	16.7	14.7
D	3.8	9.5	9.8	14.3
6/6/68	9:00 a.m.	1:00 p.m.	3:00 p.m.	
A	4.9	11.4	7.1	
B	3.3	6.1	-	
C	2.7	5.2	9.3	
D	2.7	4.1	7.1	
6/12/68	9:00 a.m.	11:00 a.m.	1:30 p.m.	
A	5.2	11.6	20.5	
B	4.8	6.5	19.5	
C	1.7	11.4	16.1	
D	2.8	13.3	21.0	
6/18/68	9:00 a.m.	1:30 p.m.		
A	0.5	12.7		
B	0.7	11.1		
C	0.9	11.0		
D	0.7	12.9		

Table 14. Influence of treatments on vapor pressure deficit in plant canopy in 1969.

Treatment	Time of Day (mm of Hg)		
5/6/69	8:30 a.m.	11:00 a.m.	2:00 p.m.
A	2.3	6.1	13.9
B	1.0	6.0	7.3
C	3.4	6.1	7.6
D	3.4	6.0	6.0
5/16/69	8:30 a.m.	10:45 a.m.	2:30 p.m.
A	3.7	3.5	7.1
B	1.0	2.2	5.8
C	1.0	2.2	5.8
D	1.0	2.2	4.6
5/22/69	8:30 a.m.	10:30 a.m.	2:45 p.m.
A	4.1	7.8	18.3
B	2.1	6.7	13.1
C	1.0	4.9	14.0
D	1.8	6.7	10.2
5/29/69	9:00 a.m.	10:45 a.m.	2:00 p.m.
A	2.3	10.9	18.8
B	1.0	7.3	18.8
C	1.0	10.9	15.2
D	1.0	9.9	8.3
6/6/69	10:00 a.m.	11:00 a.m.	1:30 p.m.
A	6.7	10.5	16.3
B	3.2	6.0	12.3
C	4.3	4.6	6.3
D	3.3	2.2	5.1
6/13/69	8:30 a.m.	10:50 a.m.	4:00 p.m.
A	11.6	13.5	22.7
B	2.4	11.9	18.3
C	2.4	7.9	15.1
D	3.4	10.5	12.3

Table 15. Average influence of certain treatments on absorption of solar radiation during the period of June 1 through July 8, 1968.

Time	Treatments (Net Radiation - gm cal/cm^2/min)		
	B	C	D
3:00 a.m.	-0.01	-0.01	-0.01
6:00 a.m.	0.01	0.02	0.01
9:00 a.m.	0.41	0.47	0.42
12:00 Noon	0.83	0.89	0.87
3:00 p.m.	0.76	0.72	0.72
6:00 p.m.	0.27	0.25	0.27
9:00 p.m.	-0.03	-0.02	-0.02
12:00 Nite	-0.02	-0.02	-0.01

Table 16. Average influence of certain treatments on absorption of solar radiation in May and June, 1969.

Month and Time of Day	Treatments (Net Radiation - gm cal/cm^2/min)		
	D	A	C
May			
3:00 a.m.	-0.03	-0.04	-0.05
6:00 a.m.	-0.01	-0.03	-0.03
9:00 a.m.	0.30	0.30	0.31
12:00 Noon	0.89	0.90	0.89
3:00 p.m.	0.49	0.53	0.58
6:00 p.m.	0.27	0.23	0.20
9:00 p.m.	-0.06	-0.06	-0.06
12:00 Midnight	-0.04	-0.05	-0.05
June			
3:00 a.m.	-0.04	-0.04	-0.05
6:00 a.m.	-0.03	-0.04	-0.04
9:00 a.m.	0.33	0.34	0.34
12:00 Noon	0.92	0.88	0.88
3:00 p.m.	0.95	0.93	0.87
6:00 p.m.	0.31	0.26	0.11
9:00 p.m.	-0.06	-0.07	-0.07
12:00 Midnight	-0.05	-0.06	-0.06

Table 17. Thermoelectric measurement of moisture flow in Chico tomato stems as influenced by treatments in 1968.

Date and Time	Treatments (cm/hr)			
	A	B	C	D
5/24/68				
10:00 to 10:30 a.m.	76.3	118.4	47.3	155.2
5/30/68				
10:00 to 11:00 a.m.	59.0	58.1	40.9	65.5
5/30/68				
1:00 to 2:00 p.m.	92.3	72.0	66.7	37.1*
6/5/68				
11:30 to 11:45 a.m.	5.17	35.6	53.6	50.3
6/5/68				
2:00 to 2:30 p.m.	80.4	35.7	91.8	78.9
6/12/68				
2:30 to 3:00 p.m.	52.0	52.3	62.1	41.9
6/18/68				
11:00 to 11:30 a.m.	21.8	32.0	48.9	43.4

* Sprinklers were on at 1:00 to 1:30 p.m. on every other day.

Table 18. Influence of different treatments on Ca^{++}, K^{+}, and K:Ca ratio of Chico tomatoes fruit parts in 1968.

Treatment	K^{+} Basal	K^{+} Distal	Ca^{++} Basal	Ca^{++} Distal	K:Ca Ratio Basal	K:Ca Ratio Distal
6/6/68	(%)		(%)			
A	3.00	3.50	0.12	0.04	25	88
B	3.39	3.75	0.17	0.09	20	42
C	3.10	3.55	0.18	0.11	17	32
D	3.18	3.63	0.13	0.07	24	52
6/20/68						
A	2.88	3.09	0.10	0.05	29	62
B	3.34	3.76	0.18	0.10	19	38
C	3.29	3.75	0.14	0.06	24	63
D	3.35	3.78	0.21	0.12	16	32

Table 19. Soil moisture use by citrus as influenced by treatments between irrigations in 1968.

Interval	Treatments (inches)		
	A	B	C
5/21/68-6/4/68	4.25	3.60	3.60
6/7/68-8/26/68	13.42	11.00	13.42
9/2/68-9/23/68	3.94	3.65	5.08
9/26/68-10/7/68	2.31	2.58	2.34
Total Water Use	23.92	20.83 (27.66)*	24.45

Heavy rainfall prevented proper evaluation of moisture use during the period of June 13 through 28.

* Value in parenthesis includes sprinkler applications.

Table 20. Moisture use by citrus as influenced by treatments in 1969.

Interval	Treatments (inches)		
	A	B	C
1/29/69-3/18/69	2.60	2.42	3.00
4/8/69-5/7/69	3.40	2.85	3.02
5/9/69-6/4/69	7.09	6.09* (7.26)**	7.25
6/9/69-6/24/69	4.48	2.86* (3.71)**	4.08
6/30/69-7/23/69	6.50	5.83* (7.53)**	6.22
7/29/69-8/12/69	3.45	2.12* (2.97)**	3.43
8/25/69-10/29/69	12.35	10.68* (12.69)**	10.66
11/5/69-12/8/69	4.23	3.54	4.91
Total Inches	44.10	36.39* (42.97)**	42.57

* Values do not include sprinkler applications.
** Values do include sprinkler applications.

Table 21. Moisture use by citrus as influenced by treatments at different times in 1968.*

Interval	Treatments (Inches/Day)		
	A	B	C
5/21/68-5/28/68	0.380	0.267 (0.313)**	0.323
5/28/68-6/4/68	0.227	0.047 (0.107)**	0.193
6/7/68-6/13/68	0.275	0.162 (0.215)**	0.257
6/28/68-7/12/68	0.243	0.228 (0.236)**	0.276
7/12/68-7/18/68	0.140	0.207 (0.260)**	0.235
7/18/68-7/25/68	0.176	0.216 (0.261)**	0.211
7/31/68-8/6/68	0.167	0.112 (0.147)**	0.150
8/6/68-8/16/68	0.169	0.196 (0.281)**	0.180
8/16/68-8/26/68	0.105	- (0.045)**	0.120
9/2/68-9/10/68	0.231	0.253 (0.305)**	0.288
9/10/68-9/16/68	0.177	0.005 (0.103)**	0.198
9/16/68-9/23/68	0.147	0.190 (0.250)**	0.226
9/23/68-10/7/68	0.217	0.239 (0.268)**	0.217

* Heavy rainfall prevented proper evaluation of moisture use during the period of June 13 through 28.

** Values include sprinkler applications.

Table 22. Moisture use by citrus as influenced by treatments at different times in 1969.

Interval	Treatments (Inches/Day)		
	A	B	C
1/29/69-2/25/69	0.049	0.048	0.065
2/25/69-3/18/69	0.060	0.051	0.059
3/18/69-4/16/69	0.219	0.178	0.179
4/16/69-5/7/69	0.079	0.068	0.076
5/9/69-5/27/69	0.306	0.257 (0.298)*	0.319
5/27/69-6/4/69	0.199	0.183 (0.235)*	0.188
6/9/69-6/24/69	0.299	0.191 (0.247)*	0.272
6/30/69-7/8/69	0.410	0.320 (0.373)*	0.366
7/8/79-7/16/69	0.249	0.249 (0.310)*	0.253
7/16/69-7/23/69	0.176	0.183	0.184
7/29/69-8/6/69	0.319	0.214 (0.240)*	0.250
8/6/69-8/12/69	0.150	0.068 (0.138)*	0.238
8/25/69-9/5/69	0.245	0.254 (0.302)*	0.275
9/5/69-9/15/69	0.266	0.199 (0.241)*	0.247
9/15/69-10/2/69	0.248	0.166 (0.222)*	0.186
10/2/69-10/14/69	0.103	0.098 (0.107)*	0.096
10/14/69-10/29/69	0.103	0.107 (0.128)*	0.103
11/5/69-12/8/69	0.128	0.107	0.149

* Values include sprinkler application.

Table 23. Yield of citrus as influenced by treatments.

Year	Treatments			
	A	B	C	Sign.
1968				
> No. 96 (Tons/A)	5.0	6.4	7.4	N.S.
Total Yield (Tons/A)	20.0	23.6	20.9	a/
Large Fruit (%)	25	21	26	
1969				
> No. 96 (Tons/A)	14.6	17.5	13.3	b/
Total Yield (Tons/A)	25.9	21.7	24.4	N.S.
Large Fruit (%)	56	81	55	

a/ Trees on sprinkler treatment significantly higher yielding than trees on A and C treatments.
b/ Trees on sprinkler treatment significantly higher yielding than treatments on A and C at 6% level.

Table 24. Canopy temperatures °F in citrus as influenced by treatments and air temperatures °F in the grove in 1968.

Date and Treatment	Time (°F)			
5/28/68	9:00	11:00	2:00	4:00
A	84	86	92	92
B	83	84	81	88
C	84	86	92	89
Air	84	85	92	91
6/3/68	9:00	11:00	1:30	4:00
A	87	92	89	90
B	82	88	85	87
C	87	91	88	91
Air	86	84	87	92
6/4/68	10:00	2:00		
A	89	98		
B	85	94		
C	89	96		
Air	98	101		
6/7/68	8:00	11:00	1:30	4:00
A	82	88	90	89
B	80	86	86	88
C	81	87	89	89
Air	81	89	88	92
6/14/68	8:30	11:00	1:00	3:00
A	84	89	96	97
B	81	88	91	91
C	83	91	94	95
Air	83	94	99	102
6/20/68	9:00	11:00		
A	79	87		
B	77	86		
C	78	87		
Air	79	86		
6/21/68	9:00	11:00	1:30	
A	87	89	94	
B	82	87	81	
C	85	88	94	
Air	85	90	92	
6/28/68	8:30	1:30	3:30	
A	84	91	93	
B	81	93.5	91	
C	82	91	92	
Air	82	95	97	
7/12/68	11:00	1:00	3:30	
A	85	86	93	
B	83	86	90	
C	85	86	93	
Air	84	87	95	
7/15/68	9:00	10:30	1:00	3:30
A	86	89	97	91
B	82	88	84	89
C	84	89	95	91
Air	85	93	90	90
7/19/68	8:00	11:00	1:30	
A	83	91	97	
B	81	87	89	
C	81	91	96	
Air	83	94	92	
7/26/68	8:50	11:00	2:00	3:30
A	86	93	96	93
B	83	89	91	89
C	84	93	95	92
Air	84	92	95	92

Table 24. Continued.

8/1/68	9:00	11:00		
A	83	89		
B	81	86		
C	82	89		
Air	82	86		
8/2/68	8:30	11:00		
A	81	90		
B	79	82		
C	80	89		
Air	80	90		
8/5/68	9:00	11:00	2:00	4:00
A	83	86	91	84
B	82	87	89	82
C	84	87	91	84
Air	83	92	93	83
8/9/68	10:00	1:30	4:00	
A	90	97	98	
B	85	91	93	
C	89	95	97	
Air	92	97	99	
8/19/68	9:30	11:20	2:30	4:00
A	88	92	96	96
B	85	89	93	93
C	86	92	95	95
Air	88	93	95	97
8/27/68	8:30	11:00	2:00	
A	79	91	92	
B	78	88	93	
C	79	91	91	
Air	80	89	93	
8/28/68	9:00	11:00	2:00	4:00
A	81	91	87	89
B	79	88	85	87
C	81	89	87	90
Air	81	89	85	89
9/3/68	9:00	11:00	2:00	4:00
A	81	93	93	95
B	83	88	92	93
C	80	92	94	95
Air	81	90	92	96
9/10/68	9:00	11:00	2:00	
A	77	79	87	
B	77	79	87	
C	77	78	87	
Air	76	78	87	
9/17/68	9:00	11:00	2:00	4:00
A	86	90	99	97
B	85	89	93	96
C	85	89	99	97
Air	84	90	93	97
9/23/68	9:00	11:00	2:00	4:00
A	87	91	96	96
B	87	90	90	90
C	87	91	95	95
Air	86	91	96	98
9/30/68	9:00	11:00		
A	73	83		
B	73	83		
C	73	82		
Air	73	83		

Table 25. Canopy temperatures in citrus as influenced by treatments in 1969 and air temperatures °F in grove in 1969.

Date and Treatment	Time (°F)				
5/14/69	9:00	11:00	2:00	4:00	
Spr. B	70	76	79	78	
Ref. C	79	84	90	86	
Con. A	81	83	89	87	
Air	80	84	90	89	
5/28/69	11:00	1:15	3:30		
Spr. B	82	82	85		
Ref. C	83	87	91		
Con. A	83	85	91		
Air	85	88	95		
6/5/69	8:45	11:30			
Spr. B	68	83			
Ref. C	75	81			
Con. A	75	82			
Air	76	82			
6/10/69	9:50	10:45	1:30	2:30	
Spr. B	82	87	92	94	
Ref. C	82	87	92	93	
Con. A	83	88	90	92	
Air	85	92	93	95	
6/25/69	8:50	11:15	2:30		
Spr. B	86	94	97		
Ref. C	85	92	95		
Con. A	87	93	94		
Air	88	95	98		
7/1/69	8:30	10:30	1:10		
Spr. B	81	87	90		
Ref. C	80	83	89		
Con. A	81	84	89		
Air	82	85	90		
7/3/69	8:15	10:30	11:45		
Spr. B	79	85	87		
Ref. C	79	85	87		
Con. A	81	89	87		
Air	84	87	88		
7/9/69	8:30	10:30	11:30	1:30	3:30
Spr. B	82	92	93	89	97
Ref. C	81	90	92	95	97
Con. A	83	94	93	95	97
Air	87	94	96	98	101
7/17/69	8:30	10:30	11:30	3:30	
Spr. B	83	94	95	95	
Ref. C	82	89	92	96	
Con. A	83	91	92	96	
Air	85	92	95	98	

Table 25. Continued.

Date and Treatment	Time (°F)			
7/24/69	8:30	10:30	2:00	3:30
Spr. B	85	93	96	97
Ref. C	84	92	98	97
Con. A	85	93	98	97
Air	87	95	99	100
7/30/69	8:30	10:30	11:30	1:15
Spr. B	80	91	93	97
Ref. C	79	88	91	95
Con. A	81	89	92	95
Air	84	92	93	96
8/14/69	8:30	10:30	1:20	3:30
Spr. B	80	91	95	98
Ref. C	78	-	97	96
Con. A	80	90	95	96
Air	84	91	97	98
8/26/69	8:30	10:40	1:00	2:30
Spr. B	82	92	96	95
Ref. C	80	84	94	95
Con. A	82	85	92	94
Air	84	85	93	96
9/8/69	8:30	10:30	1:10	
Spr. B	80	89	93	
Ref. C	77	83	88	
Con. A	78	83	88	
Air	77	81	86	
10/3/69	8:30	10:30	1:20	2:15
Spr. B	77	83	87	88
Ref. C	77	83	87	88
Con. A	78	82	88	88
Air	79	82	88	88
10/17/69	8:30	11:00	1:10	2:30
Spr. B	73	85	85	84
Ref. C	74	83	85	83
Con. A	74	82	84	82
Air	72	81	84	83

Table 26. Influence of treatments on leaf temperatures °F of citrus in 1968.

Date and Treatment	Time (°F)			
5/28/68	9:00	11:00	2:00	4:00
A	84	87	94	94
B	84	85	82	88
C	84	87	93	90
6/3/68	9:00	11:00	1:30	4:00
A	91	97	93	91
B	97	99	79	87
C	95	100	91	92
6/4/68	10:00	2:00		
A	93	109		
B	100	93		
C	93	97		
6/7/68	8:00	11:00	1:30	4:00
A	83	90	94	89
B	86	89	83	87
C	83	91	89	89
6/14/68	8:30	11:00	1:00	3:00
A	86	89	102	100
B	95	95	90	90
C	87	93	96	95
6/20/68	9:00	11:00		
A	79	96		
B	82	91		
C	80	88		
6/21/68	9:00	11:00	1:30	
A	97	100	103	
B	91	98	80	
C	90	92	97	
6/28/68	8:30	1:30	3:30	
A	85	95	93	
B	86	93	91	
C	85	91	92	
7/12/68	11:00	1:00	3:30	
A	85	86	92	
B	83	85	90	
C	85	86	92	
7/15/68	9:00	10:30	1:00	3:30
A	84	88	103	91
B	90	91	79	88
C	90	93	95	91
7/19/68	8:30	11:00	1:30	
A	84	91	99	
B	90	91	93	
C	83	96	96	
7/26/68	9:00	11:00	2:00	3:30
A	88	98	96	92
B	92	89	89	88
C	89	--	96	93

Table 26. Continued.

Date and Treatment	Time (°F)			
8/1/68	9:00	11:00		
A	83	89		
B	82	86		
C	84	88		
8/2/68	8:30	11:00		
A	81	90		
B	81	87		
C	81	90		
8/5/68	9:00	11:00	2:00	4:00
A	84	87	89	84
B	95	88	87	81
C	91	90	90	83
8/9/68	10:05	1:30	4:00	
A	90	96	96	
B	90	90	91	
C	95	95	96	
8/19/68	9:30	11:20	2:30	4:00
A	81	85	85	85
B	93	88	93	92
C	90	93	99	98
8/27/68	8:30	11:00	2:00	
A	80	96	92	
B	81	90	94	
C	82	95	91	
8/28/68	9:00	11:00	2:00	4:00
A	85	90	87	89
B	85	89	85	86
C	84	96	88	90
9/3/68	9:00	11:00	2:00	4:00
A	81	98	92	93
B	86	90	94	92
C	81	100	94	95
9/10/68	9:00	11:00	2:00	
A	77	79	86	
B	76	79	87	
C	77	79	86	
9/17/68	9:00	11:00	2:00	4:00
A	87	89	94	96
B	89	88	91	93
C	89	89	94	97
9/23/68	9:00	11:00	2:00	4:00
A	85	90	94	95
B	92	94	87	88
C	91	97	95	95
9/30/68	9:00	11:00		
A	73	83		
B	74	84		
C	74	84		

Table 27. Influence of treatments on leaf temperatures °F of citrus as evaluated with Barnes radiation thermometer in 1968.

Date and Treatment	Time (°F)							
	4:00							
5/28/68	Top	Bottom						
A	91	93						
B	92	94						
C	95	93						
	3:30							
6/3/68	Top	Bottom						
A	97	--						
B	99	--						
C	98	--						
	3:30							
6/4/68	Top	Bottom						
A	94	96						
B	95	94						
C	94	96						
	9:15		11:35		2:00		4:20	
6/7/68	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
A	88	87	94	95	95	96	93	91
B	91	90	95	96	95	92	93	93
C	87	87	93	95	94	93	93	94
	9:45		11:00					
6/20/68	Top	Bottom	Top	Bottom				
A	82	83	88	88				
B	83	84	90	90				
C	83	83	88	90				
	10:30		2:00					
6/21/68	Top	Bottom	Top	Bottom				
A	91	92	95	95				
B	89	89	91	90				
C	90	90	96	96				
	9:00		1:50		4:00			
6/28/68	Top	Bottom	Top	Bottom	Top	Bottom		
A	88	89	93	94	94	94		
B	88	87	93	94	94	94		
C	88	87	93	95	94	94		
	11:30		1:00		4:00			
7/12/68	Top	Bottom	Top	Bottom	Top	Bottom		
A	89	90	93	93	96	95		
B	90	89	93	93	96	96		
C	89	89	93	93	96	96		
	9:15		10:55		1:30		4:00	
7/15/68	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
A	91	90	96	95	94	92	94	96
B	89	89	94	95	94	93	92	91
C	90	90	95	97	94	94	93	94
	9:00		11:00					
7/19/68	Top	Bottom	Top	Bottom				
A	88	87	96	95				
B	86	85	93	94				
C	85	85	95	94				

Table 28. Influence of different treatments on temperatures °F of top and bottom of leaves of citrus as evaluated with Barnes radiation thermometer in 1969.

Date and Treatment	Time (°F)									
	9:00		11:00		2:00		4:00			
5/14/69	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom		
Spr. B	79	82	84	82	89	89	85	85		
Ref. C	80	81	83	81	89	89	86	86		
Con. A	82	82	81	83	88	87	87	87		
	11:00		1:15		3:30					
5/28/69	Top	Bottom	Top	Bottom	Top	Bottom				
Spr. B	84	83	85	84	87	87				
Ref. C	85	86	84	85	89	90				
Con. A	87	87	84	82	88	88				
	8:45		11:30							
6/5/69	Top	Bottom	Top	Bottom						
Spr. B	78	78	90	91						
Ref. C	77	77	83	83						
Con. A	79	78	83	83						
	9:50		10:45		1:30		2:30			
6/10/69	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom		
Spr. B	92	93	94	94	89	88	90	90		
Ref. C	83	82	86	87	89	89	91	90		
Con. A	89	90	90	88	86	87	89	89		
	8:50		11:15		2:30					
6/25/69	Top	Bottom	Top	Bottom	Top	Bottom				
Spr. B	87	88	99	99	91	92				
Ref. C	88	87	93	93	97	96				
Con. A	88	88	99	99	94	94				
	8:30		10:30		1:10					
7/1/69	Top	Bottom	Top	Bottom	Top	Bottom				
Spr. B	82	84	88	87	89	89				
Ref. C	84	84	87	87	89	88				
Con. A	84	84	88	87	88	88				
	8:15		10:30		11:45					
7/3/69	Top	Bottom	Top	Bottom	Top	Bottom				
Spr. B	83	82	87	87	89	90				
Ref. C	82	81	85	85	90	90				
Con. A	84	82	85	85	86	88				
	8:30		10:30		11:30		1:30		3:30	
7/9/69	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Spr. B	84	84	90	91	91	92	90	90	92	92
Ref. C	82	82	90	90	92	92	92	93	95	95
Con. A	84	84	89	89	91	92	92	91	93	94
	8:30		10:30		11:30		3:30			
7/17/69	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom		
Spr. B	84	84	89	89	93	93	93	92		
Ref. C	84	83	91	92	94	94	97	97		
Con. A	84	84	92	91	92	92	94	94		

Table 28. Continued.

Date and Treatment	Time (°F)							
	8:30		10:30		2:00		3:30	
7/24/69	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Spr. B	85	86	92	92	93	92	95	95
Ref. C	86	85	93	93	96	96	99	99
Con. A	86	85	91	91	97	97	97	95
	8:30		10:30		11:30		1:15	
7/30/69	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Spr. B	81	81	91	89	93	93	96	95
Ref. C	82	82	90	90	93	93	97	97
Con. A	83	83	90	89	91	92	95	96
	8:30		10:30		1:20		3:30	
8/14/69	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Spr. B	81	81	93	93	92	93	95	96
Ref. C	82	80	91	90	90	90	95	94
Con. A	82	83	91	92	92	91	95	95
	8:30		10:40		1:00		2:30	
8/26/69	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Spr. B	84	85	89	89	91	91	90	92
Ref. C	84	84	88	87	94	93	93	93
Con. A	85	85	89	88	89	90	92	92
	8:30		10:30		1:10			
9/8/69	Top	Bottom	Top	Bottom	Top	Bottom		
Spr. B	79	80	85	86	89	89		
Ref. C	80	80	86	86	88	88		
Con. A	82	81	86	86	86	87		
	8:30		10:45		1:30		3:30	
9/17/69	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Spr. B	81	80	90	90	92	90	89	88
Ref. C	80	81	90	88	95	95	89	89
Con. A	83	82	89	89	94	93	91	90
	8:30		10:30		1:20		2:15	
10/3/69	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Spr. B	78	79	85	83	88	87	88	89
Ref. C	79	79	89	87	88	88	89	88
Con. A	81	80	85	84	89	89	89	87
	8:30		11:00		1:10		2:30	
10/17/69	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Spr. B	78	76	85	85	86	84	84	85
Ref. C	75	75	86	85	86	86	84	84
Con. A	78	78	84	84	86	87	83	83

Table 29. Influence of treatments on soil temperatures °F at 1 and 3 inch depths in 1968.

Date and Treatment	Time (°F)							
5/28/68	9:00		11:00		2:00		4:00	
	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.
A	82	81	83	82	86	86	87	86
B	80	80	80	80	81	81	82	82
C	82	81	83	82	86	86	87	86
6/3/68	9:00		11:00		1:30		4:00	
	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.
A	84	83	85	85	88	87	88	87
B	81	81	81	81	80	80	83	83
C	84	83	85	85	88	87	88	87
6/4/68	10:00		2:00					
	1 in.	3 in.	1 in.	3 in.				
A	85	81	89	88				
B	82	81	82	85				
C	85	84	89	88				
6/7/68	8:00		11:00		1:30		4:00	
	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.
A	78	79	81	80	81	81	81	81
B	79	79	80	80	80	80	80	79
C	82	81	84	83	86	85	86	86
6/14/68	8:30		11:00		1:00		3:00	
	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.
A	77	77	82	79	84	81	86	83
B	80	80	79	79	81	81	82	83
C	85	83	88	86	90	89	91	89
6/20/68	9:00		11:00					
	1 in.	3 in.	1 in.	3 in.				
A	77	77	79	78				
B	78	78	78	78				
C	79	79	79	78				
6/21/68	9:00		11:00		1:30			
	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.		
A	79	78	80	79	84	82		
B	79	79	78	78	80	80		
C	80	80	81	81	84	83		
6/28/68	8:30		1:30		3:30			
	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.		
A	82	81	89	87	87	86		
B	77	77	77	77	78	78		
C	80	78	83	82	82	82		
7/12/68	11:00		1:00		3:30			
	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.		
A	87	83	84	84	90	88		
B	82	82	82	82	85	84		
C	83	83	84	84	86	85		
7/15/68	9:00		10:30		1:00		3:30	
	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.
A	83	82	91	90	94	90	88	88
B	83	82	84	83	81	82	81	81
C	85	83	85	85	88	87	88	87
7/19/68	8:30		11:00		1:30			
	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.		
A	82	82	86	83	89	86		
B	80	80	82	82	80	81		
C	84	83	86	85	89	87		
7/26/68	9:00		11:00		2:00		3:30	
	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.
A	80	80	83	82	85	83	85	84
B	79	79	79	79	79	79	80	80
C	83	83	86	85	88	87	88	88

Table 29. Continued.

Date and Treatment	Time (°F)							
	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.
8/1/68	9:00		11:00					
A	80	80	82	81				
B	79	79	80	80				
C	81	81	83	82				
8/2/68	8:30		11:00					
A	78	78	82	81				
B	78	78	79	79				
C	78	79	81	81				
8/5/68	9:00		11:00		2:00		4:00	
A	79	79	86	84	87	86	85	85
B	79	79	79	79	79	79	79	78
C	78	78	80	80	82	81	82	82
8/9/68	10:00		1:30		4:00			
A	81	81	84	82	84	82		
B	81	80	80	79	79	79		
C	83	82	85	84	86	85		
8/19/68	9:30		11:30		2:30		4:00	
A	81	81	83	82	86	85	86	85
B	80	78	79	78	79	79	79	79
C	81	81	83	82	86	85	86	86
8/27/68	8:30		11:00		2:00			
A	79	79	82	81	84	83		
B	77	77	77	77	79	79		
C	79	79	81	81	84	84		
8/28/68	9:00		11:00		2:00		4:00	
A	79	80	82	81	84	83	84	83
B	76	77	78	78	78	78	79	79
C	80	80	82	82	85	84	85	85
9/3/68	9:00		11:00		2:00		4:00	
A	80	80	81	81	84	82	84	83
B	78	78	79	79	79	79	79	79
C	80	80	82	82	84	83	85	84
9/10/68	9:00		11:00		2:00			
A	81	82	81	82	84	84		
B	78	78	78	78	79	79		
C	78	79	78	79	79	80		
9/17/68	9:00		11:00		2:00		4:00	
A	93	93	94	93	--	--	--	--
B	80	80	80	81	83	84	82	83
C	83	83	85	85	89	86	89	88
9/23/68	9:00		11:00		2:00		4:00	
A	80	80	80	80	83	82	84	83
B	77	78	78	79	78	79	78	78
C	82	82	83	83	85	85	87	86
9/30/68	9:00		11:00					
A	73	74	75	74				
B	77	77	76	76				
C	75	76	77	77				

Table 30. Influence of treatments on soil temperature ^{o}F at 1 and 3 inches in citrus grove in 1969.

Date and Treatment	Time (^{o}F)									
	9:00		11:00		2:00		4:00			
5/14/69	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.		
Spr. B	66	65	67	66	70	67	69	68		
Ref. C	74	73	73	73	77	76	78	77		
Con. A	74	74	73	72	77	75	77	76		
	11:00		1:15		3:30					
5/28/69	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.				
Spr. B	74	72	78	75	77	75				
Ref. C	79	76	80	79	82	80				
Con. A	78	77	79	77	81	79				
	8:15		11:30							
6/5/69	1 in.	3 in.	1 in.	3 in.						
Spr. B	69	70	77	78						
Ref. C	71	73	78	77						
Con. A	77	78	78	76						
	9:50		10:45		1:30		2:30			
6/10/69	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.		
Spr. B	80	78	80	78	82	80	82	80		
Ref. C	79	77	81	78	84	80	85	80		
Con. A	77	76	79	77	80	78	81	78		
	8:50		11:15		2:30					
6/25/69	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.				
Spr. B	86	83	88	85	90	87				
Ref. C	84	84	90	85	92	87				
Con. A	84	84	87	85	89	87				
	8:30		10:30		1:10					
7/1/69	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.				
Spr. B	81	80	83	81	84	82				
Ref. C	78	78	80	79	81	81				
Con. A	79	79	80	79	81	81				
	8:15		10:30		11:45					
7/3/69	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.				
Spr. B	79	79	83	81	83	82				
Ref. C	78	78	80	79	81	80				
Con.	79	78	80	79	81	80				
	8:30		10:30		11:30		1:30		3:30	
7/9/69	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.
Spr. B	81	80	85	83	85	85	85	85	84	83
Ref. C	80	80	85	82	85	82	88	84	90	85
Con. A	81	80	84	81	84	82	85	83	87	83
	8:30		10:30		11:30		3:30			
7/17/69	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.		
Spr. B	81	80	84	82	84	82	83	82		
Ref. C	83	83	85	84	87	84	90	86		
Con. A	84	83	86	84	87	84	89	86		

Table 30. Continued.

Date and Treatment	Time (°F)							
	8:30		10:30		2:00		3:30	
7/24/69	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.
Spr. B	82	83	84	88	84	90	85	90
Ref. C	84	85	87	88	91	92	93	92
Con. A	86	85	91	88	92	93	92	85
	8:30		10:30		11:30		1:15	
7/30/69	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.
Spr. B	78	79	82	81	83	81	83	82
Ref. C	80	81	83	82	84	84	85	84
Con. A	82	82	86	83	86	83	87	85
	8:30		10:30		1:20		3:30	
8/14/69	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.
Spr. B	79	80	82	81	83	82	84	83
Ref. C	80	81	84	82	87	85	88	86
Con. A	83	82	86	83	89	84	90	86
	8:30		10:40		1:00		2:30	
8/26/69	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.
Spr. B	81	81	82	82	83	82	84	83
Ref. C	78	79	81	80	82	81	83	82
Con. A	82	80	82	81	84	81	85	82
	8:30		10:30		1:10			
9/8/69	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.		
Spr. B	78	79	80	80	81	80		
Ref. C	77	77	76	76	80	79		
Con. A	79	78	80	77	85	80		
	8:30		10:45		1:30		3:30	
9/17/69	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.
Spr. B	78	79	81	80	82	81	81	81
Ref. C	79	79	81	80	85	82	85	84
Con. A	80	80	85	81	99	83	88	85
	8:30		10:30		1:20		2:15	
10/3/69	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.
Spr. B	75	75	77	76	79	76	79	77
Ref. C	76	76	78	77	81	79	82	79
Con. A	77	76	81	78	88	80	82	80
	8:30		11:00		1:10		2:30	
10/17/69	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.	1 in.	3 in.
Spr. B	73	73	77	75	77	76	78	76
Ref. C	72	72	74	73	80	76	78	77
Con. A	72	72	74	73	76	75	76	76

Table 31. Influence of treatments on vapor pressure deficit in citrus canopy in 1968.

Date and Treatment	Time (mm of Hg)			
5/28/68	9:00	11:00	2:00	4:00
A	5.9	7.1	16.8	10.2
B	5.8	7.1	12.6	10.1
C	5.9	7.1	17.1	12.6
6/3/68	9:00	11:00	1:30	4:00
A	9.3	14.1	16.6	18.1
B	7.6	7.1	13.3	10.2
C	11.4	16.6	13.7	18.7
6/4/68	10:00	2:00		
A	10.8	20.8		
B	11.8	18.8		
C	11.8	23.4		
6/7/68	8:00	11:00	1:30	4:00
A	4.5	10.2	7.8	7.9
B	6.0	9.6	9.6	11.2
C	6.0	10.2	12.6	9.2
6/14/68	8:30	11:00	1:00	3:00
A	5.8	12.6	16.3	16.9
B	2.6	11.2	18.3	19.6
C	4.5	12.6	18.8	20.8
6/20/68	9:00	11:00		
A	1.0	4.6		
B	2.3	7.3		
C	2.4	5.8		
6/21/68	9:00	11:00	1:30	
A	6.9	10.9	13.1	
B	5.6	12.2	11.2	
C	6.9	9.9	15.7	
6/28/68	8:30	1:30	3:30	
A	3.3	12.6	13.7	
B	2.3	13.7	15.2	
C	2.4	12.6	13.7	
7/12/68	11:00	1:00	3:30	
A	5.8	8.3	13.4	
B	6.0	8.3	14.8	
C	6.0	8.3	14.6	
7/15/68	9:00	10:30	1:30	3:30
A	4.6	10.2	18.3	13.7
B	3.4	13.7	10.5	15.2
C	3.4	10.2	18.3	15.2
7/19/68	8:30	11:00	1:30	
A	3.3	11.2	23.4	
B	3.3	12.6	17.1	
C	2.4	10.2	20.8	
7/26/68	9:00	11:00	2:00	3:30
A	5.4	11.2	20.6	15.7
B	6.7	10.2	16.4	13.7
C	5.6	11.2	16.3	15.7

Table 31. Continued.

Date and Treatment	Time (mm of Hg)			
8/1/68	9:00	11:00		
A	2.4	10.2		
B	2.4	9.3		
C	3.4	13.1		
8/2/68	8:30	11:00		
A	2.4	6.8		
B	1.0	10.2		
C	1.0	6.8		
8/5/68	9:00	11:00	2:00	4:00
A	3.5	8.8	15.2	5.8
B	3.3	2.4	13.7	5.8
C	3.5	7.6	15.2	5.8
8/9/68	10:00	1:30	4:00	
A	8.6	18.8	21.8	
B	7.4	17.5	18.1	
C	8.8	18.8	21.8	
8/19/68	9:30	11:20	2:30	4:00
A	6.0	11.9	16.5	18.0
B	5.9	11.2	17.5	11.2
C	5.9	11.6	18.8	18.3
8/27/68	8:30	11:00	2:00	
A	2.2	12.2	15.2	
B	2.2	7.5	13.7	
C	2.2	12.4	13.7	
8/28/68	9:05	11:00	2:00	4:00
A	2.2	12.2	10.8	12.2
B	3.2	12.4	9.5	12.2
C	3.2	12.2	9.5	12.6
9/3/68	9:00	11:00	2:00	4:00
A	3.3	13.7	17.1	17.1
B	4.5	12.6	15.7	18.8
C	4.9	12.6	18.8	18.8
9/10/68	9:00	11:00	2:00	
A	3.0	4.2	8.6	
B	2.1	4.2	5.4	
C	3.1	4.2	10.2	
9/17/68	9:00	11:00	2:00	4:00
A	4.8	7.8	18.3	16.5
B	3.5	8.3	16.5	16.5
C	4.8	7.8	16.5	16.5
9/23/68	9:00	11:00	2:00	4:00
A	15.1	11.2	20.8	22.0
B	8.3	11.9	17.5	17.3
C	9.9	9.6	18.8	20.6
9/30/68	9:00	11:00		
A	1.0	6.7		
B	1.0	5.5		
C	1.0	5.4		

Table 32. Thermoelectric measurement of moisture flow in citrus as influenced by treatments in 1968.

Date	Time	Treatments (cm/hr)		
		A	B	C
5/28/68	1:30 p.m. to 2:00 p.m.	24.3	29.1	22.8
6/3/68	2:00 p.m. to 3:00 p.m.	47.6	37.1	33.7
6/7/68	1:30 p.m. to 2:00 p.m.	51.1	33.3	34.7
6/14/68	2:00 p.m. to 3:00 p.m.	41.7	52.9	26.9
6/21/68	2:00 p.m. to 3:00 p.m.	36.6	39.8	39.5
6/28/68	11:00 a.m. to 12:00 Noon	24.9	14.0	23.8
7/15/68	2:00 p.m. to 3:00 p.m.	42.3	49.2	28.0
7/19/68	1:00 p.m. to 2:30 p.m.	40.9	24.6	35.4
7/26/68	11:30 a.m. to 1:30 p.m.	57.7	42.5	24.1
8/4/68	10:30 a.m. to 11:30 a.m.	50.0	39.8	14.5
8/19/68	1:30 p.m. to 2:30 p.m.	34.1	35.2	51.7
8/28/68	11:00 a.m. to 12:00 Noon	60.8	76.3	54.9

Table 33. Influence of treatments on moisture flow and moisture content of stem in 1969.

Date	Time	Treatments		
		Sprinkler	Reflective	Control
	Sap Flow ($cc/cm^2/hr$)			
6/10/69*	1:45 p.m.	4.57	4.21	4.96
6/25/69	1:00 p.m.-3:00 p.m.	1.64	1.80	1.36
7/3/69	10:30 a.m.-12:00 Noon	2.99	1.89	1.37
7/9/69	10:30 a.m.-12:00 Noon	2.13	2.13	1.79
7/17/69	10:30 a.m.-12:00 Noon	1.62	2.45	1.24
7/24/69	10:30 a.m.-12:00 Noon	1.29	3.25	2.09
7/30/69	10:30 a.m.-12:00 Noon	3.39	1.87	3.55
8/14/69	1:30 p.m.-2:00 p.m.	0.88	1.33	1.37
8/26/69	10:30 a.m.-12:00 Noon	1.72	2.82	3.36
9/8/69	10:30 a.m.-12:00 Noon	3.40	4.39	2.53
9/17/69	10:30 a.m.-12:00 Noon	2.59	1.70	4.67
10/3/69	10:30 a.m.-12:00 Noon	1.54	1.18	1.99
10/17/69	10:30 a.m.-12:00 Noon	1.66	2.20	1.73
	% Moisture of Sample Stem X100			
6/10/69		0.713	0.761	0.754
6/25/69		0.749	0.708	0.707
7/3/69		0.786	0.693	0.817
7/9/69		0.773	0.756	0.737
7/17/69		0.792	0.714	0.756
7/24/69		0.760	0.683	0.699
7/30/69		0.781	0.706	0.720
8/14/69		0.725	0.738	0.725
8/26/69		0.685	0.756	0.757
9/8/69		0.745	0.740	0.791
9/17/69		0.781	0.691	0.711
10/3/69		0.837	0.680	0.782
10/17/69		0.757	0.740	0.751

* The distance between thermistors was altered slightly during this evaluation possibly contributing to error in flow evaluations.

** Percent moisture on oven dry basis.

Table 34. Influence of treatments on properties of citrus juice.

Year	Treatment A	Treatment B	Treatment C
1968			
Brix°	10.3	9.3	10.1
Acid	1.27	1.20	1.27
Yield of juice (%)	50	54	49
Yield of juice cc/fruit	209	227	195
1969			
Brix°	10.3	10.0	10.3
Acid	1.27	1.15	1.28
Yield of juice (%)	57	54	54
Yield of juice cc/fruit	208	227	190

Table 35. Influence of treatments on ion concentration of leaves in 1968 and 1969.

Treatment	$\%K^{+}$	$\%Mg^{++}$	$\%Ca^{++}$	Zn ppm	Fe ppm	Mn ppm	%P
1968							
A	0.53	0.37	4.90	60	53	29	0.11
B	0.35	0.33	4.46	51	67	23	0.11
C	0.62	0.42	4.15	40	48	27	0.12
1969							
A	-	0.34	4.50	120	39	-	-
B	-	0.30	4.35	175	38	-	-
C	-	0.35	4.55	100	31	-	-

Table 36. Influence of treatments on leaf drop and Cl concentration of leaves in 1969.

	Treatments		
	A	B	C
Leaf drop/day*	0.7	6.1	1.8
Cl 7/8/69 ppm	4500	7300	3700
8/4/69 ppm	5200	11700**	4500
Leaf area lost/day (cm^2)	10	100	20

* Leaf drop in August and September.
** Fallen leaves had 15900 ppm.

FIGURES

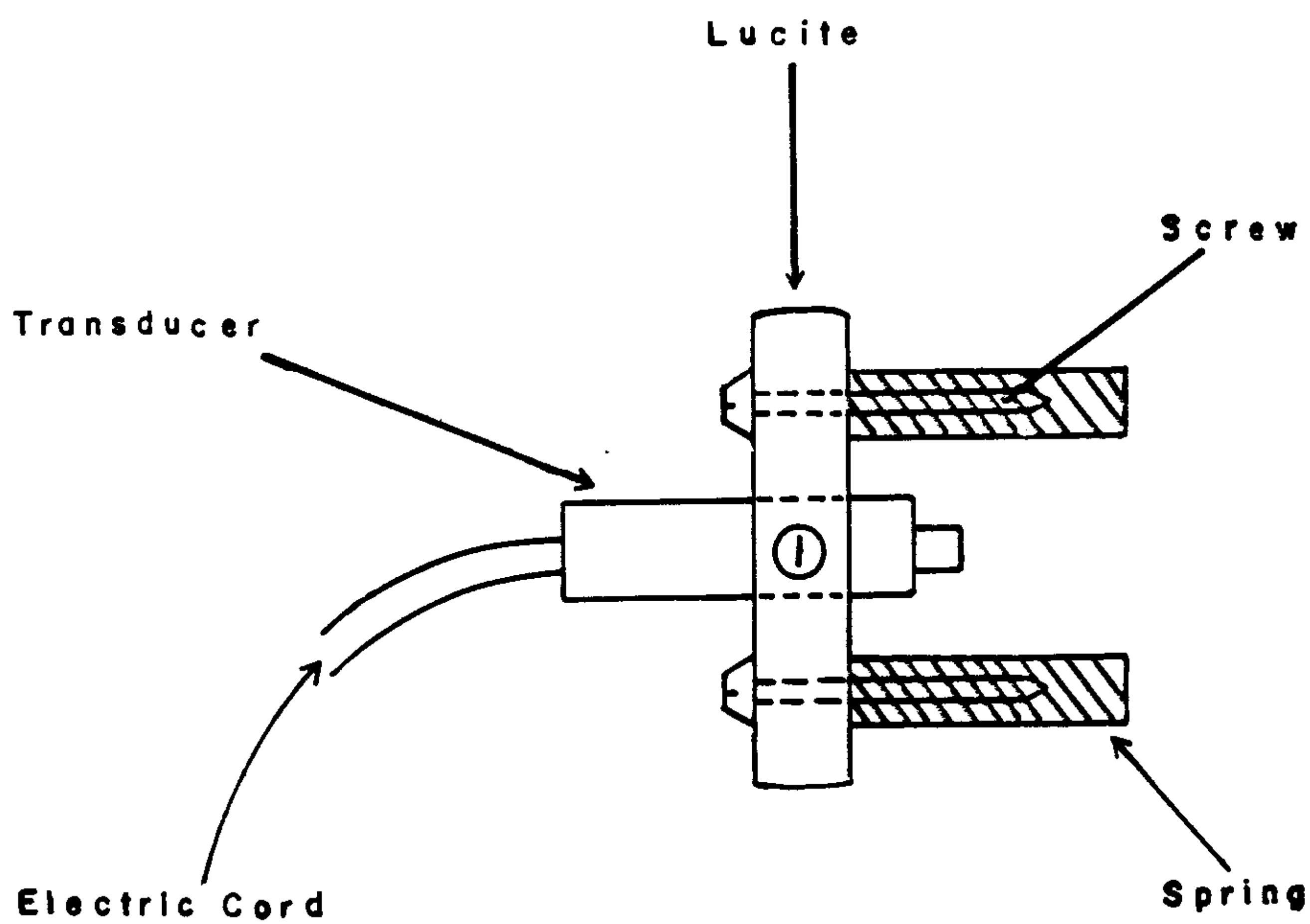

Figure 1A. Holder which was used to position transducers to trunk of trees.

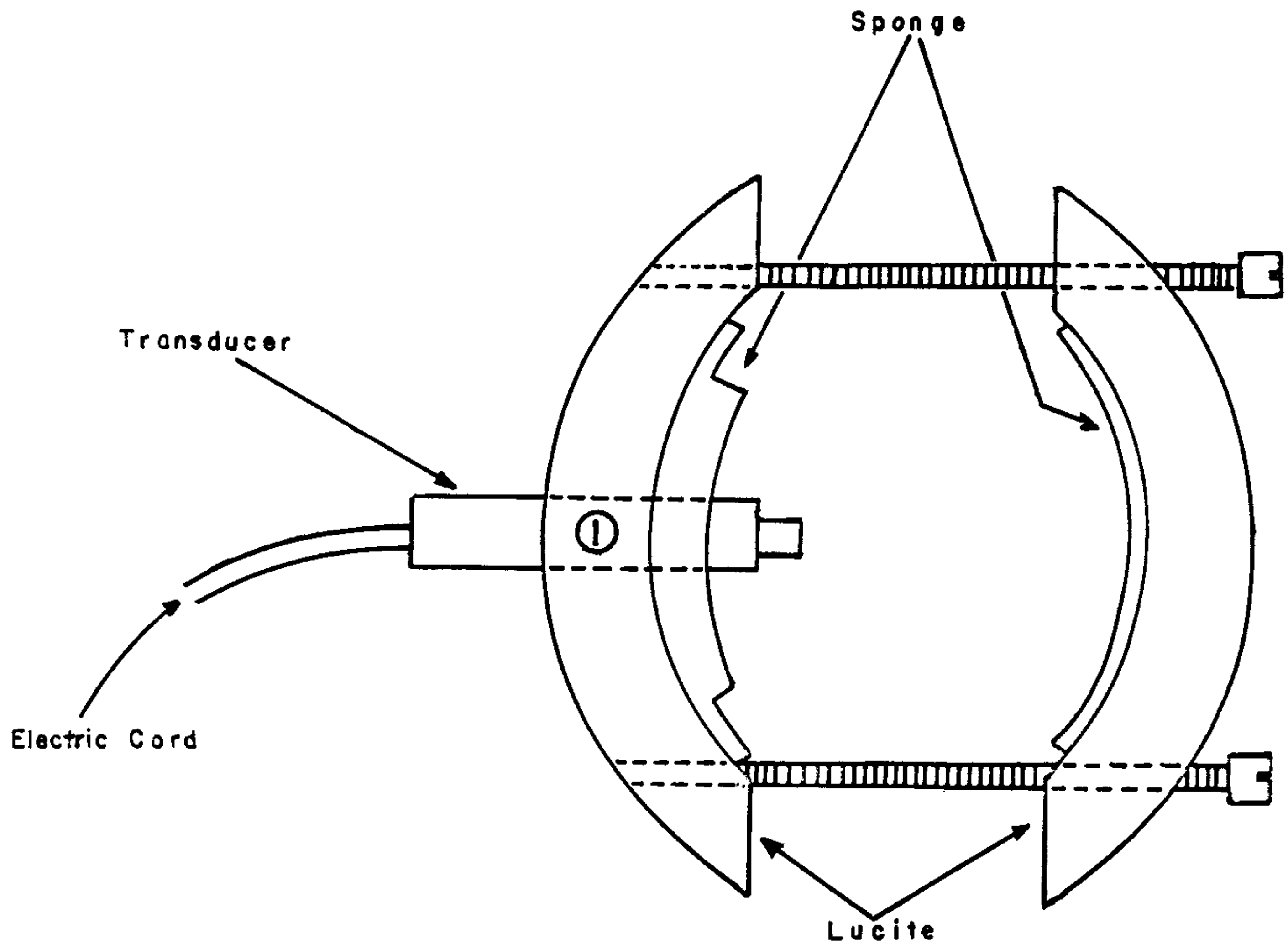

Figure 1B. Holder which was used to position transducers to citrus fruits.

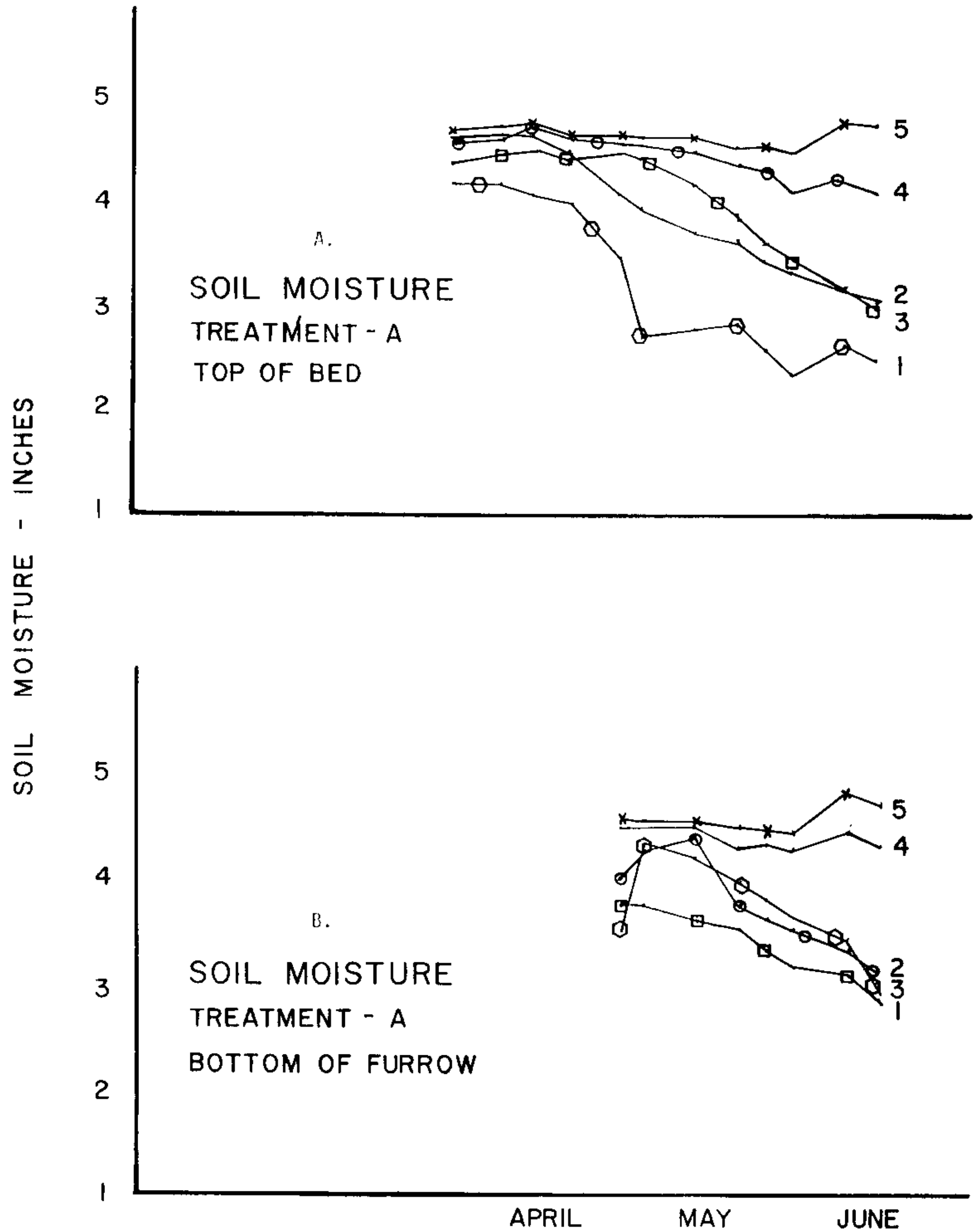

Figure 2. Moisture depletion at different soil depths taken on top of bed (A) and in the furrow (B) as influenced by moisture level treatment A.

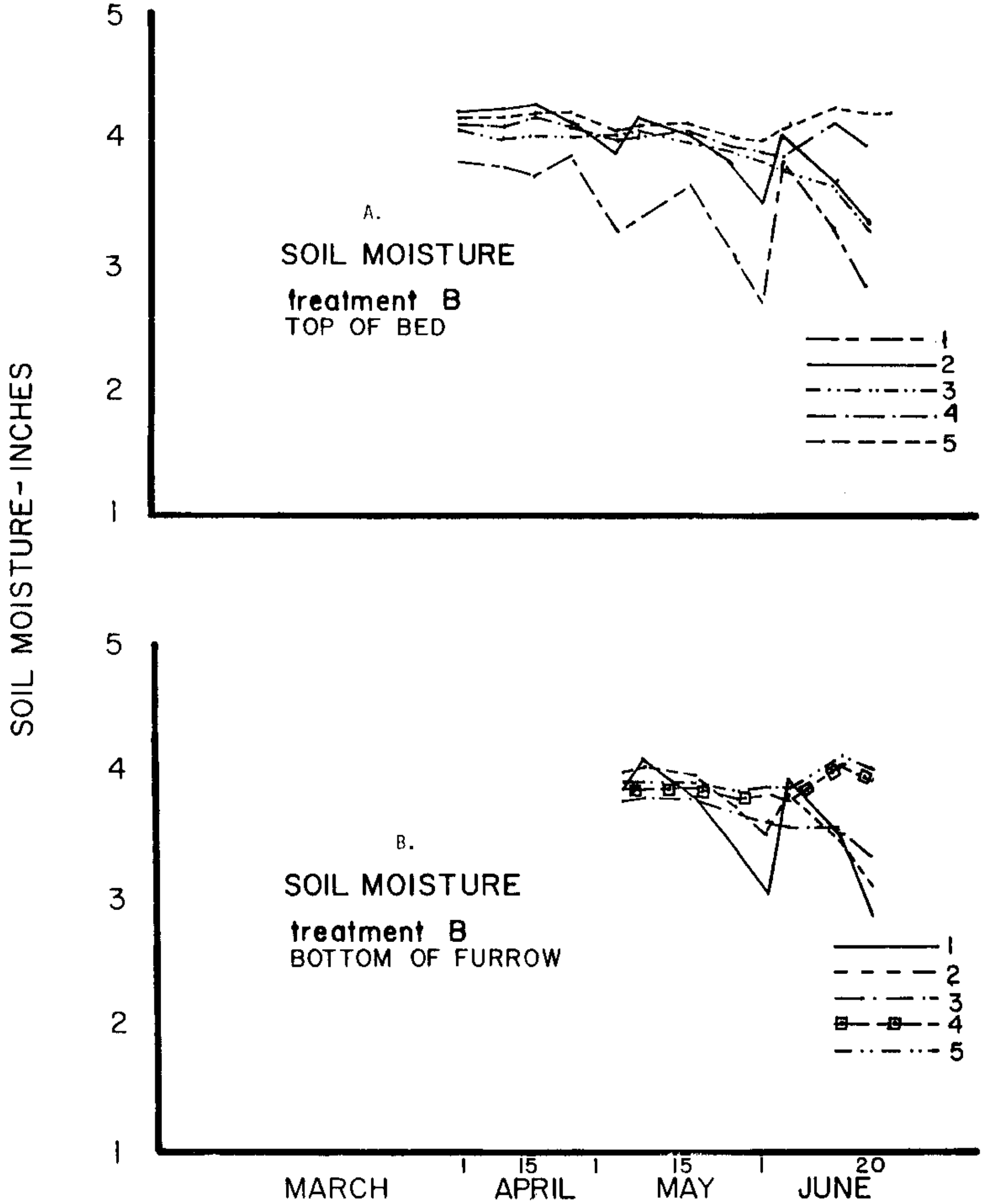

Figure 3. Moisture depletion at different soil depths taken on top of bed (A) and in the furrow (B) as influenced by moisture level treatment B.

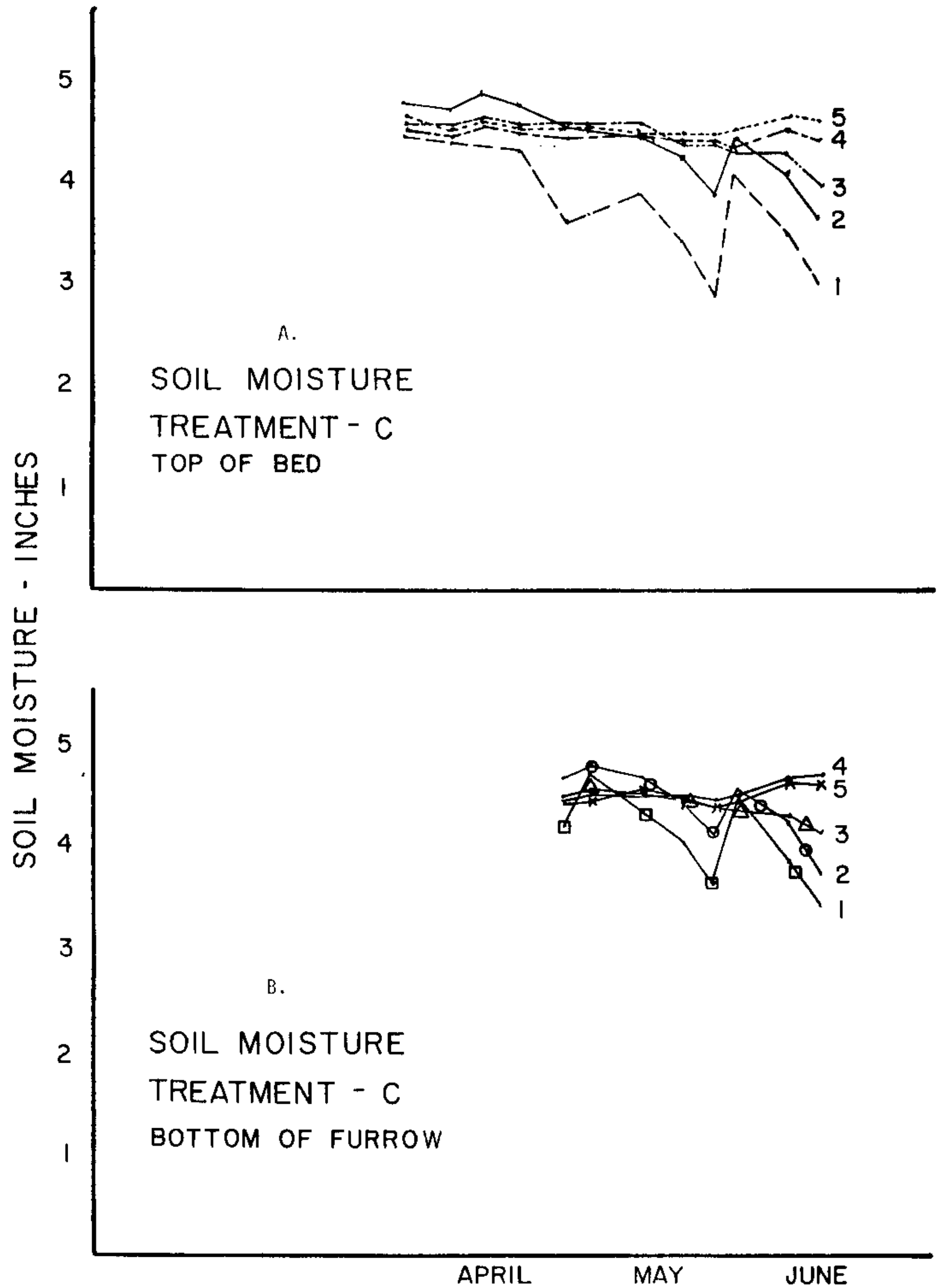

Figure 4. Moisture depletion at different soil depths taken on top of bed (A) and in the furrow (B) as influenced by moisture level treatment C.

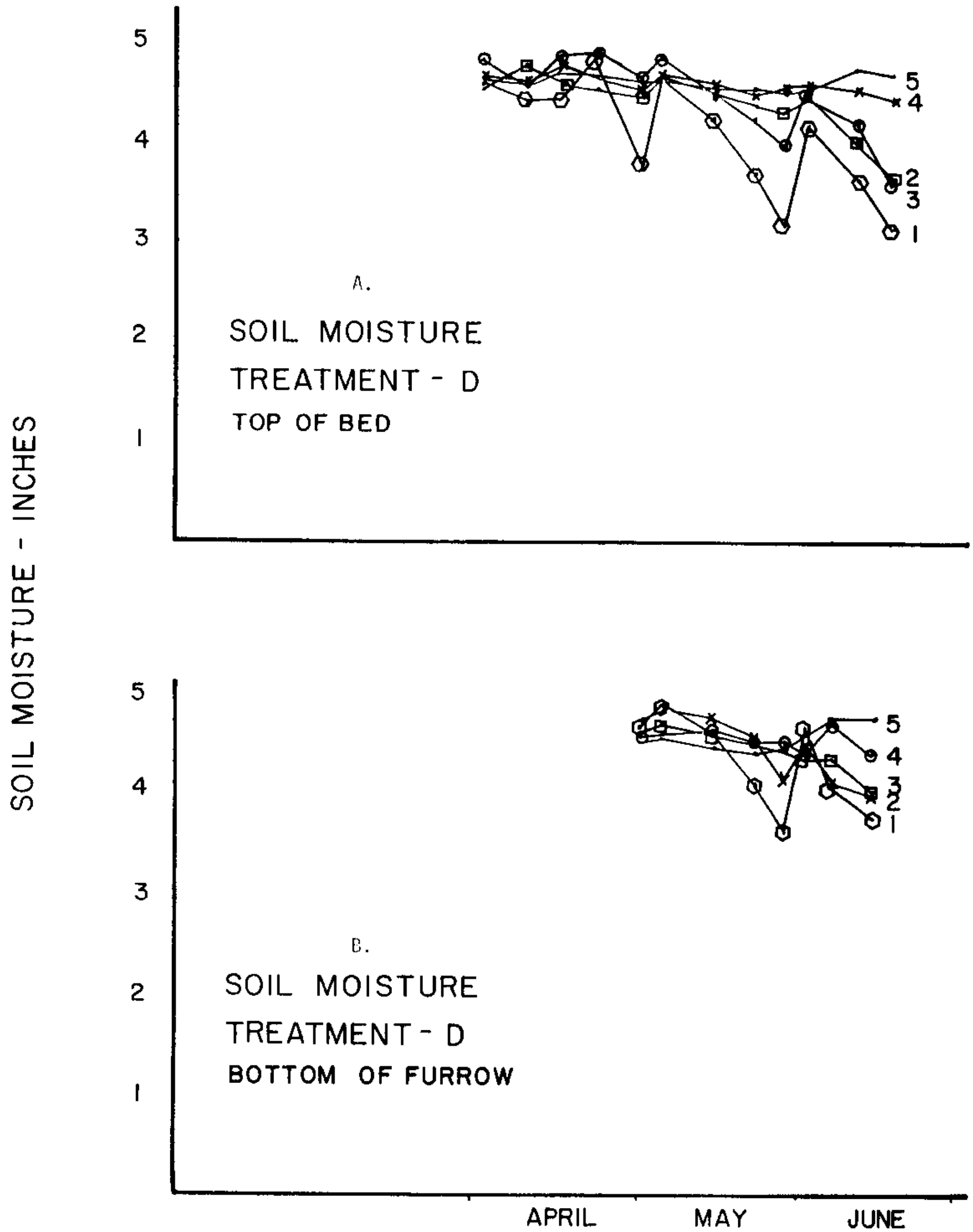

Figure 5. Moisture depletion at different soil depths taken on top of bed (A) and in the furrow (B) as influenced by moisture level treatment D.

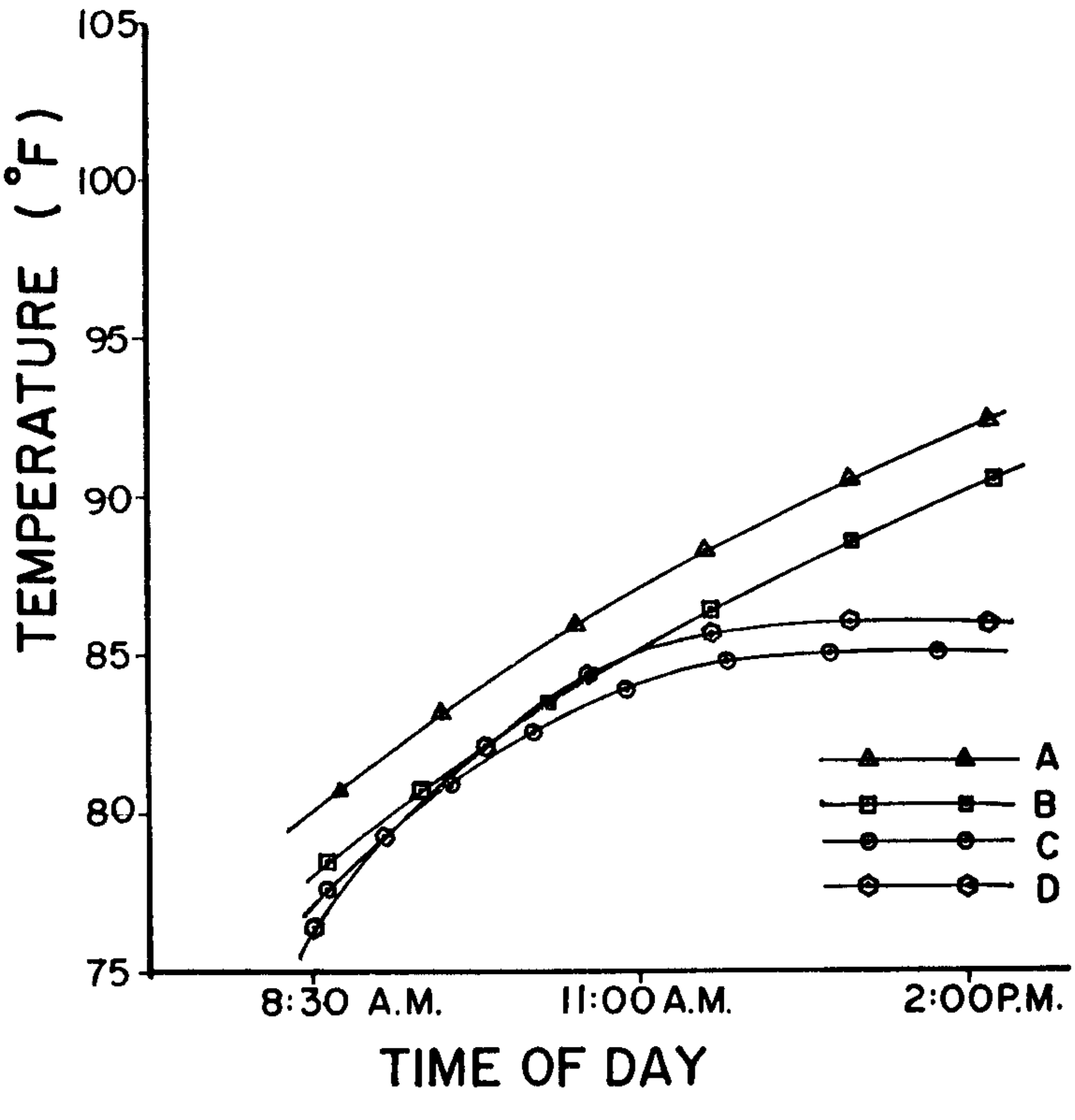

Figure 6. Influence of treatments on canopy temperatures in Chico tomatoes in May., 1969.

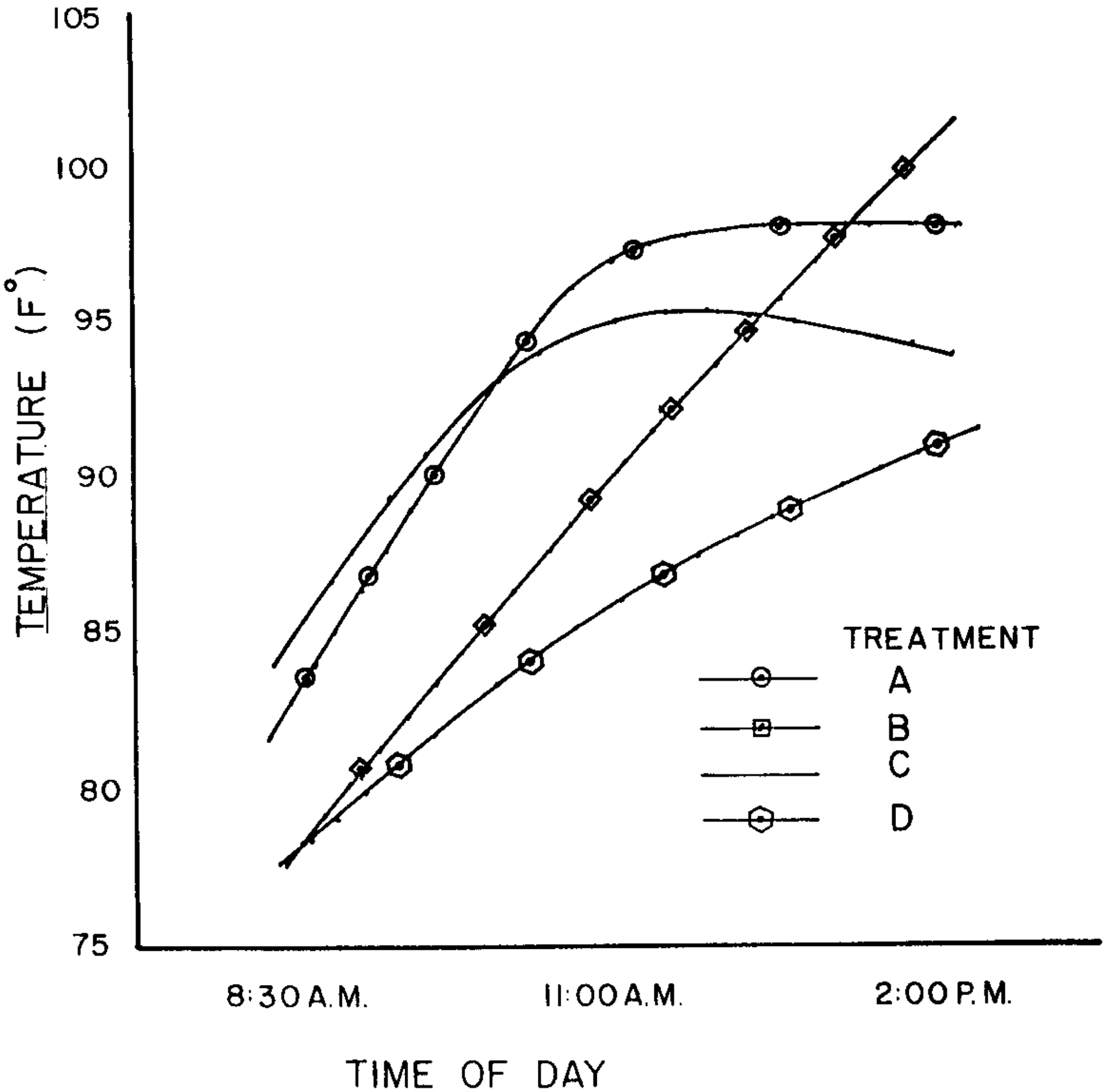

Figure 7. Influence of treatments on canopy temperatures in Chico tomatoes in June, 1969.

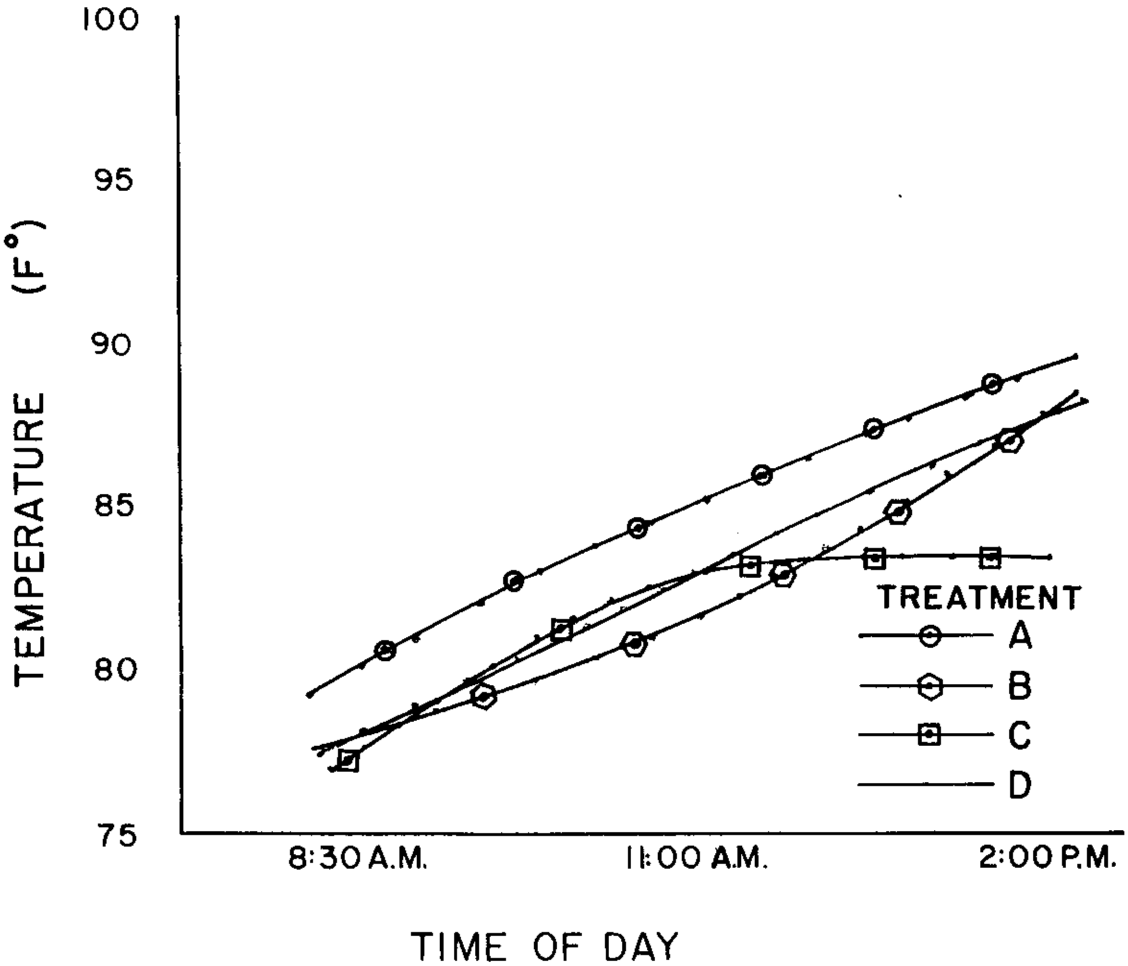

Figure 8. Influence of treatments on leaf temperatures as evaluated with a Barnes radiation thermometer in May, 1969.

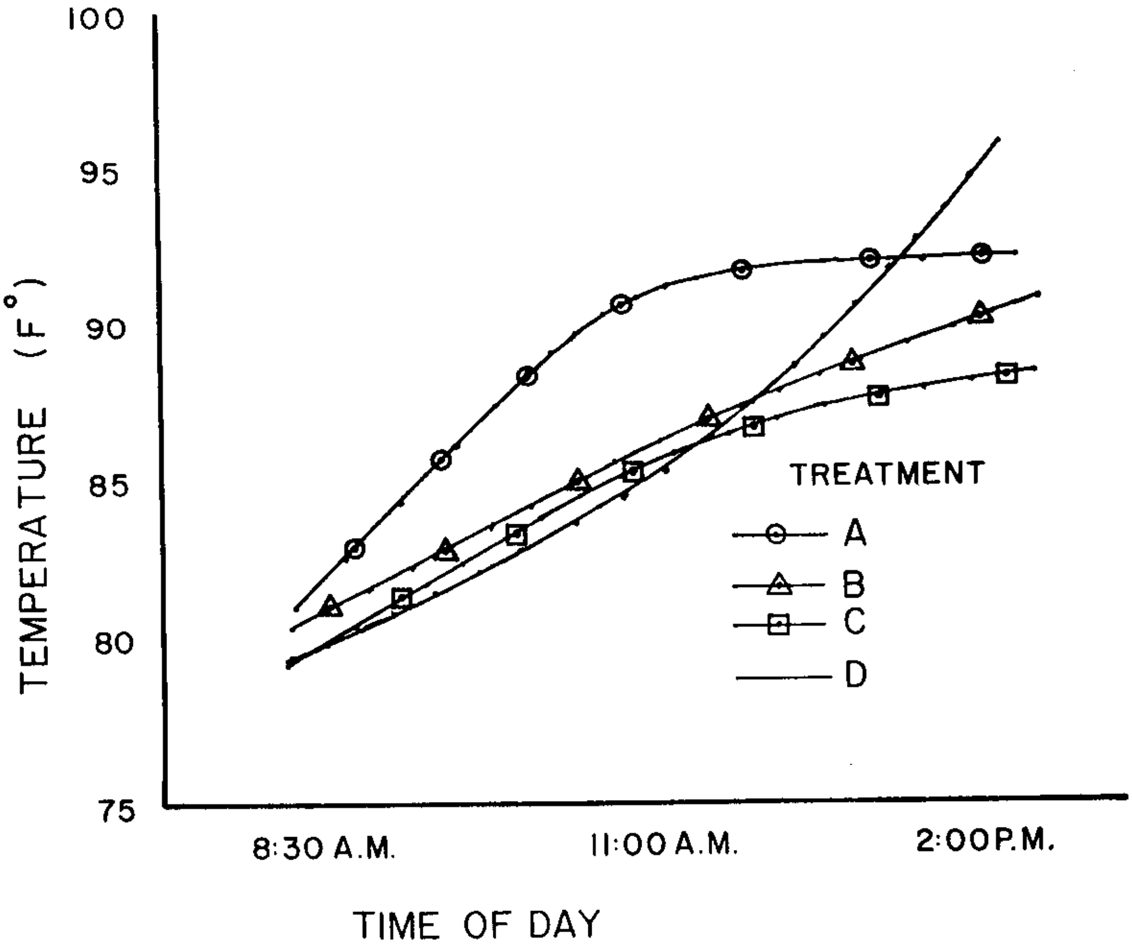

Figure 9. Influence of treatments on leaf temperatures as evaluated with a Barnes radiation thermometer in June, 1969.

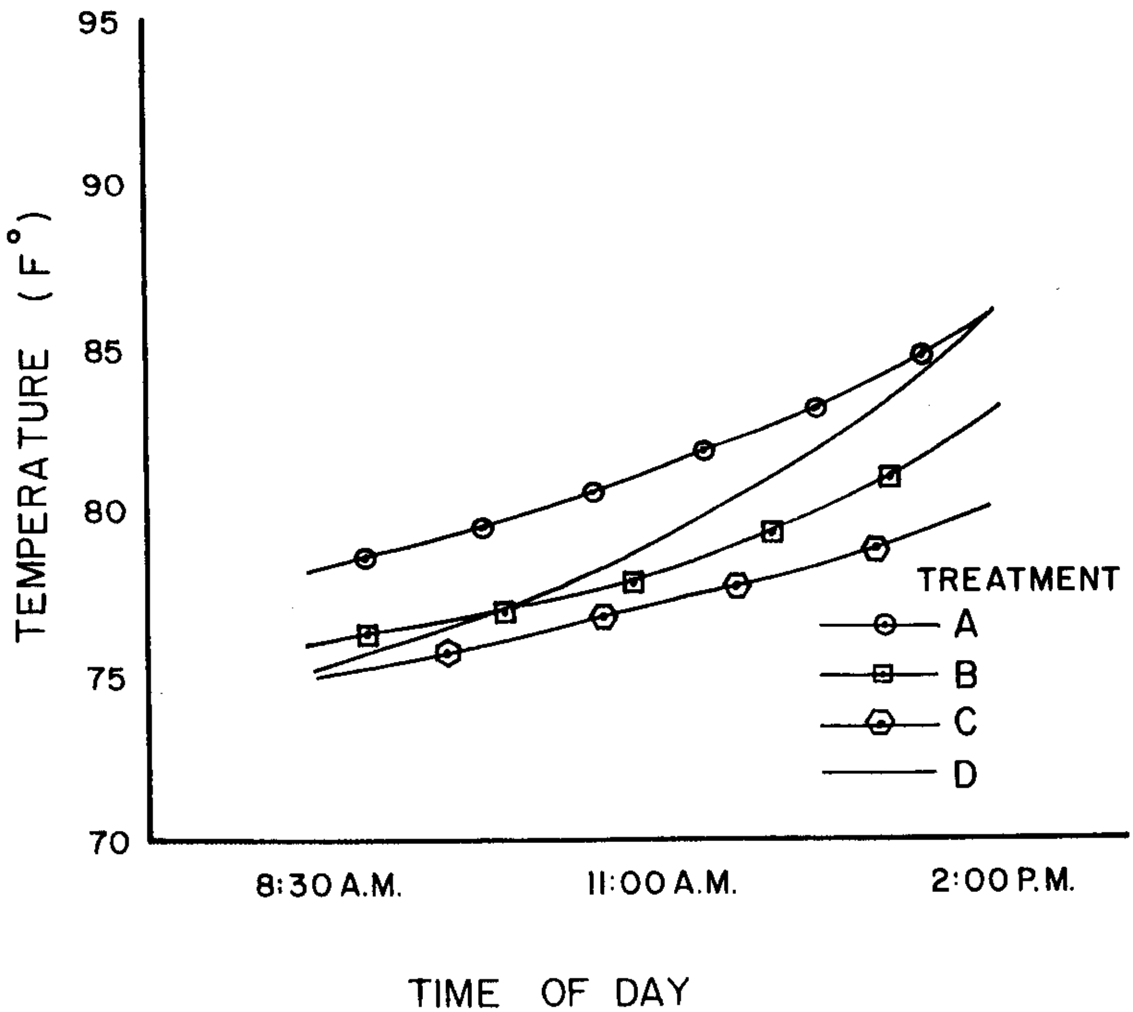

Figure 10. Soil temperatures at 1 inch depth as influenced by treatments in May, 1969.

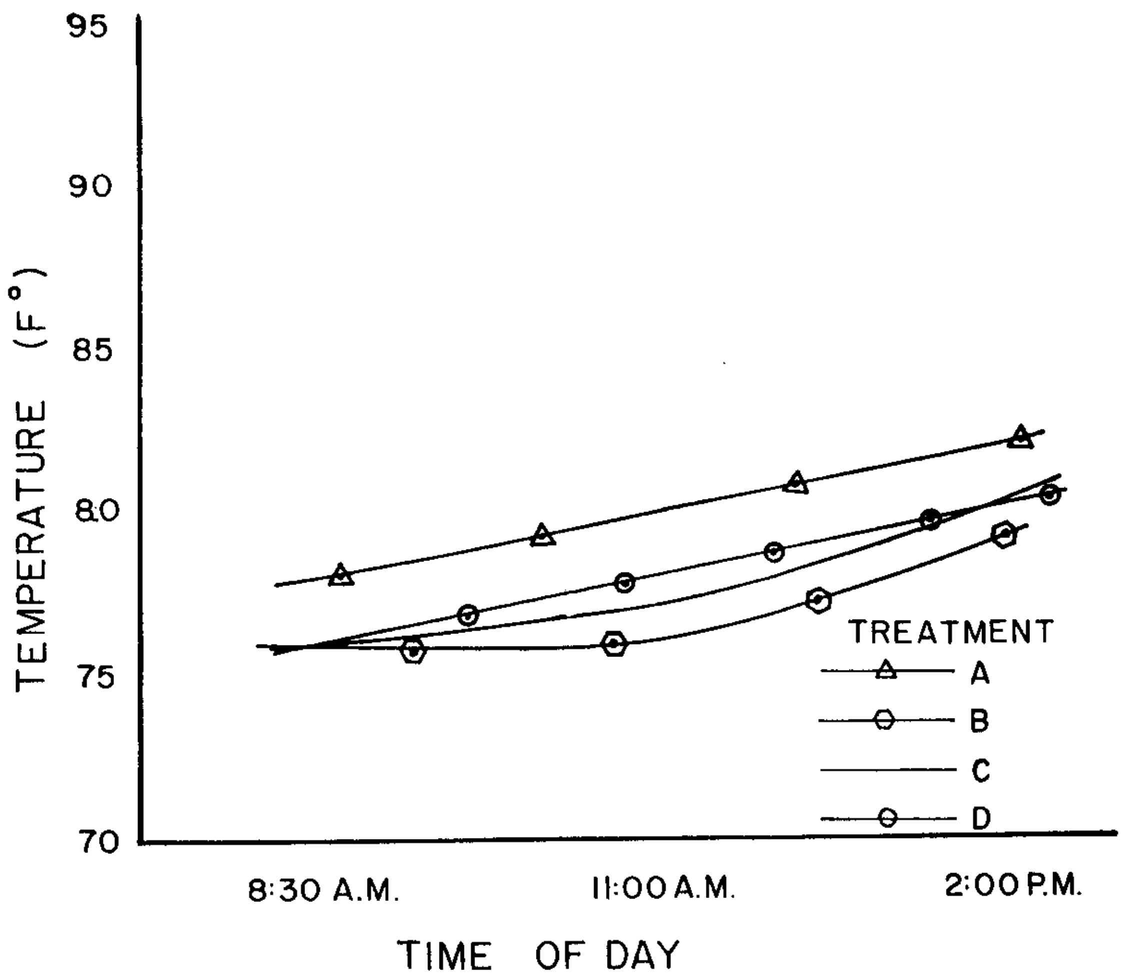

Figure 11. Soil temperatures at 3 inch depth as influenced by treatments in May, 1969.

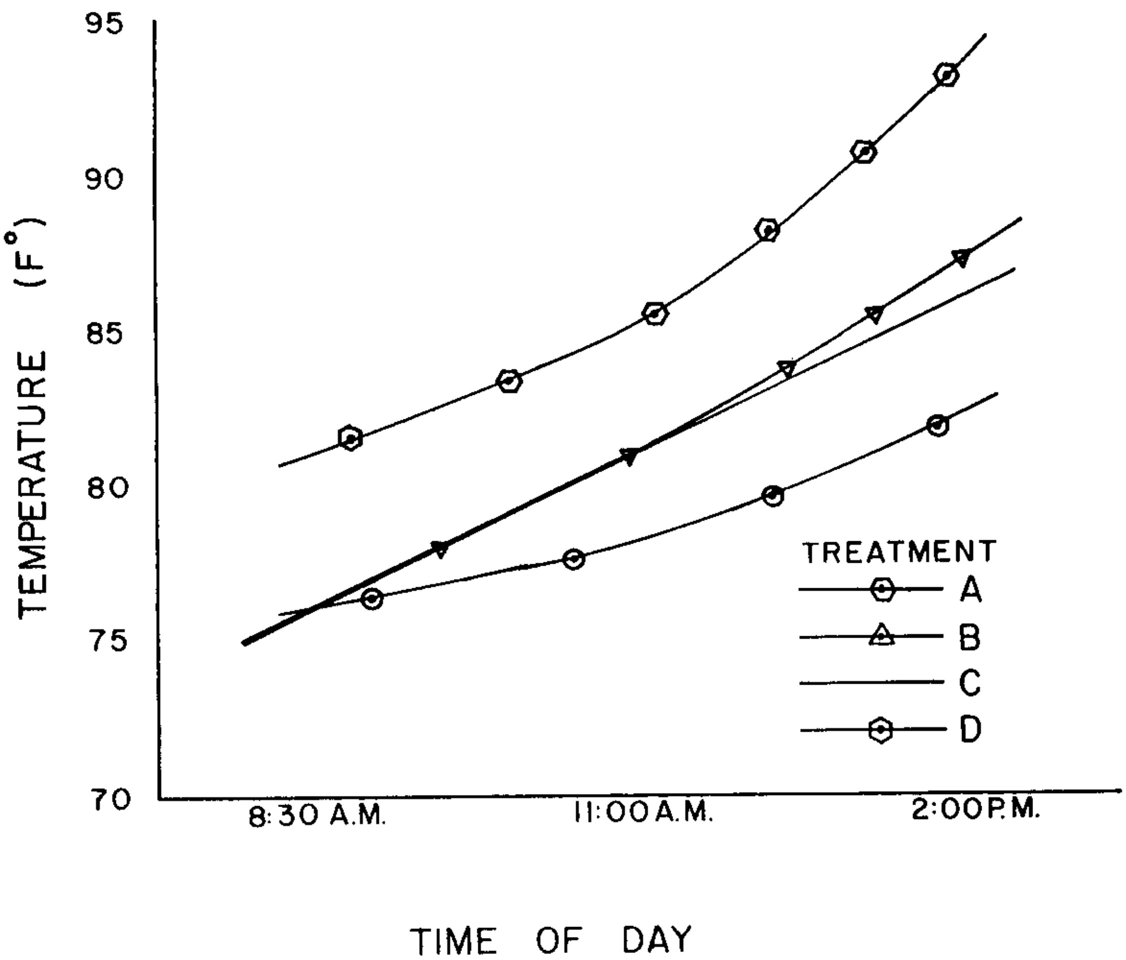

Figure 12. Soil temperatures at 1 inch depth as influenced by treatments in June, 1969.

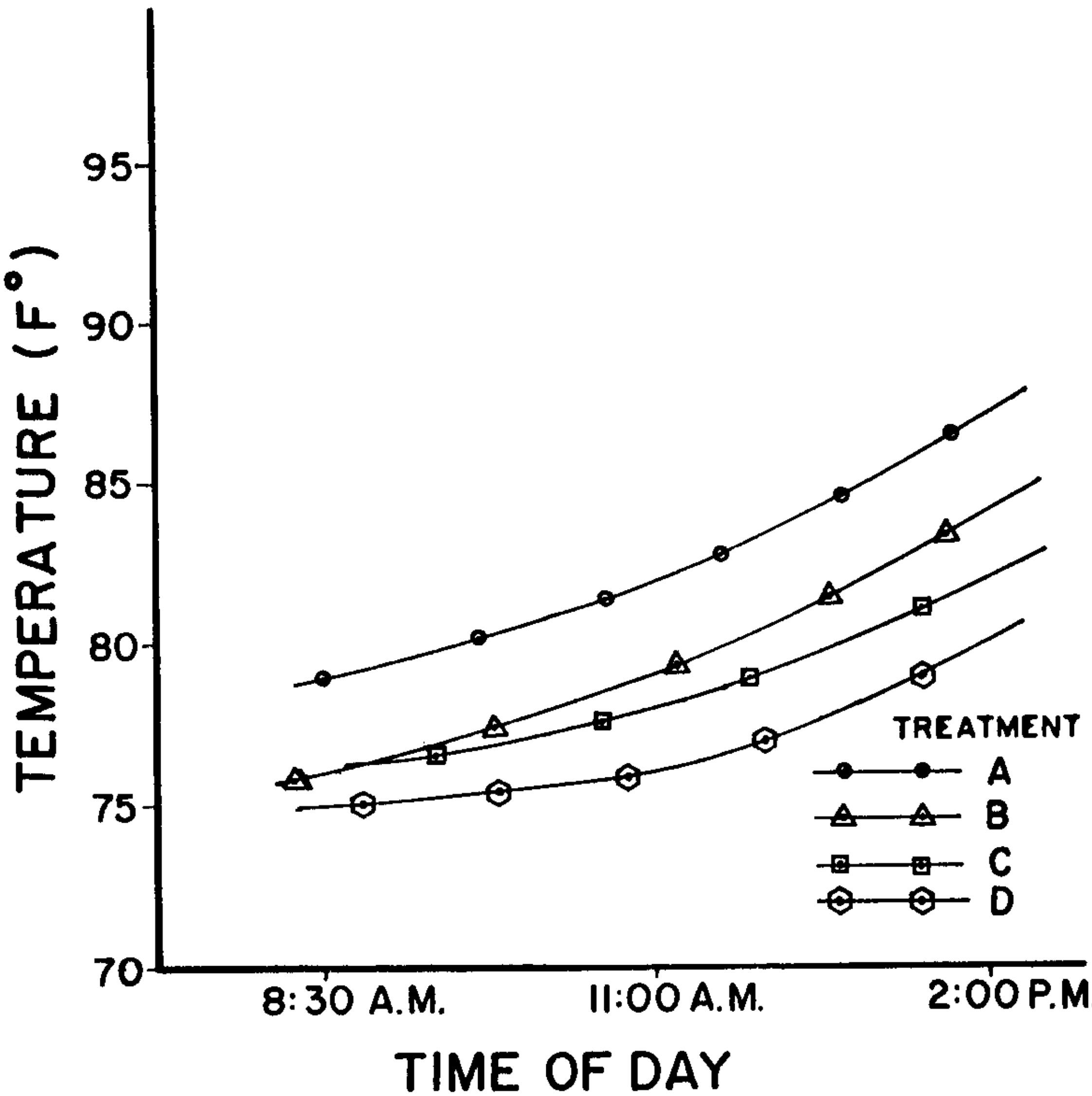

Figure 13. Soil temperatures at 3 inch depth as influenced by treatments in June, 1969.

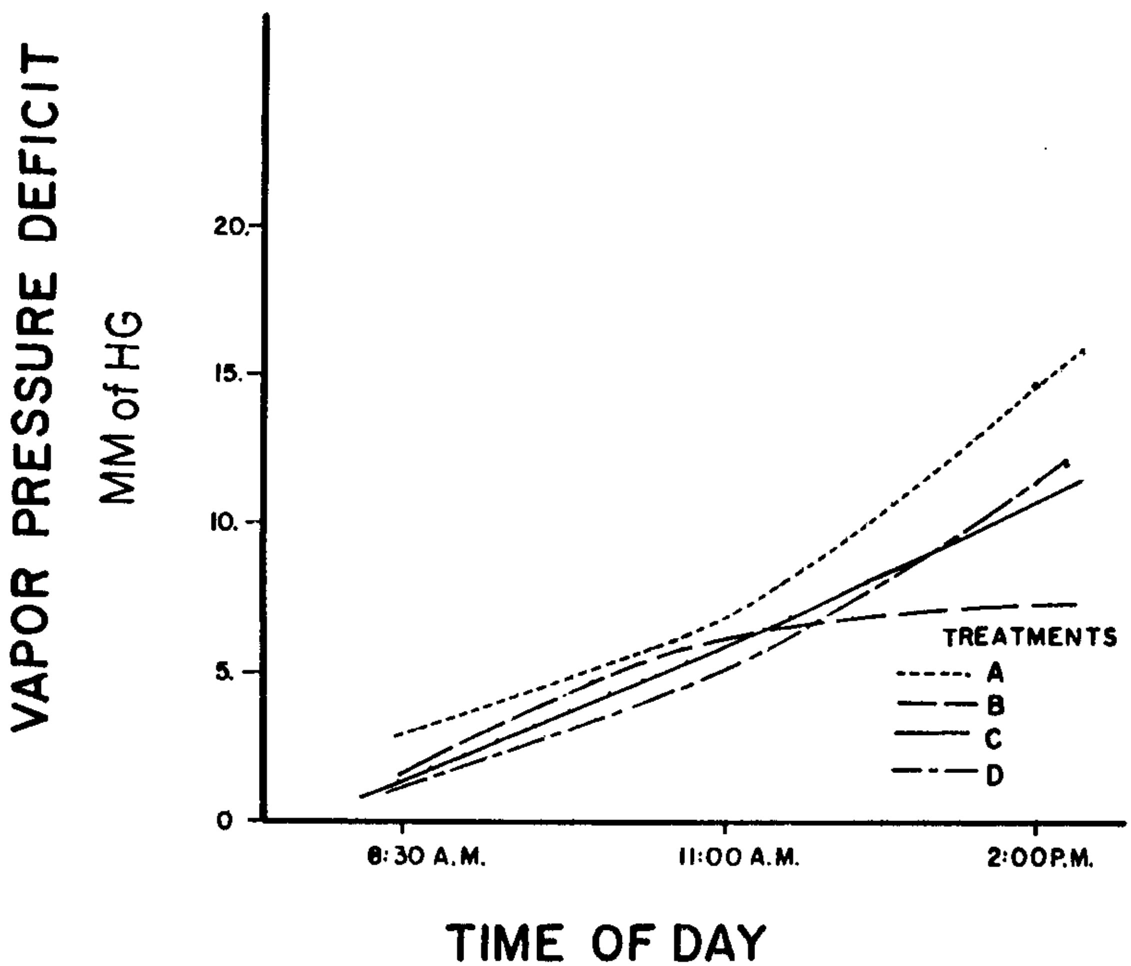

Figure 14. Influence of treatments on vapor pressure deficit in plant canopy in May, 1969.

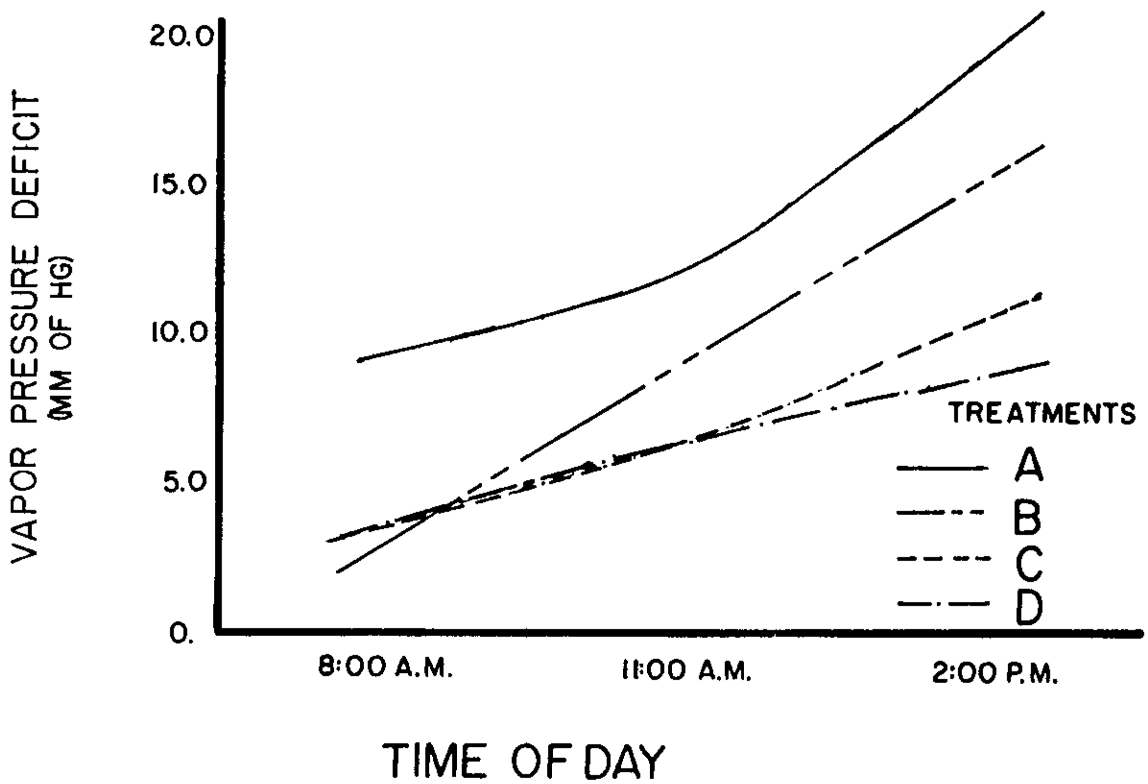

Figure 15. Influence of treatments on vapor pressure deficit in plant canopy in June, 1969.

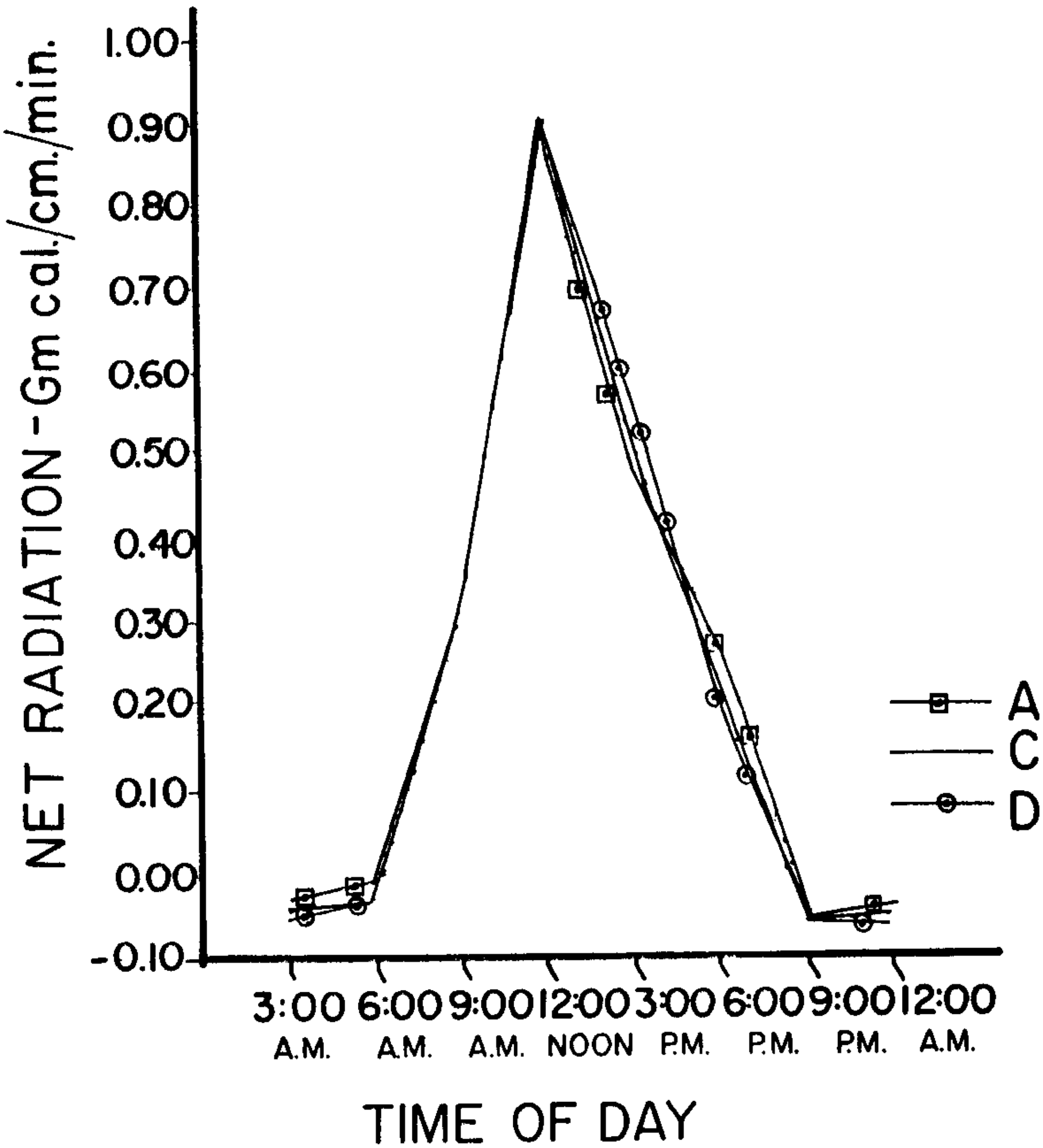

Figure 16. Influence of certain treatments on absorption of net radiation in May, 1969.

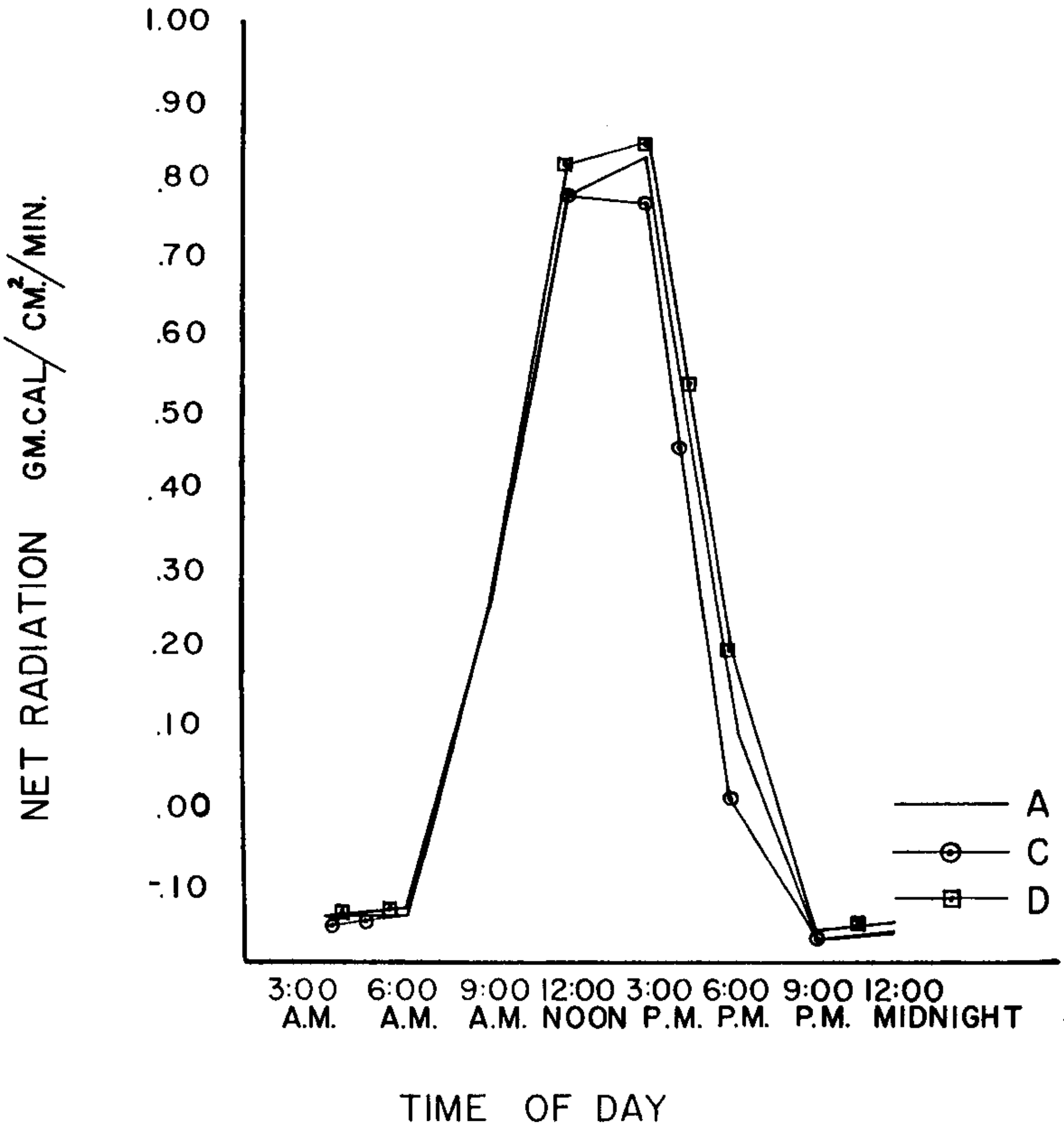

Figure 17. Influence of certain treatments on absorption of net radiation in June, 1969.

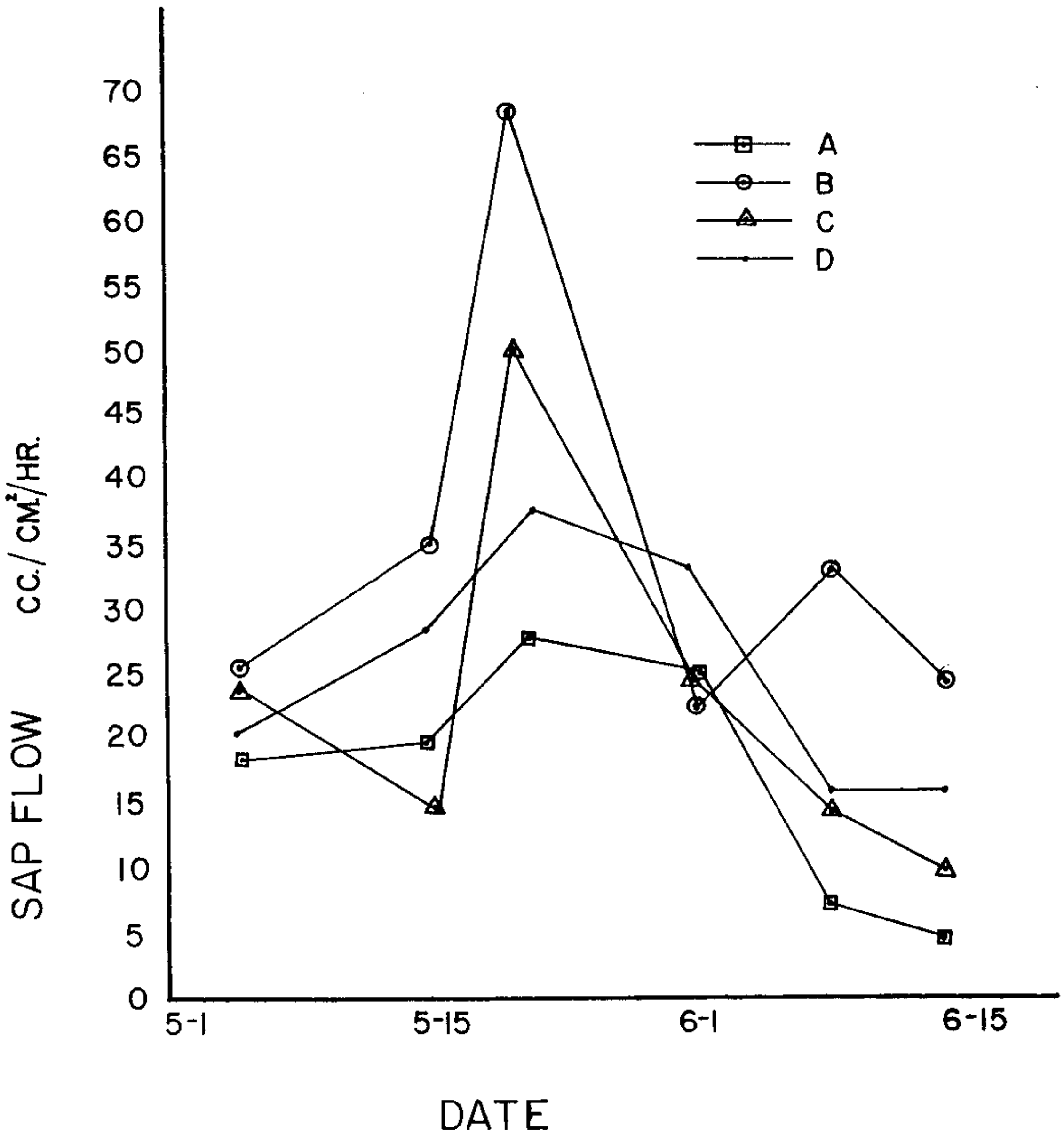

Figure 18. Influence of treatment on sap flow in tomatoes in 1969 as evaluated with thermoelectric method.

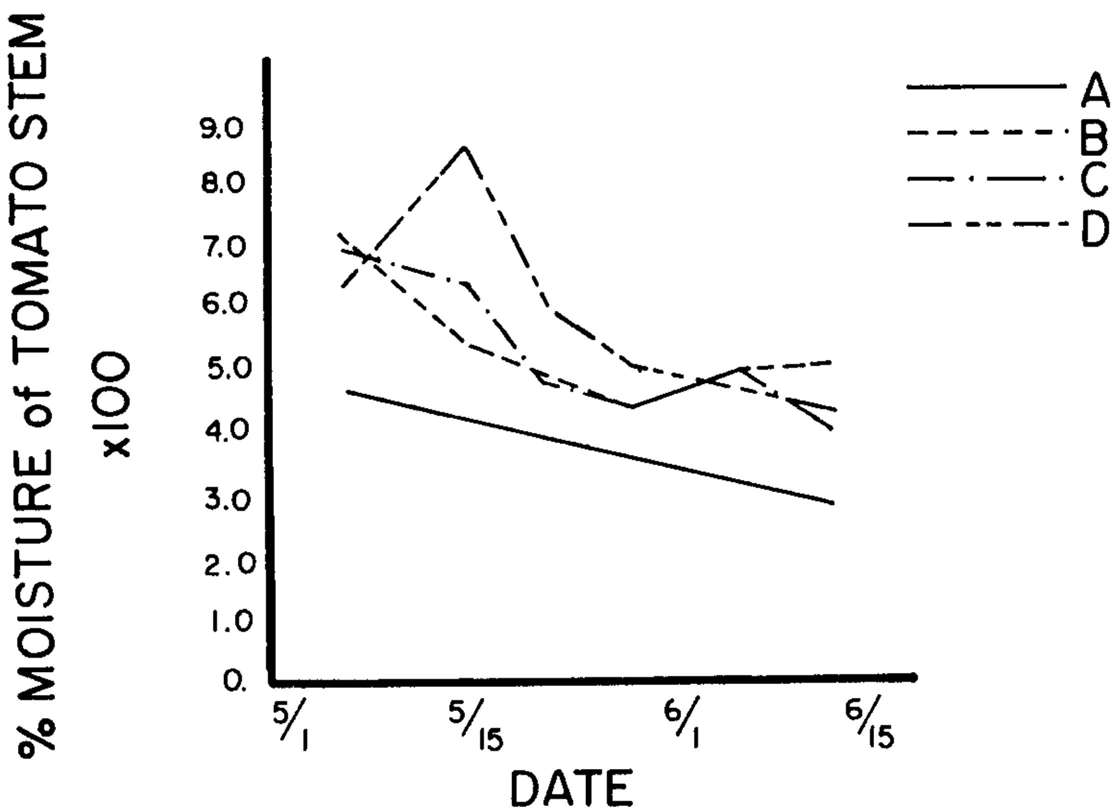

Figure 19. The influence of treatments on moisture content of tomato stems in 1969.

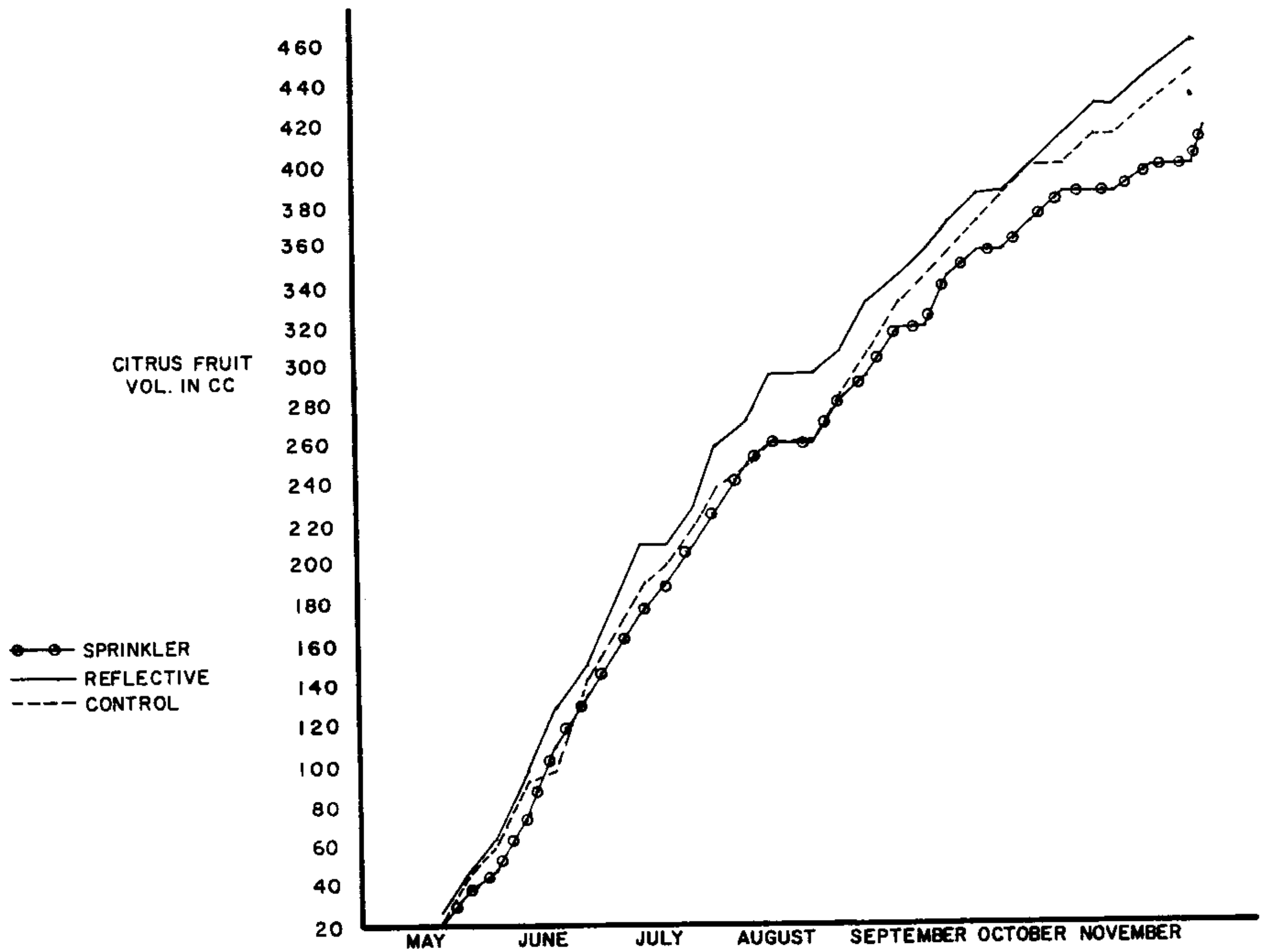

Figure 20. Influence of treatments on citrus fruit volume changes during growing season in 1968.

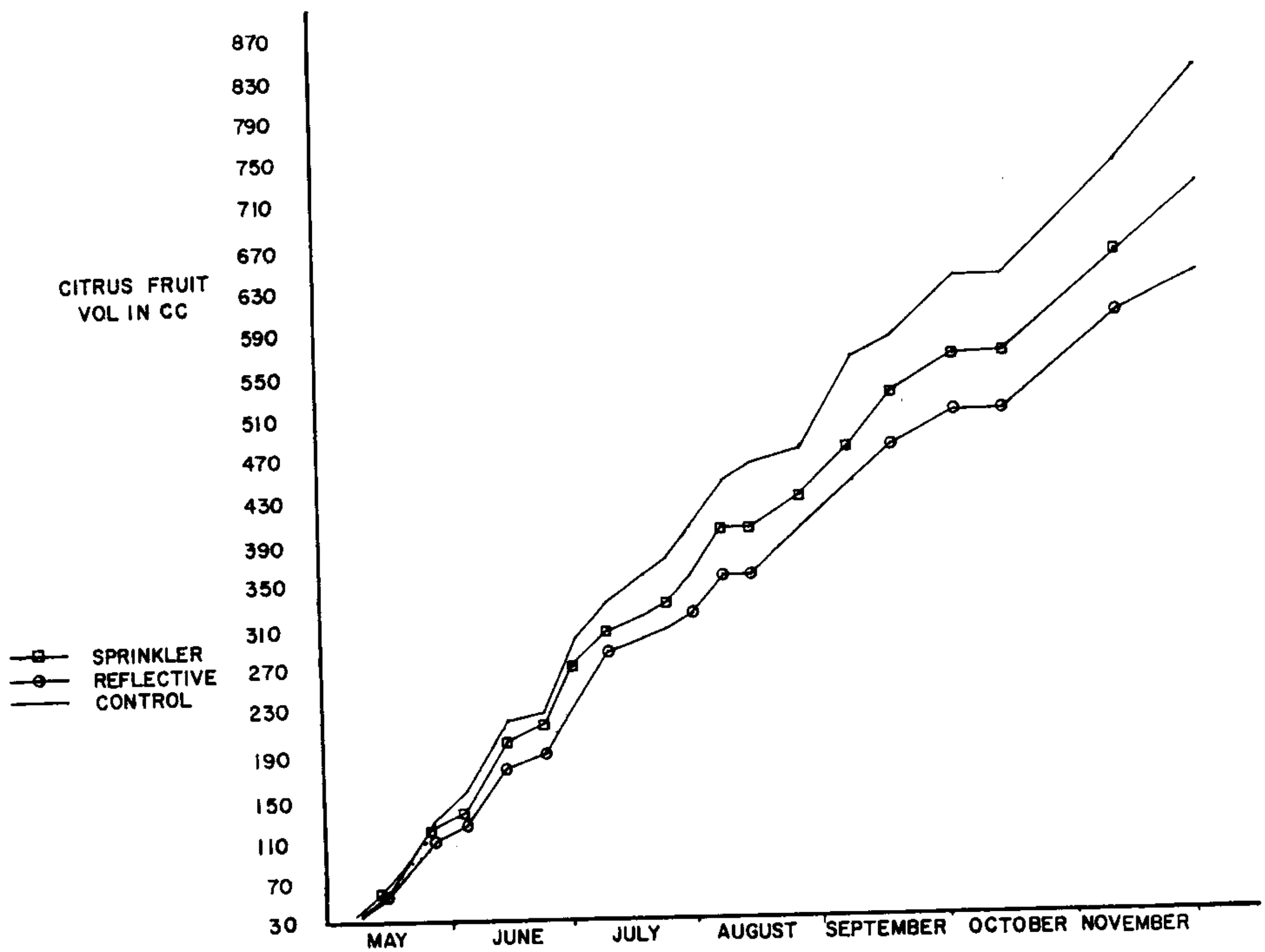

Figure 21. Influence of treatments on citrus fruit volume changes during growing season in 1969.

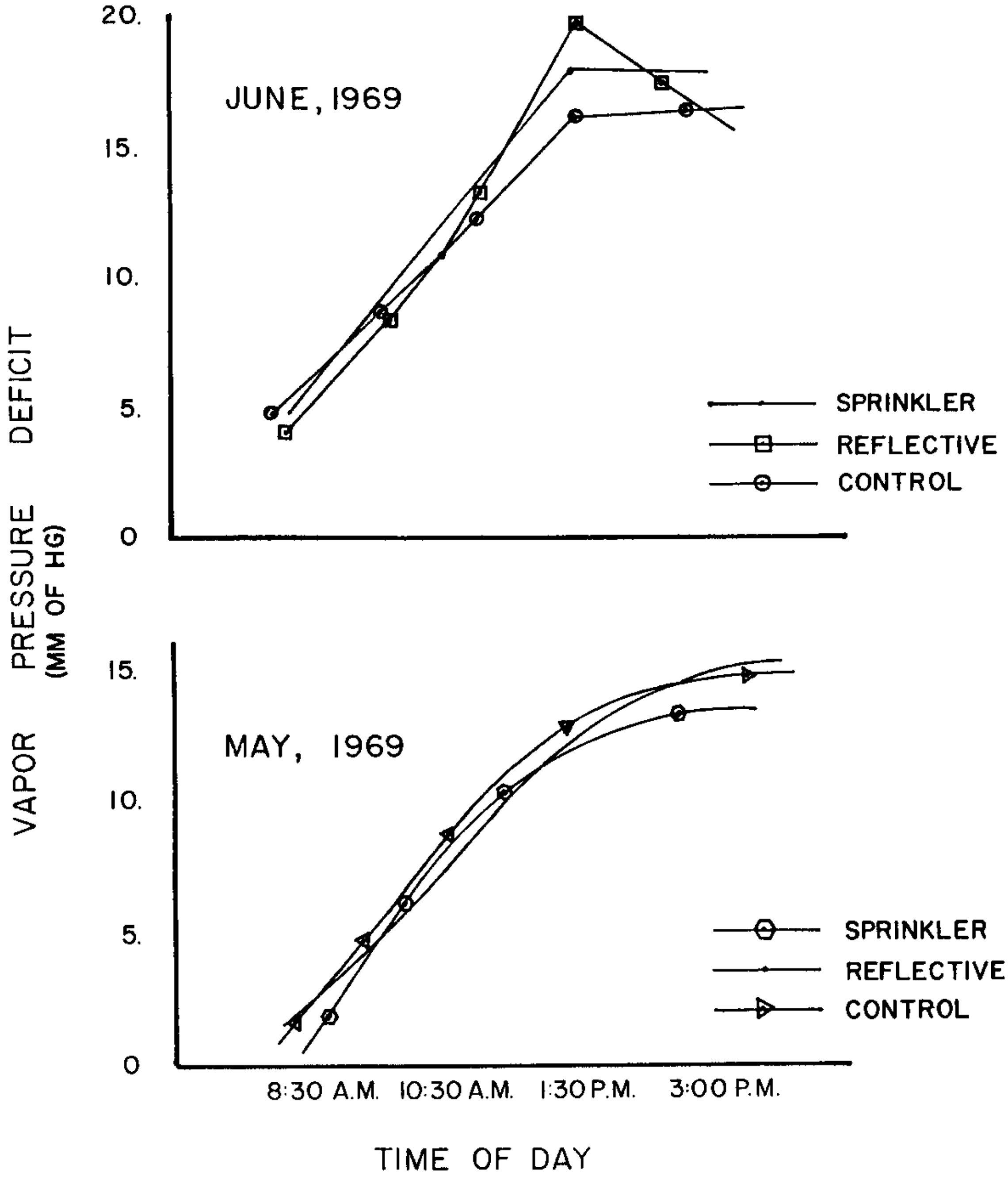

Figure 22. Vapor pressure deficits in citrus grove as influenced by treatments in May and June, 1969.

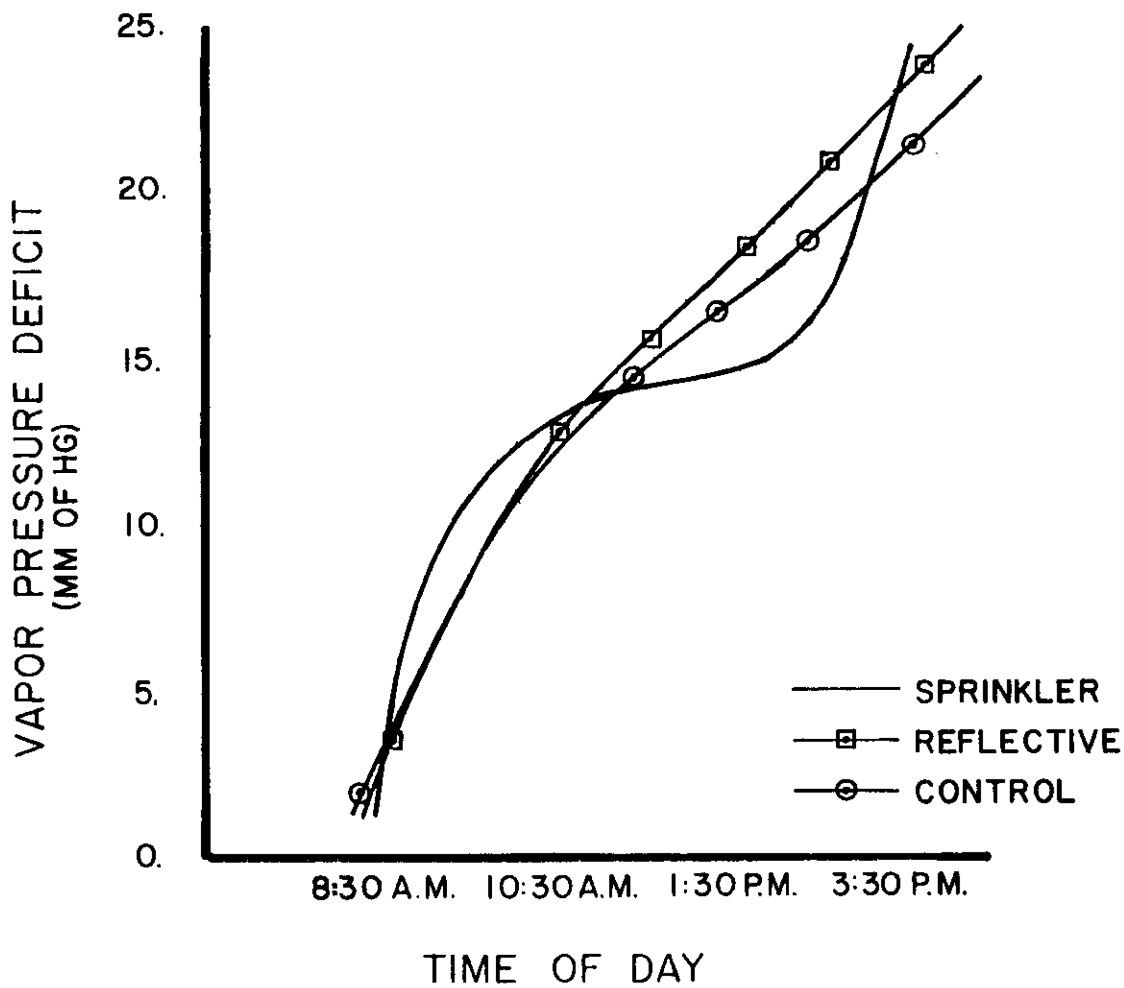

Figure 23. Vapor pressure deficits in citrus grove as influenced by treatments in July, 1969.

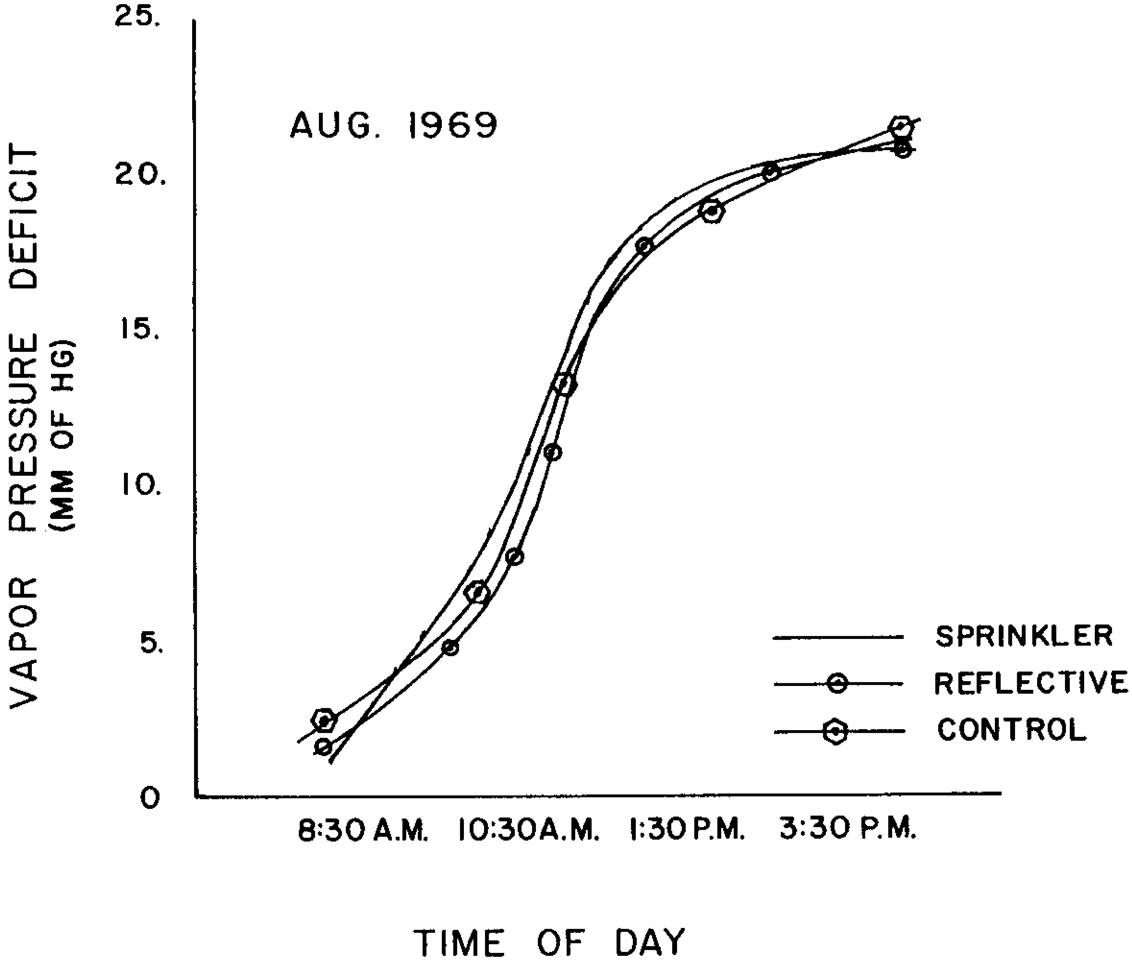

Figure 24. Vapor pressure deficits in citrus grove as influenced by treatments in August, 1969.

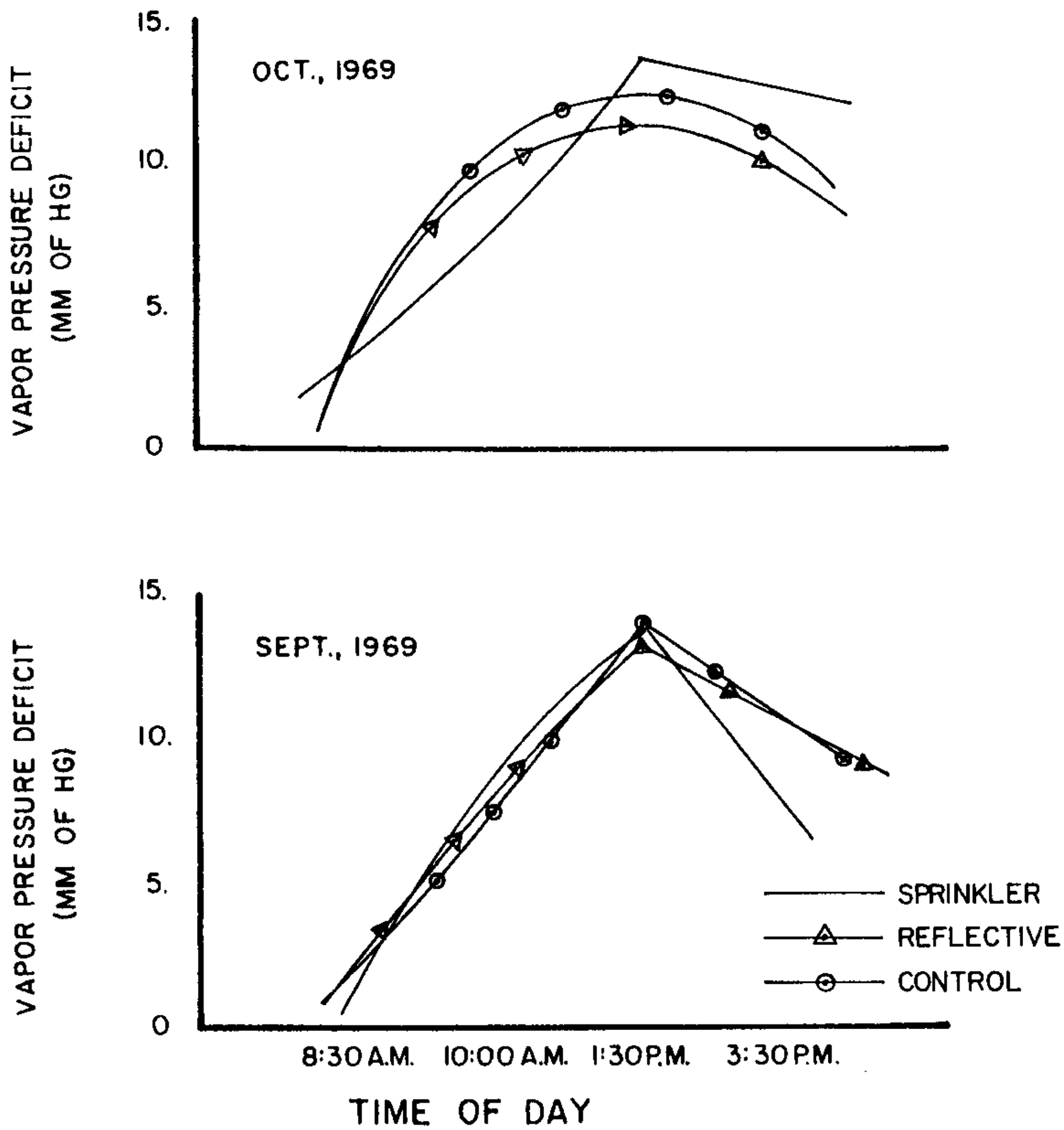

Figure 25. Vapor pressure deficits in citrus grove as influenced by treatments in September and October, 1969.

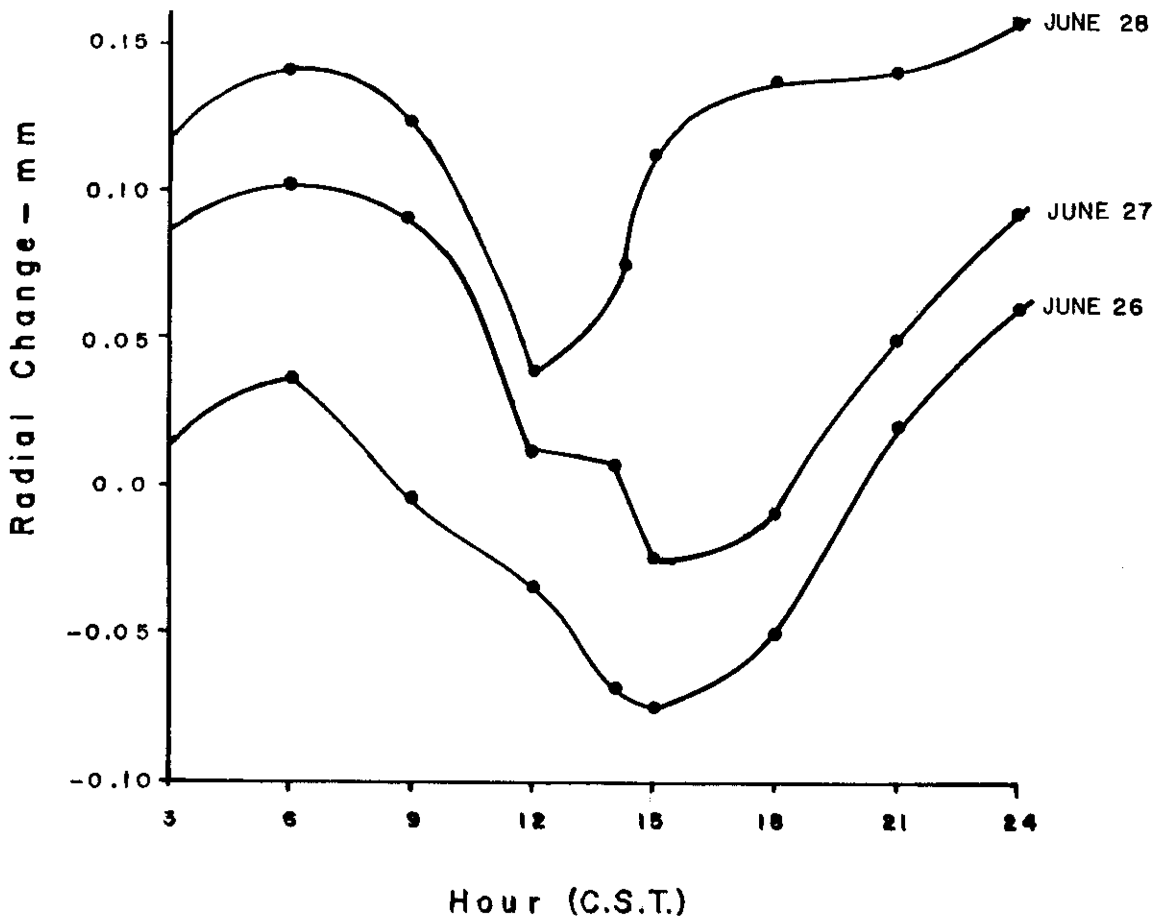

Figure 26. Radial changes in citrus tree trunk during days of June 26, June 27, and June 28.

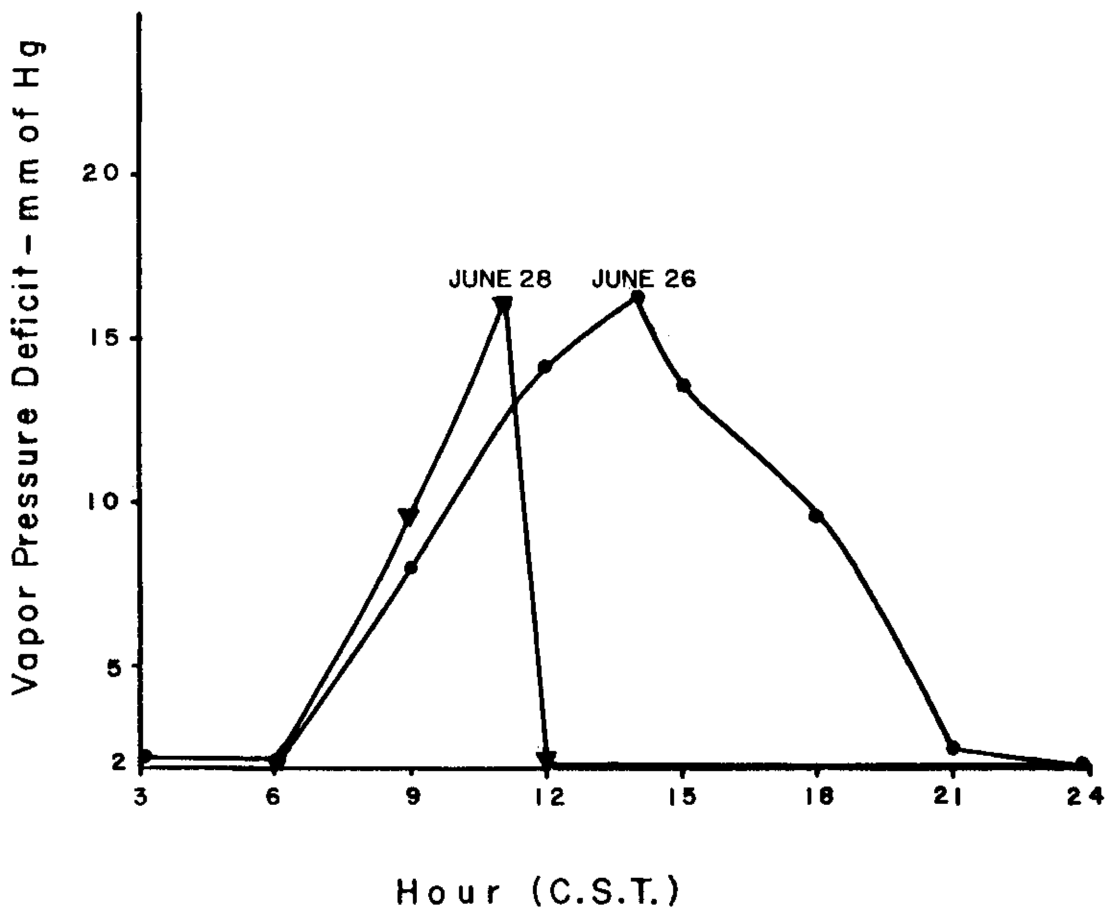

Figure 27. Vapor pressure conditions on June 26 and June 28.

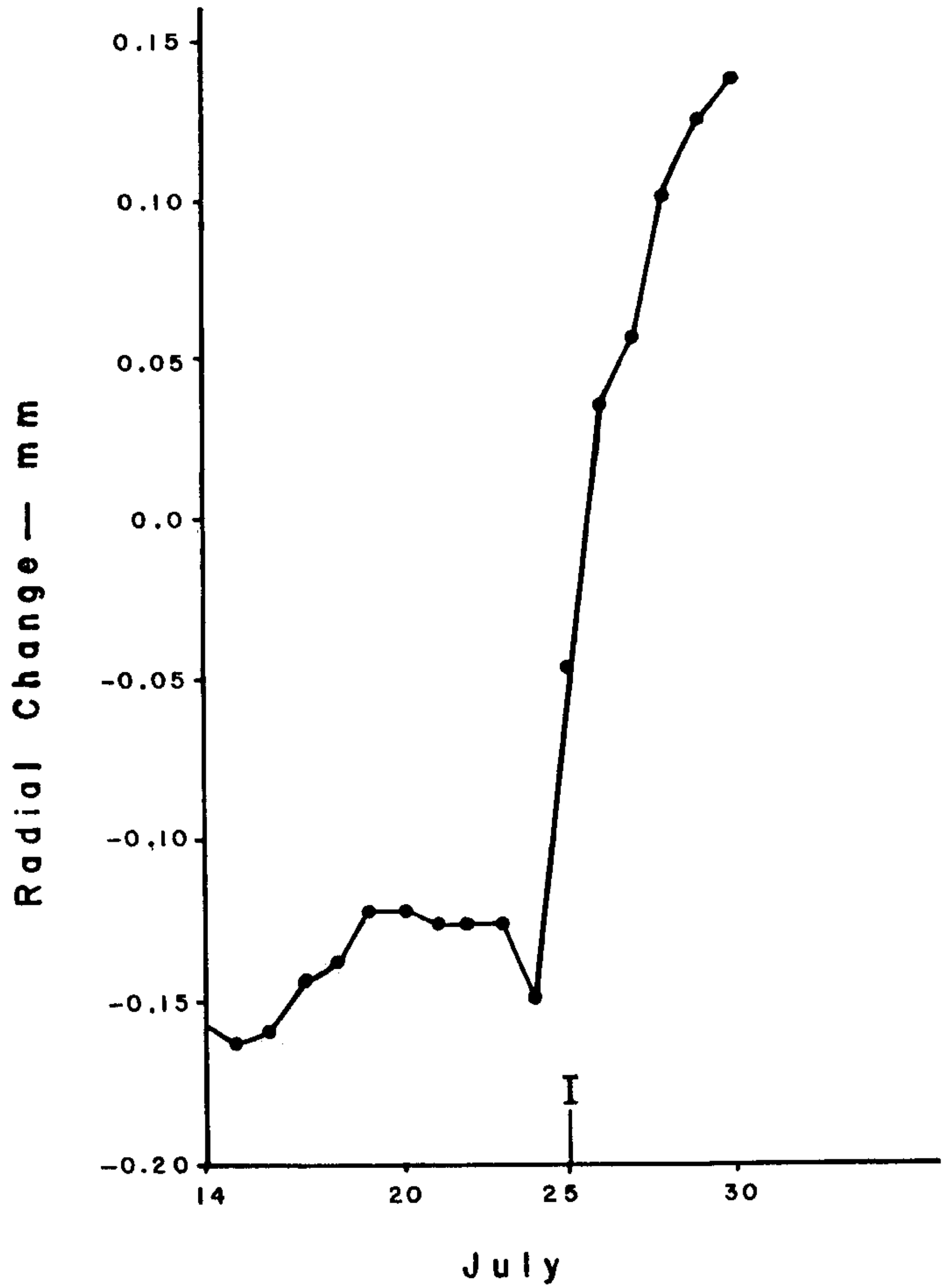

Figure 28. Maximum daily radial contraction of citrus tree trunk prior to and following an irrigation (I) in July, 1969.

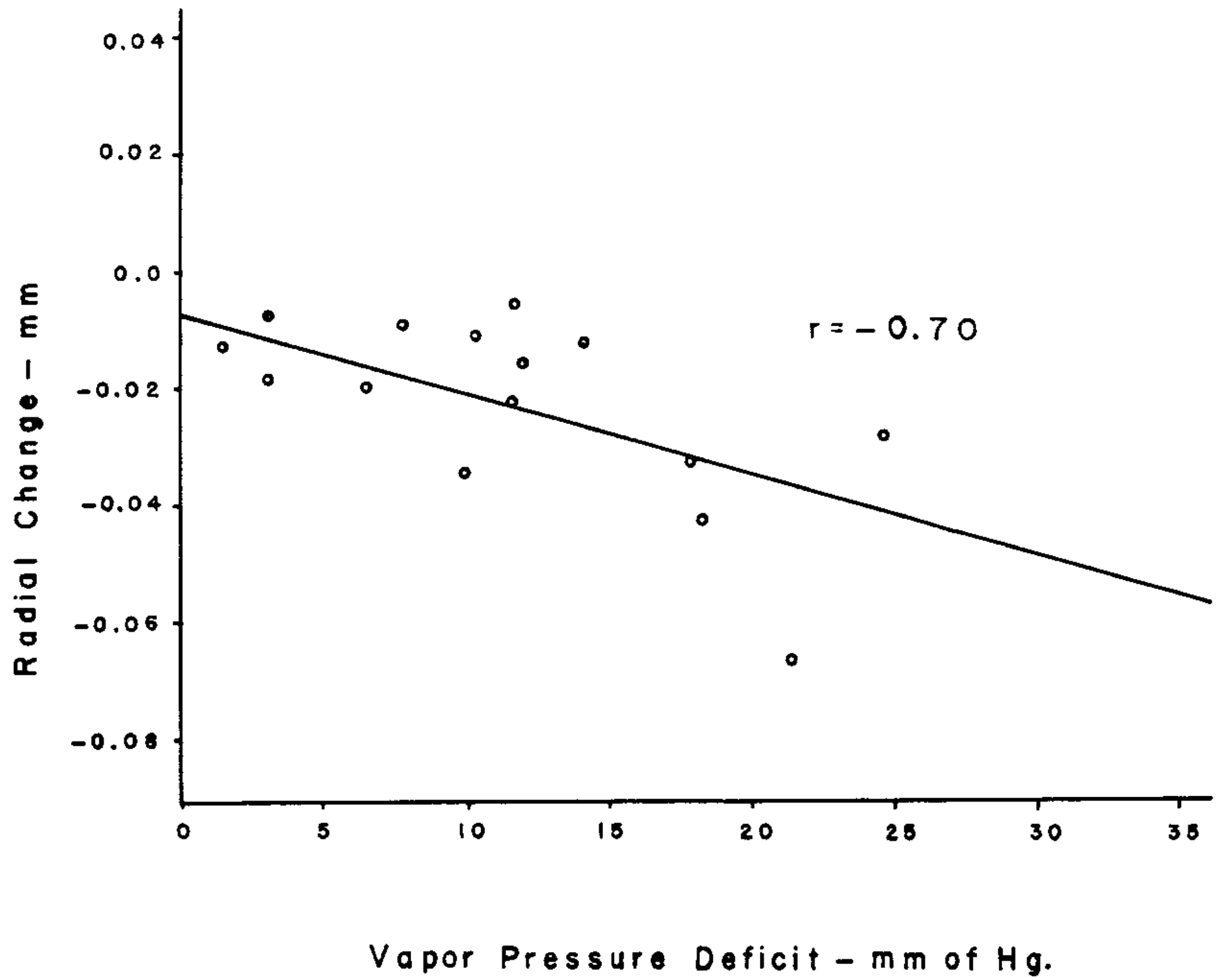

Figure 29. Relationship between climatic stress and daily radial changes in citrus fruit in August and September, 1969 (Control treatment).

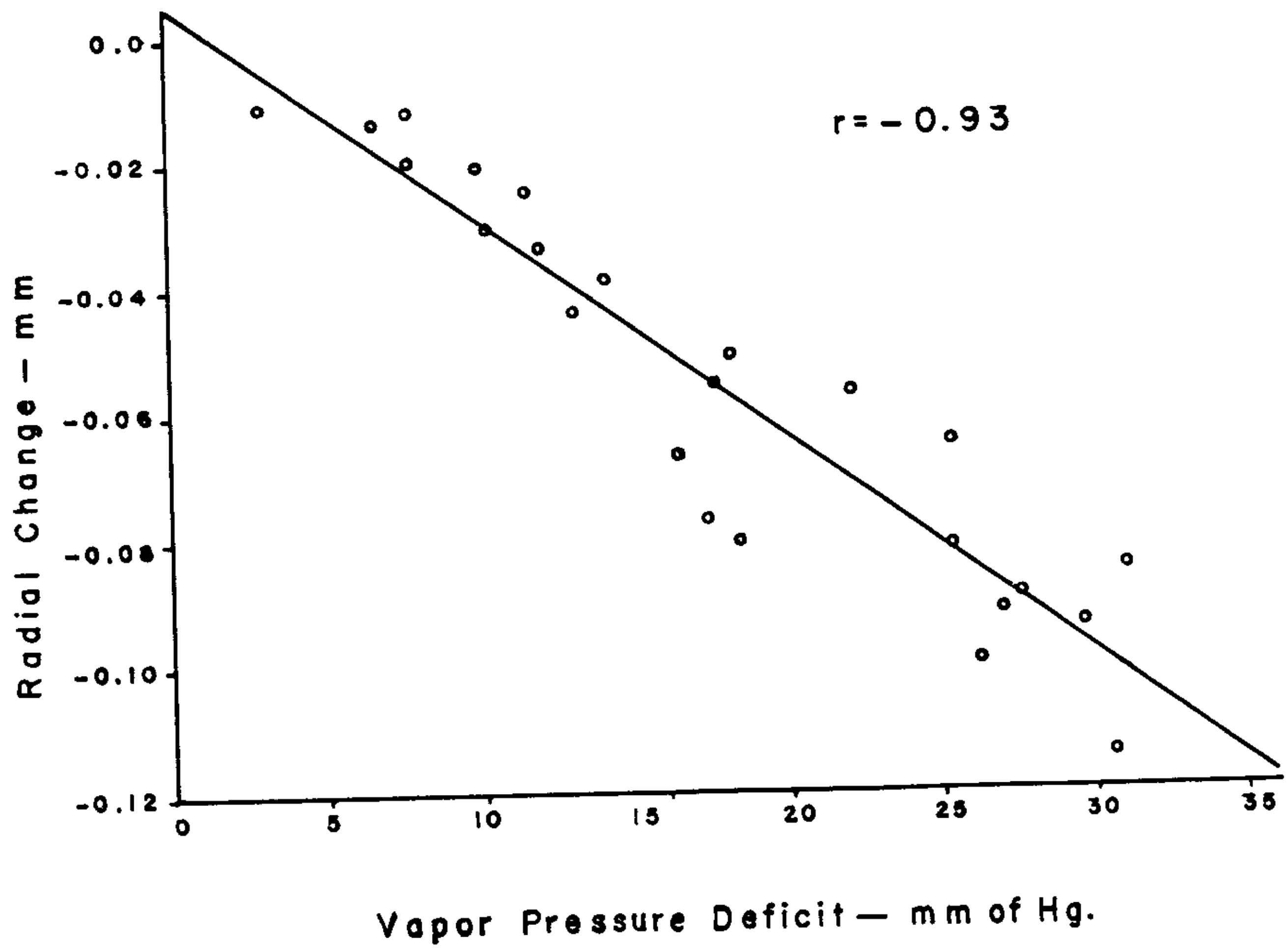

Figure 30. Relationship between climatic stress and daily radial changes in citrus fruits in August and September, 1969 (Sprinkler treatment).

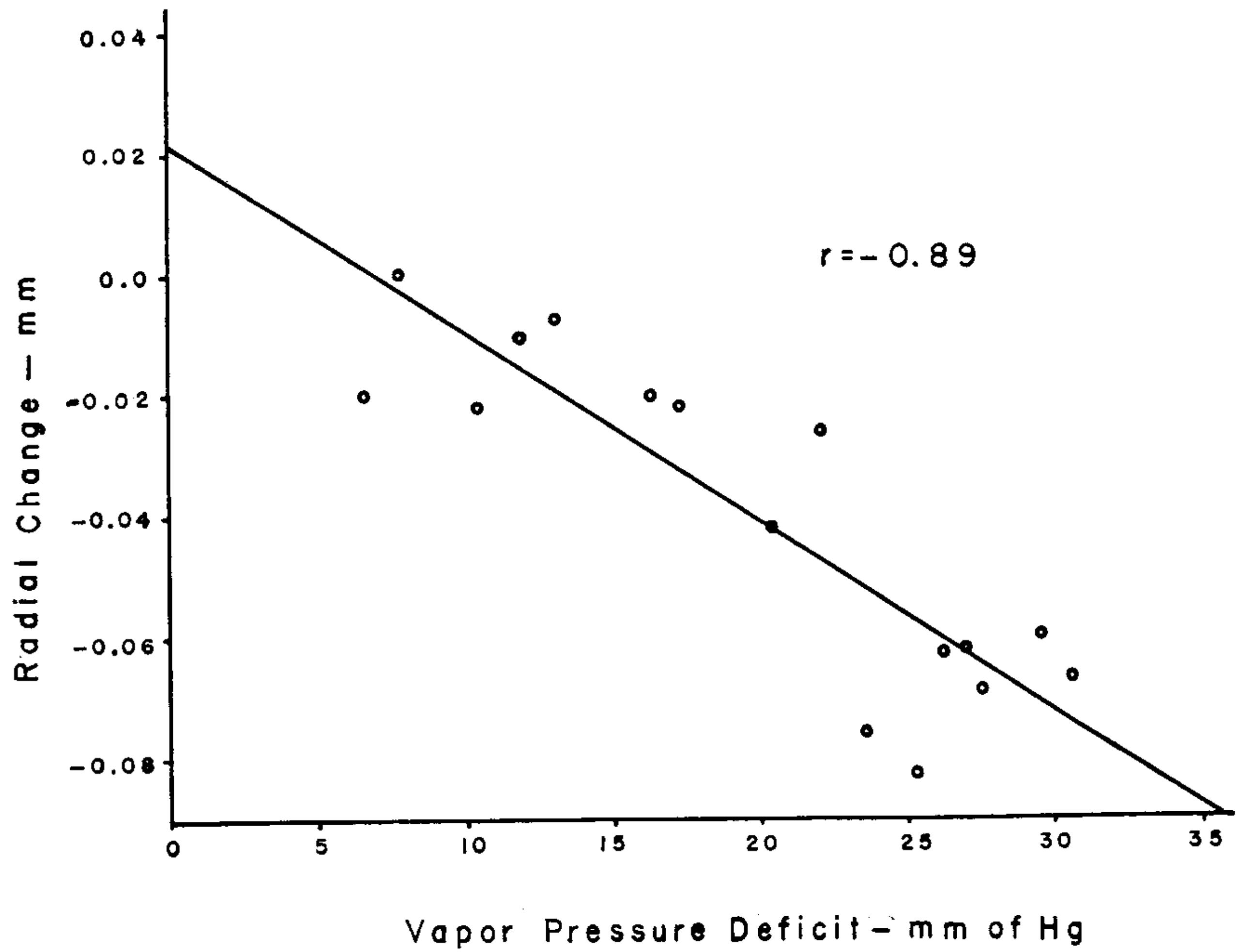

Figure 31. Relationship between climatic stress and daily radial changes in citrus fruits in August, 1969 (Trees sprayed with white acrylic paint).

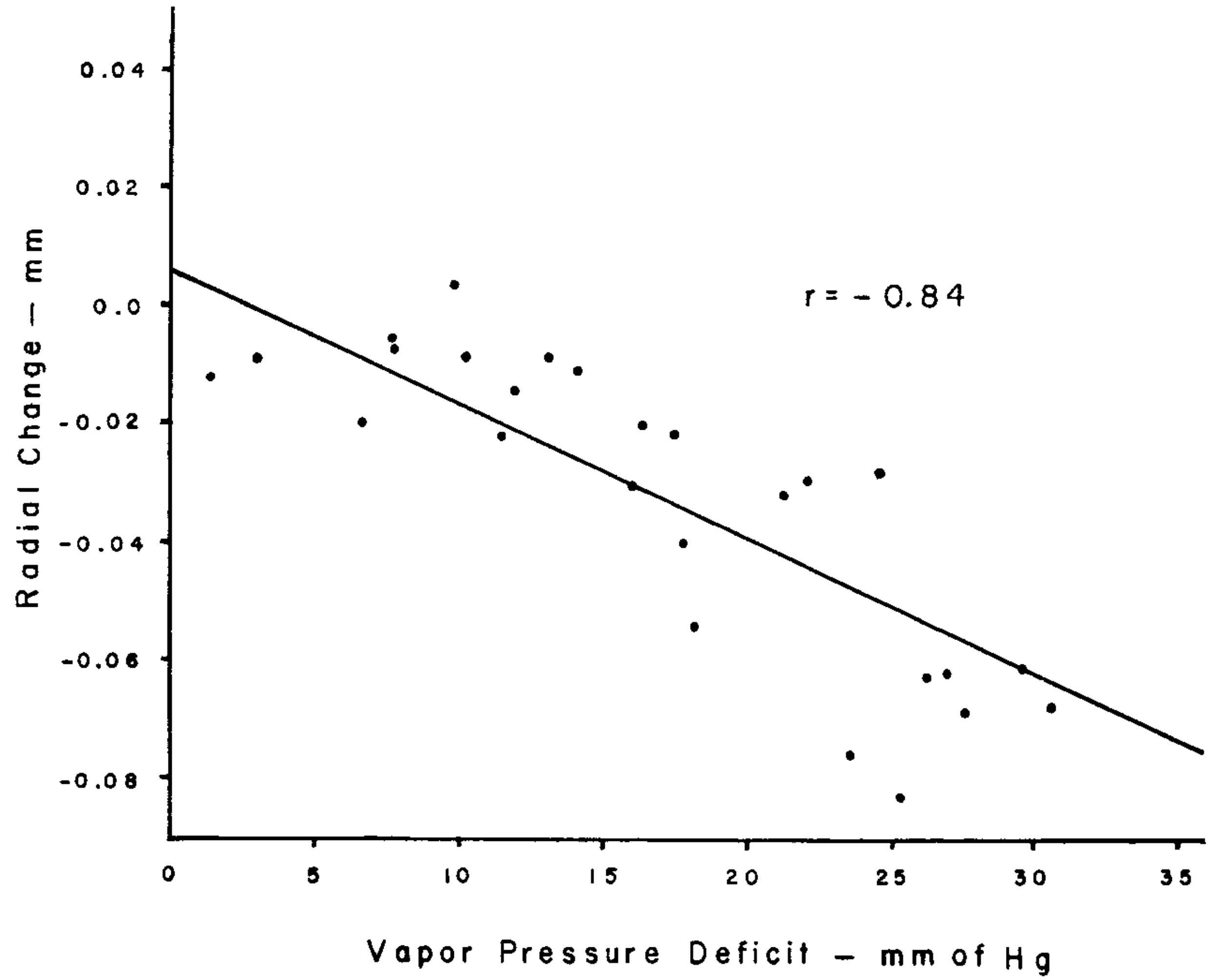

Figure 32. Relationship between climatic stress and maximum daily fruit shrinkage in August and September, 1969 (Fruits from trees on control and white reflective treatments).

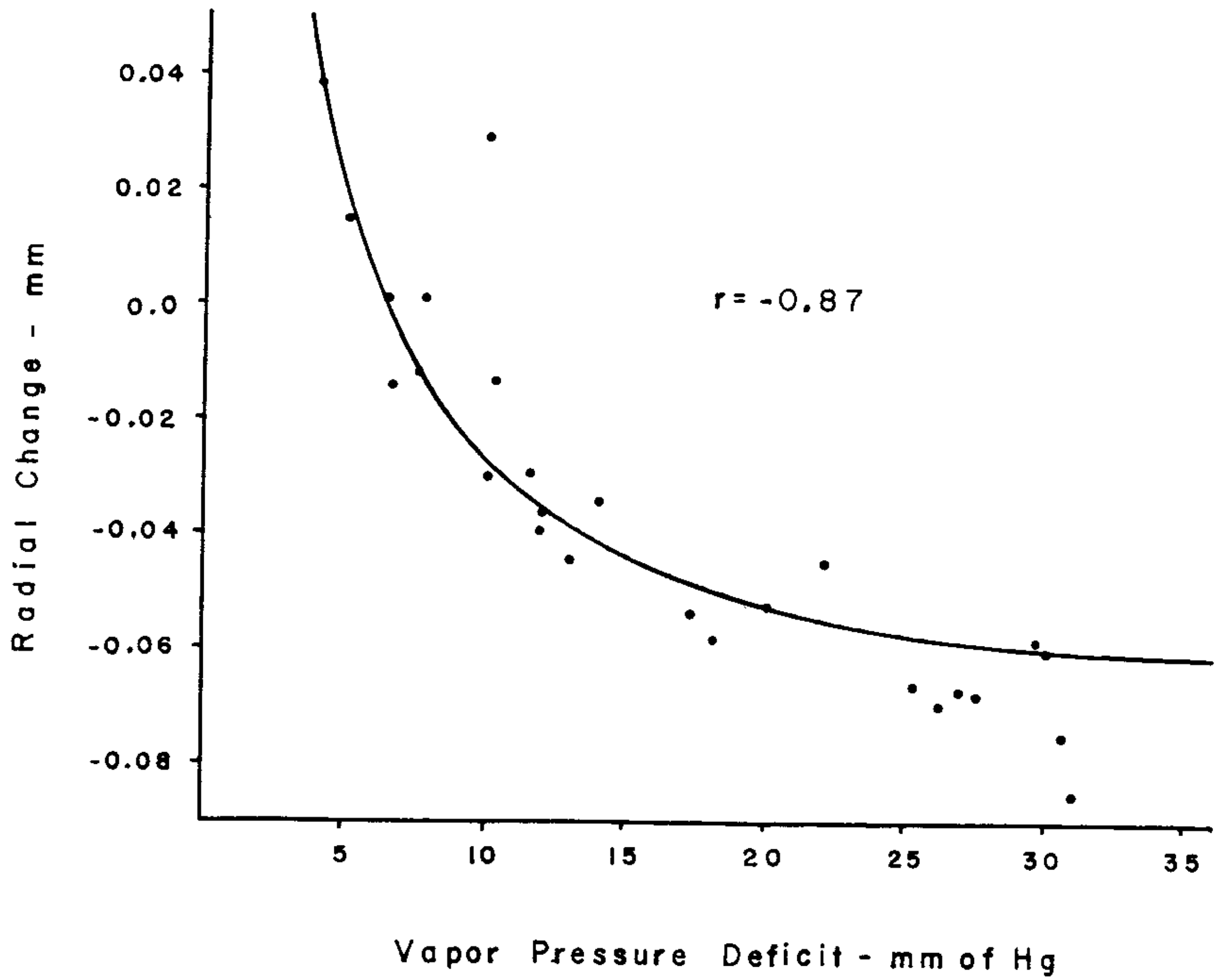

Figure 33. Relationship between climatic stress and maximum daily fruit shrinkage in August and September, 1969 (Sprinkler treatment).