WATER-USE RATES OF IRRIGATED PECAN TREES IN OKLAHOMA

By

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WATER-USE RATES OF IRRIGATED PECAN

TREES IN OKLAHOMA

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This study is concerned with the water-use rates of irrigated pecan trees in Oklahoma. The main objectives are to determine the water-use rate of the pecan trees and the effects of second year irrigation on nut characteristics, nut yield and leaf mineral concentrations. A soil analysis was also performed to determine field capacity, permanent wilting point, available water and textural classification of the soils at different locations and depths in the test area.

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TABLE OF CONTENTS

LIST OF TABLES

Table		Page
XVII.	Comparison Between 1983 and 1984 Average Pecan Crop Yields.	71
XVIII.	Nut Characteristics of 20-Nut Samples.	73
XIX.	Elemental Concentrations of the Leaf Samples . .	74
XX.	Soil Characteristics of Various Test Plots . . .	76
XXI.	Soil Textural Classes of Various Test Plots. . .	77
XXII.	Soil Properties Classified By Soil Textures. . .	80
XXIII.	Equivalent Depths of Water for Soil Characteristics of Various Test Plots.	81

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Relevance of the Research

Pecan trees are native to Oklahoma and as the commercial value of pecans increases, more cultivars have been developed and distributed throughout the area. Presently, Oklahoma ranks as the fifth state in production of pecans, following Georgia, Texas, Alabama and Louisiana. The average annual production of pecans in Oklahoma is 6.8 to 7.3 million kg (15 to 16 million lb) per year (Table I). Oklahoma now has 68,400 hectares (169,000 acres) of native pecans, which is 20.1% of the total in the U.S., and 4850 hectares (12,000 acres) of cultivars, which is 2.1% of the U.S. total (Thompson, 1984).

One of the limiting factors in production has been water. Survival of young trees is reduced, and growth and production of established trees are limited by water stress almost every year. Rainfall in Oklahoma is usually not distributed evenly throughout the growing season. Instead there are short drought periods in early and midsummer with periods of heavy rain in late summer and fall. Table II shows the monthly rainfall distribution over the last five years at the Pecan Research Station at Sparks, Oklahoma.

TABLE I

OKLAHOMA PECAN PRODUCTION IN THOUSAND POUNDS

Year	Native Pecans	Variety Pecans	Total Production
1930	14,925	75	15,000
1931	13,365	135	13,500
1932	22,365	345	23,000
1933	10,240	260	10,500
1934	11,130	370	11,500
1935	26,880	1,120	28,000
1936	1,910	90	2,000
1937	17,480	920	18,400
1938	1,848	252	2,100
1939	18,240	760	19,000
1940	26,040	1,960	28,000
1941	29,376	1,224	30,600
1942	3,700	300	4,000
1943	24,450	1,550	26,000
1944	12,600	1,400	14,000
1945	24,500	1,500	26,000
1946	5,900	1,100	7,000
1947	40,900	3,100	44,000
1948	14,000	1,000	15,000
1949	21,960	2,040	24,000
1950	6,370	630	7,000
1951	23,500	1,500	25,000
1952	2,660	340	3,000
1953	26,000	1,600	27,600
1954	13,000	1,500	14,500
1955	29,700	3,300	33,000
1956	6,500	600	7,100
1957	28,800	2,200	31,000
1958	13,900	1,600	15,500
1959	8,500	500	9,000
1960	38,000	3,000	41,000
1961	10,900	700	11,600
1962	6,800	800	7,600
1963	15,000	1,000	16,000

TABLE I (Continued)

Year	Native Pecans	Variety Pecans	Total Production
1964	35,000	2,000	37,000
1965	40,000	3,000	43,000
1966	5,800	200	6,000
1967	49,000	4,000	53,000
1968	1,400	100	1,500
1969	13,800	700	14,500
1970	7,700	300	8,000
1971	17,500	1,500	19,000
1972	3,600	600	4,200
1973	26,000	2,000	28,000
1974	2,300	200	2,500
1975	18,500	1,500	20,000
1976	1,500	800	2,300
1977	12,000	1,500	13,500
1978	13,500	2,000	15,500
1979	9,000	1,000	10,000
1980	3,000	500	3,500
1981	44,500	2,500	47,000
1982	3,500	500	4,000

Source: USDA Crop Reporting Board (HORT 5)

TABLE II

MM OF RAINFALL AT PECAN RESEARCH STATION, SPARKS OKLAHOMA

Month	Year					
	1980	1981	1982	1983	1984	Average
January	50	00	133	35	13	46
February	32	32	20	81	32	39
March	40	126	45	83	87	76
April	73	43	60	103	81	72
May	171	80	314	182	77	165
June	82	139	169	42	65	99
July	10	67	93	00	7	35
August	9	148	23	65	103	70
September	85	44	56	74	128	77
October	48	156	35	347	219	161
November	25	78	86	47	111	69
December	43	2	00	17	59	24
Total:	668	915	1034	1076	982	933

Pecans, like many other tree crops, until recently were considered a crop which could tolerate drought conditions quite well. However, moisture deficiencies have been shown to cause death of the tree, die back, retarded growth, reduced nut or fruit size, reduced nut filling and premature fruit shedding. Supplemental irrigation of pecans has shown increased yield, nut quality and nut size (Madden, 1971).

Alternate bearing in Oklahoma is very pronounced (Table I). Recent experiments and commercial practices have shown that alternate bearing can be virtually eliminated by good orchard management that includes proper fertility together with optimum moisture achieved through controlled irrigation and/or drainage (Woodroof, 1978).

In order to irrigate effectively, water-use rates need to be determined for pecans grown under Oklahoma conditions. Oklahoma's climatic conditions differ significantly from other states which have conducted research related to frequency, timing and amount of irrigation water for pecans; therefore, this type of research is needed.

Objectives

The specific objectives of this study were:

1. To determine the water-use rates of irrigated pecan trees in Oklahoma.

2. To evaluate the effects of different irrigation treatment levels on:

   (a) elemental absorption

   (b) nut characteristics

i. nut weight

ii. kernel weight

iii. percent kernel

(c) total nut yield

3. Investigate the apparent variability of the soil in the experimental area through the analysis of soil samples taken at different locations and depths to determine:

(a) field capacity

(b) permanent wilting point

(c) amount of available water

(d) soil textural class

Scope and Limitations

This research was conducted at the Oklahoma State University Pecan Research Station at Sparks, Oklahoma. Similar research on consumptive water use and irrigation effects on pecans was performed the previous year by Said (1984). The same experimental plots were used in this study as used previously in order to determine if there were any carry-over effects of his irrigation study.

During the course of Said's (1984) work and this study, it became evident that the soil of the test area was not homogeneous between experimental blocks and within the profile of the plots themselves. Therefore, soil samples were taken at different locations and depths in the experimental area and analyzed to determine field capacity, permanent wilting point, amount of available water and soil textural class.

The levels of the irrigation treatments and amount of water to apply per irrigation were based on Said's (1984) research and suggestions. The irrigation levels were based on the cumulative moisture content over a root zone depth of 120 cm (4 ft) and were lowered slightly from the previous irrigation levels. The following irrigation levels were used:

T1 - No irrigation.

T2 - Irrigate when the cumulative moisture content falls below 25 cm (9.8 in).

T3 - Irrigate when the cumulative moisture content falls below 27.5 cm (10.8 in).

T4 - Irrigate when the cumulative moisture content falls below 30 cm (11.8 in).

CHAPTER II

REVIEW OF LITERATURE

Pecans: General

Pecan trees [Carya illinoensis (Wang.) K. Koch] are native to the North American continent. Native pecans grow mainly in the southern states west of the Mississippi River, but can be found as far north as Illinois and Nebraska (Jaynes, 1979). They are only developed commercially in the southern U.S., mainly from Wilmington, NC to Atlanta, GA; Birmingham, AL to Jackson, MS to Pine Bluff, AR; and McAlister, OK to Galveston, TX. Pecan trees live very long. Native trees are known to be 1000 years old (Woodroof, 1967). The U.S. contributes 95% of the world production, with some being produced in Mexico, Israel and Australia (Loggins, 1981). Georgia is the leading state producing cultivars, while Oklahoma ranks fifth.

The cultivar of pecan used in this study was of the 'Mohawk' cultivar. Whitehead and Hinrichs (1967, p. 31) described this cultivar as follows:

> Mohawk is the largest nut released from the USDA Pecan Research Station at Brownwood, Texas. It is a cross between Success and Mahan. It shells well; long, blunt shaped; 45 to 50 nuts per pound; 60 to 65% kernel. It has been tested since 1960; appears to fill well; early for a large nut; earlier than either parent; resistant to scab. Trees grow fast; large leaves; propagates easily;

productive.

Pecans grow and develop better under favorable conditions. There are many environmental and climatic factors which affect them. Pecans require a growing season, the period of time between frosts, from 140 to 220 days, depending on the cultivar. They grow the best where the average summer temperatures are within the 24° C (75° F) to 29° C (85° F) range (Westwood, 1978).

Pecans are normally found in alluvial soils. The soil should be well drained with 75 to 90 cm (30 to 36 in) of topsoil, which should be a clay loam, silt loam or sandy loam, with a sandy clay subsoil. The static water table should be 250 cm (8 ft) or deeper because soils with a high water table will cause very short tap roots (Woodroof, 1978; Smith, 1984).

Water Requirements of Pecans

Effects of Soil Moisture

Pecans, like all living plants, require an adequate amount of moisture to sustain a healthy growth. The production of pecans, aside from disease, insect injury and cultivar, is largely dependent upon soil moisture and fertility. Pecans draw heavily upon the soil moisture at all times during the summer, but the lack of soil moisture during the periods when the nuts are enlarging rapidly and when nut filling is taking place has the most serious consequences (Woodroof, 1978). Moisture stress also slows growth and photosynthesis along with reductions in yield (Privette, 1979). Gammon, Sharpe and Leighty (1963) found that the most common symptoms of drought injury to pecans were the shedding of fruit, shedding of the leaves and the failure of the fruit to size properly.

The presence of excess water can have a detrimental effect on nut quality in much the same way as a moisture deficit (Aitken and Camp, 1983). Excess water may cause leaf scorch or dieback anytime during the growing season, and if excess water is present during nut filling, the kernel percentage and yield may be reduced (Gammon, Sharpe and Leighty, 1963).

Consumptive Water Use

It is believed that pecans require 80 cm (32 in) of rainfall or supplemental irrigation annually, with 60 cm (24 in) of the water required from April through September, to produce a successful crop of high quality pecans (Huddleston and McEachern, 1984; McEachern, 1981).

Consumptive water use can vary with several factors. Miyamoto (1982a) found that water use increases with increasing tree size, planting density, leaf development and growing season. The consumptive water use also decreases with decreases in soil moisture. Miyamoto (1983a) estimated the consumptive water use for full-grown, closely spaced trees in the El Paso area to be from 100 to 130 cm (40 to 50 in) per season. He developed an empirical equation for computing crop coefficients and consumptive water use from trunk diameters, planting densities and weather data.

Daniell (1979) recommended the application of 22,450 liters per hectare (2400 gallons per acre) per day for pecans in the Southeast. Romberg (1960) estimated pecans use 0.41 to 0.71 liters per day per cm^2 of trunk cross-sectional area (100 to 175 gal per day per ft^2 cross-sectional area).

Rothe and Madden (1971) estimated that pecan trees in the Brownwood area of Texas would use about 105 to 130 cm (42 to 50 in) of water per year with the average daily use varying from 0.25 cm (0.1 in) in March and October to 0.70 cm (0.28 in) in May and June.

Privette (1979) estimated water-use rates between 0.51 and 0.89 cm (0.20 and 0.35 in) per day, with an average of about 0.53 cm (0.21) per day for pecans in the Southeast.

Said (1984) found the average water-use rate to vary from 0.26 to 0.36 cm (0.10 to 0.14 in) per day, depending upon the level of irrigation, for pecan trees in Oklahoma. He determined that there was a direct correlation between the average water-use rate and the amount of supplemental irrigation applied.

Woodroof (1978) proposed that the weekly water requirement (WWR), measured in hectare-cm, be calculated as follows:

$$\text{WWR} = \text{Total net evaporation for week (cm)} \times 70\% \times 90\% \text{ canopy} \times 99927 \text{ liters of water} \qquad (2.1)$$

Keese (1975) estimated the daily irrigation requirement for pecans to be:

$$Q = A \times E \times C \qquad (2.2)$$

where:

Q = daily irrigation water requirement in liter/day (gal/day)

A = plant canopy area in m^2 (ft^2)

E = class A evaporation in cm/day (in/day)

C = constant of 3.15 (0.436)

Irrigation of Pecans

Design Parameters

Pecan growers usually rely heavily on rainfall for the water requirements of their trees. However, during most growing seasons there are one or more periods when rainfall is lacking and soil moisture becomes very low. Therefore, irrigation can be used to supplement the soil moisture in periods of stress.

Many factors have to be considered when designing an irrigation system. Some of the factors include the root zone depth, available soil moisture, consumptive water use and irrigation scheduling.

Root Zone Depth. Privette (1979) defined effective rooting depth as the depth from which most of the water was absorbed by the roots. He stated that the effective rooting depth of pecans varies with soil texture, but is normally about 60 cm (24 in).

Rothe and Madden (1971) set a root zone depth of 150 cm (5 ft), based on field observations at the U.S. Pecan Field Station at Brownwood, Texas. Woodroof (1967) stated that soil samples should be taken to a depth of 120 to 150 cm (4 to 5 ft) when designing an irrigation system.

Miyamoto (1982a) stated that 90% of the soil water depletion occurs in the top 90 cm (36 in) of the soil in the El Paso-Las Cruces area. Smith and Hinrichs (1975) stated that a majority of the active pecan feeder roots are in the upper 40 cm (15 in) of soil even though many roots extend to 90 cm (36 in) and beyond.

Irrigation Scheduling. One of the most important factors in the design is the scheduling of the irrigations. Miyamoto (1982b) stated that a water savings of about 25 to 35% is possible through implementation of improved irrigation scheduling. He determined that pecan trees can easily tolerate an available soil water depletion of 50% under normal cycles of irrigation. He also added that, under variable soil conditions, areas having low water holding capacities dry out faster and reach the allowable depletion earlier than other areas within an irrigation block. To prevent excessive stress in the trees in the low capacity areas, the depletion level needs to be raised. Rothe and Madden (1971) also irrigated when about one-half of the available moisture had been depleted.

Some researchers use tensiometers to determine when to irrigate. Daniell (1981a) found that around 3.8 cm (1.5 in) of water was needed per application for most pecan soils in Georgia. He suggested that maintaining the soil moisture below 52 centibars of tension at a depth of 45 cm (18 in) would be adequate. Privette (1984) carried out irrigation studies in sandy soil and stated that irrigations should begin when the soil moisture tension is around 10 centibars at a depth of 50 cm (20 in). Woodroof (1978) suggested that water should be applied to maintain soil suction at a depth of 45 cm (18 in) below 75 centibars for optimum growth and production of trees.

Period of Irrigation. Bearing trees will respond to irrigation in early spring before bud break, in midsummer as the fruit grows and in early fall as the kernel develops (McEachern, 1981). Smith and Hinrichs (1975) stated that the critical time for moisture is during rapid sizing of the fruit between the eighth and fourteenth week after pollination (mid-July to early August). Less water is needed during nut filling between the fourteenth and eighteenth weeks after pollination (early August to early September).

Daniell (1981b) suggests trees should be watered adequately before shell hardening in order to have good nut size. Irrigation after shell hardening cannot increase nut size, but will increase percent kernel and pecan quality. He also recommended adequate water late in the season to enable shucks to open and to reduce alternate bearing of pecans.

Killey (1980) suggests the last application of water should occur from mid to late September in order that the trees will shed their leaves in the fall and go dormant. Also, if the trees are flood irrigated, they should receive a watering in December to keep roots moist during winter.

Irrigation Effects on Pecans

Studies on the effects of irrigation on pecan trees were conducted mainly in Georgia and Texas. Only two reported studies on this subject have been made in Oklahoma. Smith and Hinrichs (1975) drip irrigated twenty-three year old trees of 'Western,' 'San Saba Improved' and 'Success' cultivars with 0.25 liter/sec (4 gal/hr) per tree. Some of their findings were that trunk growth was not affected by irrigation while shoot growth of only 'Success' was significantly longer. Nuts of 'San Saba Improved' were evaluated and it was found that percent kernel was not significantly increased with supplemental irrigation, but nut size was increased with irrigation. Said (1984) conducted his experiment on ten-year old trees of the 'Mohawk' cultivar and found irrigation had no significant effect on percent fruit drop, nut size, kernel size, percent kernel or nut yield.

Overcash, Laiche and Kilby (1983) trickle irrigated trees of the 'Cape Fear' and 'Mahan' cultivars over a three year study and found no significant increase in yield, but found significant increases in percent shellout and nut weight.

Madden (1971) reported significant increases in yield and nut size of six cultivars of irrigated pecan trees as compared to nonirrigated trees. He also determined that irrigation had little or no effect on percent kernel.

Miyamoto (1982a) reported that yields from drier irrigation treatments were lower, but the differences between treatments were not statistically significant. There were also no differences in nut size, percent kernel and kernel color.

Woodroof (1968) stated that experiments have shown that irrigated pecan orchards yielded larger nuts with higher percent kernel, higher specific gravity and smaller number of nuts per unit weight. Also, irrigated trees made more growth and retained foliage longer than nonirrigated trees.

Alternate Bearing of Pecans

Alternate bearing is a problem with pecan production. According to Woodroof (1978), the cause of alternate bearing is that high yields one year tend to inhibit fruit initiation the following year.

Barnett and Mielke (1981) had two theories concerning alternate bearing. One is that a crop developed during the heavy crop year utilizes carbohydrates which normally would be stored for use during the following early spring growth. As a result there is an insufficient amount of carbohydrates to ensure adequate shoot growth, leaf developement and normal bud differentiation. This triggers a year with little yield.

The second theory is that the crop developing during the heavy year may cause the production of a chemical inhibitor. The inhibitor could act by preventing bud initiation or by masking the effects of normally occuring growth promoters. In either case, bud developement and growth in the year following the good year would be minimal, resulting in the low production of fruit.

Woodroof (1978) states that recent experiments and commercial practice have shown that alternate bearing can be virtually eliminated by orchard management that includes high fertility with all of the essential elements; optimum moisture by controlled irrigation and/or drainage; rigid control of orchard insects and disease; spacing trees so that no outside shoots are shaded by other trees; and pruning to allow all bearing branches exposure to light.

Some researchers believe that irrigation in one year can be carried over to the next years crop, resulting in improved nut production and quality (Said, 1984; Daniell, 1982). In one experiment, Miyamoto (1983b) purposely salted a portion of his pecan orchard. During the first year he found no significant difference between trees, but in the second year the growth rate of trunks, shoots and leaf areas declined by about 20% from those in the unsalted area.

Soil Characteristics

Soil types may have a profound influence on nut production (Overcash, Laiche and Kilby, 1983). The amount of available water for the tree is one of the most important soil characteristics. The amount of available water held by a soil is related to many factors such as the soil's texture, structure, type of clay and organic matter content (Privett, 1979).

Availability of Soil Water

Field capacity and permanent wilting point once were considered to be soil water constants. They are now recognized as very imprecise but qualitatively useful terms (Skaggs, Miller and Brooks, 1983).

Field Capacity. Field capacity can be defined as the amount of water held in the soil after excess water has drained away and the rate of downward movement has materially decreased. This usually takes place two to three days after an irrigation (Veihmeyer and Hendrickson, 1949; Skaggs, Miller and Brooks, 1983; Brady, 1974; Hansen, Israelsen and Stringham, 1980; Peters, 1965). For most soils this is a near optimum condition for growing plants. The soil moisture at 1/3 bar tension has been found to closely estimate the field capacity for many soils (Peters, 1965). This value may vary with different soil types. Sandy soils tend to be near 1/10 bar at field capacity, while the tension in some soils may be as high as 0.6 bar (Hansen, Isralsen and Stringham, 1980).

Permanent Wilting Point. The soil-moisture content at which wilted plants can no longer recover even when placed in a saturated atmosphere is called the permanent wilting point. This point is at the lower end of the available moisture range (Skaggs, Miller and Brooks, 1983; Peters, 1965; Hansen, Israelsen and Stringham, 1979; Brady, 1974). The soil moisture at 15 bars tension is commonly used to estimate the permanent wilting point (Skaggs, Miller and Brooks, 1983; Hansen, Israelsen and Stringham, 1979).

Available Water. The amount of water released by a soil between field capacity and permanent wilting point is called the available water. This represents the moisture which can be stored in the soil for subsequent use by plants (Skaggs, Miller and Brooks, 1983; Hansen, Israelsen and Stringham, 1980). Knowing the amount of available water can be very useful. Many irrigate when a certain percentage of the available water has been depleted.

Soil Water Content

It is often necessary to determine the amount of water in a soil. Gardner (1965) discussed several methods of determining the soil moisture content. The discussion here will be limited to those techniques considered most useful in the field.

Gravimetric. The accepted standard for soil water measurement is the gravimetric method (Skaggs, Miller and Brooks, 1983). This method involves weighing a sample of moist soil, drying it at a temperature of 105 to 110^{o} C until it is free from moisture (about 24 hours), and reweighing it to determine the amount of water lost.

The water content is calculated as:

$$\theta_{dw} = \frac{\text{Wt. of Moist Soil - Wt. of Oven Dry Soil}}{\text{Wt. of Oven Dry Soil}} \qquad (2.3)$$

where

θ_{dw} = water content expressed on a dry weight basis

It is often convenient to express soil water content on a volume basis, that is the ratio of the soil water volume to the total soil volume (Skaggs, Miller and Brooks, 1983; Hansen, Israelsen and Stringham, 1974). This is calculated as:

$$\theta_v = \theta_{dw} \frac{D_b}{D} \qquad (2.4)$$

where

θ_v = water content on a volume basis

D_b = soil bulk density

D = water density

The water content of the soil can also be represented as a depth of water by multiplying the water content on a volume basis by the depth of the soil, as:

$$d = \theta_v H \qquad (2.5)$$

where

d = depth of water

H = depth of soil

Neutron Scattering. Another method of measuring soil moisture that has gained wide acceptance in recent years is the neutron scattering procedure. In this method a source of fast neutrons is lowered into the soil through an access tube. The fast neutrons are emitted into the surrounding soil and gradually lose energy by collision with various atomic nuclei. Hydrogen, present almost entirely in soil water, is the most effective element in the soil in slowing the neutrons. The slowed neutrons form a cloud around the source and some of these randomly return to a detector, which measures the number of returning neutrons over a given period of time. The count rate is almost linearly related to the soil moisture content, which is determined on a volume basis (Brady, 1974; Skaggs, Miller and Brooks, 1983; Troxler, 1980).

Soil Water Potential

It is often desirable to measure soil water potential in addition to soil water content. Water in the soil is subjected to many forces which cause its potential to differ from that of pure, free water. Factors that contribute to the total potential energy of soil water include the gravitational, osmotic and pressure potentials (Hillel, 1982).

Soil-Moisture Characteristic Curve. Soil water content and pressure potential, sometimes called matric potential, are functionally related to each other. The graphical representation of this relationship is called the soil-moisture characteristic curve, or moisture release curve (Hillel, 1982; Trout, Garcia-Castillas and Hart 1982). The relationship is not always unique, however, because it is affected by the direction and rate of change of soil moisture and is sensitive to changes in soil volume and structure (Hillel, 1982).

Moisture release curves are usually determined in the laboratory. This is done by creating a differential pressure between the soil water and the surrounding air while allowing water to move out of the soil sample. This differential pressure is usually obtained using a pressure vessel with ceramic pressure plates for pressures above 1 bar and using Tempe cells for pressures below 1 bar, as discussed by Richards (1965) and Trout, Garcia-Castillas and Hart (1982).

Tensiometers. The tensiometer is widely used for measuring soil water potential in the field. A tensiometer consists of a porous ceramic cup placed in the root zone and attached to a tube connected to a vacuum gauge or a mercury manometer. The tube is filled with water and as the roots withdraw water from the soil, the soil pulls water from the porous cup creating a vacuum in the tube which can be measured by the gauge or manometer. As water is applied to the soil either through rainfall or irrigation, water will enter the porous cup from the soil reducing the vacuum level (Aitken, 1982; Skaggs, Miller and Brooks, 1983). This vacuum, or tension, is usually measured in centibars when using vacuum gauges and cm of water when using manometers.

One drawback of tensiometers is that they can only be used to measure soil tension up to about 0.8 bar (80 kPa). However, with irrigation, soil moisture can usually be maintained at low-tension conditions which are favorable for most plants.

Soil Classification

One of the most important factors affecting available water for plants is the soil texture. The sizes of particles making up a soil determine its texture. The three major soil separates are sand, silt and clay. According to the USDA classification system, anything smaller than 0.002 mm is clay, 0.002 to 0.05 mm is silt and 0.05 to 2.0 mm is sand.

Most soils consist of a mixture of these soil separates and are grouped into soil textural classes according to the percent of each separate present. Figure 1 shows the basic soil textural classes according to the USDA (Soil Survey Staff, 1951).

The soil textural class of a soil is determined in the laboratory using particle-size analysis. The two most common methods of particle-size analysis are the pipette method and the hydrometer method, discussed in detail by Day (1965) and Trout, Garcia-Castillas and Hart (1982).

Soil physical properties vary between the different textural classes. Table III summarizes some of these

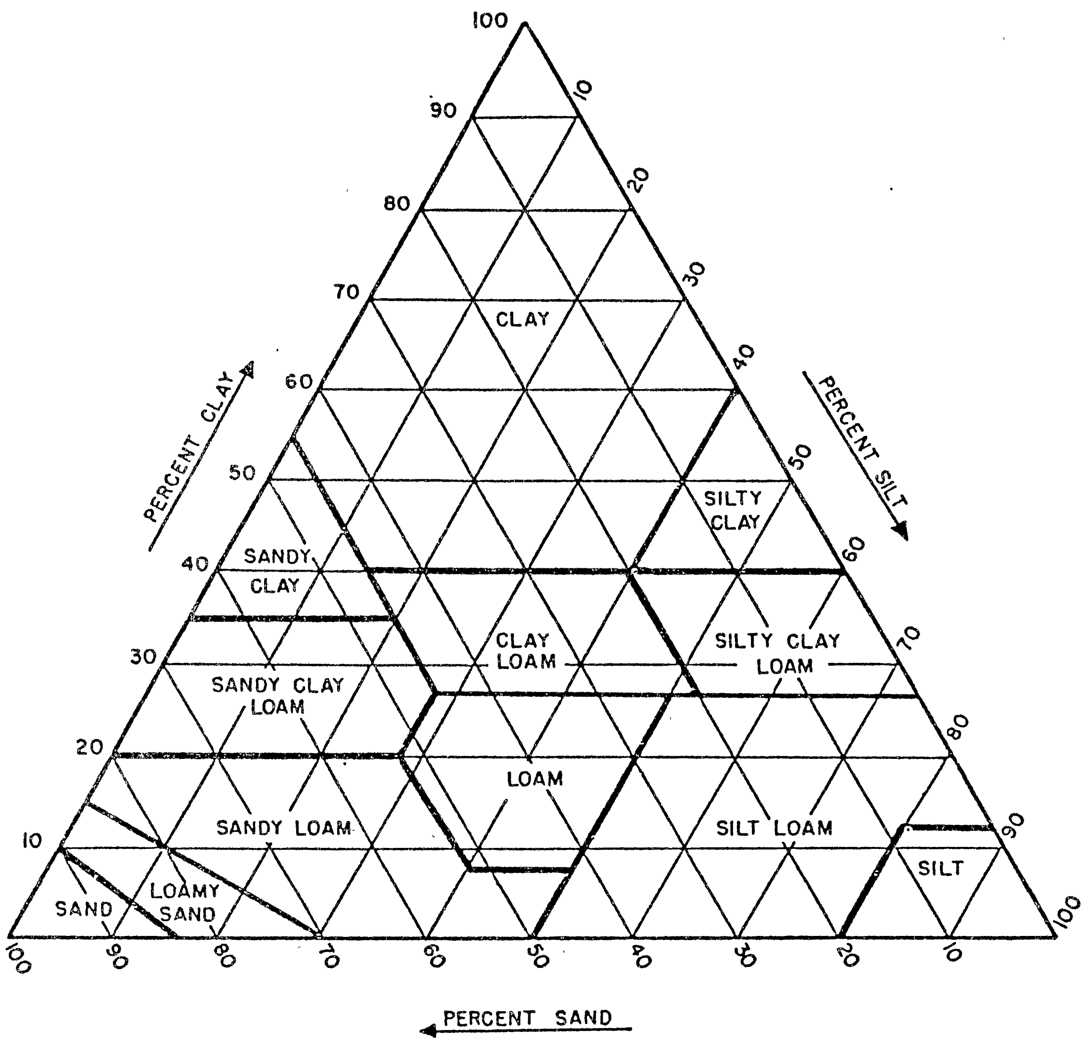

Figure 1. Proportions of Sand, Silt and Clay in the Basic Soil Textural Classes. (From U.S. Dept. Agr. Handbook 18. Soil Survey Manual. 1951.)

Table III

Representative Physical Properties of Soil

Soil Texture	Bulk Density (g/cm^3)	Field* Capacity (%)	Permanent* Wilting (%)	Total Available Moisture: Dry Weight (%)	Total Available Moisture: Volume (%)
Sandy	1.65 (1.55-1.80)	6 (6-12)	4 (2-6)	5 (4-6)	8 (6-10)
Sandy loam	1.50 (1.40-1.60)	14 (10-18)	6 (4-8)	8 (6-10)	12 (9-15)
Loam	1.40 (1.35-1.50)	22 (18-26)	10 (8-12)	12 (10-14)	17 (14-20)
Clay loam	1.35 (1.30-1.40)	27 (23-31)	13 (11-15)	14 (12-16)	19 (16-22)
Silty clay	1.30 (1.30-1.40)	31 (27-35)	15 (13-17)	16 (14-18)	21 (18-23)
Clay	1.25 (1.20-1.30)	35 (31-39)	17 (15-19)	18 (16-20)	23 (20-25)

Source: Hansen, Israelsen and Stringham (1980)
* Dry weight basis

physical properties, such as bulk density, field capacity, permanent wilting point and available moisture.

CHAPTER III

MATERIALS AND EQUIPMENT

Research Location

This research on irrigation of pecan trees was conducted at the Pecan Research Station at Sparks, Oklahoma. The research station was well equipped for the proper maintenance and management of the pecan orchard. The station contained various weather recording instruments. The instruments present included a standard rain guage to collect the daily precipitation, a recording thermograph to record the temperature variation throughout the year and an evaporation pan equipped with an anemometer to measure the evaporation rate and daily wind travel.

The Test Trees (Plots)

Sixteen trees from a 12-year old pecan orchard were used in this study on the irrigation treatment effects. These trees were the same ones used in the previous year's irrigation study conducted by Said (1984). The trees in this orchard, which were of the 'Mohawk' cultivar, were planted on a 10.7 m x 10.7 m (35 ft x 35 ft) spacing. Figure 2 shows a schematic view of the orchard. The orchard slopes very gently toward Quapaw Creek which borders the

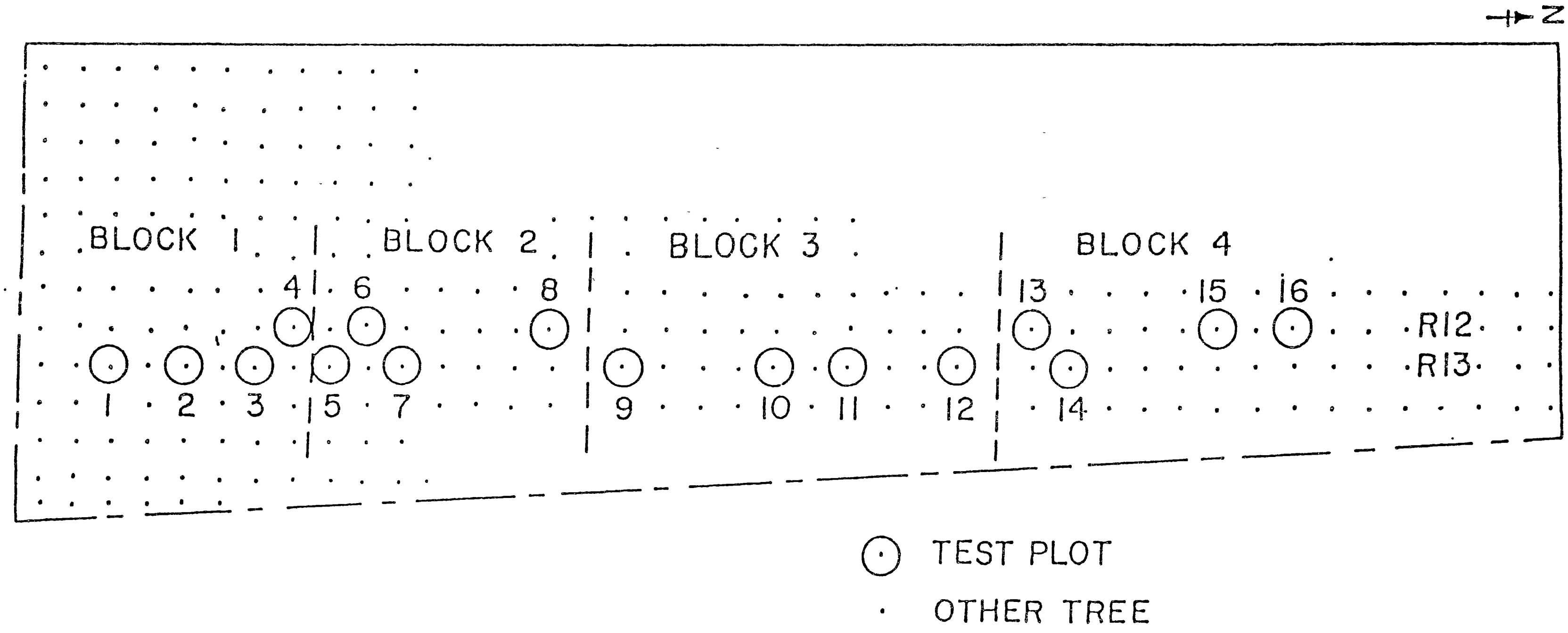

Figure 2. Schematic View of the Test Plots

orchard to the north. Said (1984) surveyed the test area and determined the elevation of each test plot, taken at the base of the tree, and found the ground slope to be about 0.25%.

The Irrigation Pump Sets

Water was delivered from the well to the test plots through a submersible pump. The pump was electrically driven and had an average discharge of about 1 liter/sec (15 gpm) of water. The pump had a rated power of 0.56 kW (3/4 Hp) and a maximum operating speed of 3450 rpm. A 24-hour time clock was used to control the pump in order to aid in shutting off the pump at the desired times.

The irrigation water was supplied to the test plots through 5.1 cm (2 in) diameter pipe. The pipeline was constructed of several 6.1 m (20 ft) PVC pipes which were coupled and glued together. The pipeline was branched to each plot and a gate valve at the end of each branch was kept closed until the individual tree was to be irrigated.

A double-filter screen was inserted at the beginning of the pipeline directly after the pump outlet. The screen filtered out the larger sand particles and had to be cleaned at least once daily.

The Soil of the Test Plots

The plots were located in the flood plain of the Quapaw Creek, a tributary of the Deep Fork River which is about 4 km (2 1/2 mi) to the north. The Quapaw Creek has a history of overflowing at least once every five years. However, it has flooded the orchard at least once in the last three consecutive years. It flooded the whole orchard in May of 1982, October of 1983 and twice in 1984 (late May and early September). The northern one-third of the test plots usually stood under water at least one to two days longer than the other test plots.

A detailed soil survey of the research area was conducted in 1963 by the Department of Agronomy, Oklahoma State University, and was published as Processed Series P-451. A detailed discussion of the soils of the test plot and their profiles is given in Appendix A.

The Tensiometers

Tensiometers were used to determine the soil moisture tension at different depths. They were constructed in four different lengths: 30 cm, 60 cm, 120 cm and 150 cm. The 120 and 150 cm tensiometers enabled one to determine whether the soil moisture was moving upward or downward in the root zone. Personnel of the Soil Physics Laboratory at Oklahoma State University assisted in the construction and installation of the tensiometers.

In late May, the tensiometers from the previous year's study were tested for air leaks and replaced if they were faulty. The nylon tubing for the mercury manometers on each tensiometer was also replaced.

The Neutron Probe

The soil moisture content of the plots was measured with a Troxler series 3220 moisture gauge. The neutron probe uses the neutron scattering procedure to estimate soil moisture content on a volume basis. In most soils, a nearly linear relation exists between the volumetric moisture content and the count ratio. The count ratio is the ratio of the measured count made with the probe in the access tube in the soil to the standard count made with the probe secured in the gauge body. Calibration of the moisture gauge can be accomplished by either field calibrations in the natural soil profiles or calibrating in the laboratory in barrels filled with materials of predetermined moisture contents.

Because of the variability among different soils, it is best to calibrate the neutron moisture gauge specifically for each soil type. However, for Oklahoma soils, Stone (1983) has determined that there are no significant differences in their calibration curves. This fact was established over many years of data collection.

The neutron moisture gauge used for this study was calibrated in the Soil Physics Laboratory, Oklahoma State University. The calibration was determined in a soil media containing aluminum sulphate, urea and pure water. The calibration curves for this gauge are as follows:

For soil depths to 23 cm (9 in):

$$\theta_v = 0.00422 + (0.6094) * (R) \qquad (3.1)$$

For soil depths 23 cm (9 in) or greater:

$$\theta_v = -0.0215 + (0.5909) * (R) \qquad (3.2)$$

where:

θ_v = volumetric moisture content

R = measured count / standard count

The statistical stability and drift tests indicated that the instrument would be highly reliable in all of its measurements.

The Access Tubes

Electrical metallic thinwall (EMT) access tubes were used with the neutron probe for the measurement of soil moisture content. The tubes were the same ones used in the previous study by Said (1984). The tubes were 1.5 m (5 ft) long, had an inside diameter of 3.8 cm (1 1/2 in) and a wall thickness of about 0.15 cm (1/16 in).

During late spring, the water table in the test area rose above the bottom of the access tubes, causing water to enter the tubes. Therefore, the water was removed from the tubes and 'ground-down' no. 9 rubber stoppers were forced to the bottom of the tubes, allowing the tubes to stay dry. Between readings, the top of each tube was also sealed with a no. 9 rubber stopper.

The Soil Testing Equipment

The soil samples were collected using a standard core sampler. The sampler consisted of an outer steel housing, a thin steel cutting edge, four brass cylinders, a metal pipe extension with handles and a driving hammer. The brass cylinders were 5.7 cm (2 1/4 in) O.D. and housed inside the outer housing. Two of the brass cylinders were 1 cm long and used as spacers while the other two brass cylinders were 3 cm long and used to retain the soil samples. The cutting edge was threaded allowing its removal from the outer housing in order that the sample rings could be removed.

A 15-bar ceramic plate extractor was used for the moisture retention experiments. The pressure plate extractor consisted of a pressure vessel, two different pressure rated cells and the internal fittings and outlet tubes. There were three 15-bar pressure plate cells and one 1-bar pressure plate cell. Each pressure plate cell consisted of a porous ceramic plate, covered with a thin neoprene diaphragm and sealed to the edges. An internal screen provided for the passage of water. An outlet stem connected the passage to an outflow tube fitting, which connected to the atmosphere outside of the extractor. The brass cylinders containing the soil samples were placed directly on the ceramic pressure plate during runs. Up to three pressure plate cells could be stacked in the pressure vessel at a time.

The air for the pressure vessel was provided by a PM compressor. The compressor was powered by a 0.37 kW (1/2 HP) motor and was capable of providing pressures up to 2000 kPa (295 psi). The air pressure was regulated by two different manifolds. One of the manifolds contained a regulator which regulated the pressure from 0-345 kPa (0-50 psi) and the other manifold was used for pressures from 0-1760 kPa (0-255 psi). When working in the low pressure ranges, the pressure could be double regulated by regulating the pressure through the high pressure regulator to the low pressure regulator. This provided pressure with accuracy within 7 Pa (1/1000 psi) in the lower pressure ranges.

Determination of Soil Class

The soil classifications were determined using the hydrometer method of particle-size analysis. To prepare the samples, each sample was dried overnight in an oven at 105° C (220° F). The samples were then passed through a 0.25 mm sieve and a 40.0 g sample was obtained. A 5% solution of sodium hexametaphosphate ($NaPO_4$) was used as a dispersing agent.

Each soil sample was then added to 400 ml of water and 50 ml of the dispersing agent and mixed for five minutes with an electrically driven mixer. The samples were transfered to 1-liter sedimentation cylinders, water was added to bring the volume to one liter, remixed with a plunger, and readings were taken with a standard hydrometer (ASTM No. 152H with Bouyoucos scale in g/liter) at the reccomended settling times for the specific particle sizes.

The system established by the U. S. Department of Agriculture was used to determine the different soil classifications. According to this classification system, anything smaller than 0.002 mm is clay, 0.002 to 0.05 mm is silt and 0.05 to 2.0 mm is sand. The percentages of sand, silt and clay were calculated and these values were used along with a standard USDA soil triangle (Figure 1) to determine soil textural class.

CHAPTER IV

EXPERIMENTATION

Preparation of The Irrigation Plots

The test plots used in this experiment were the same ones used by Said (1984) in the previous year's experiment. Each plot consisted of a circular bund built up about 15 cm (6 in) high at a distance of approximately 5 m (16 ft) from the base of the tree, with a 1.5 m (5 ft) long access tube 3 m to the west of the tree.

In early May, the test trees were pruned and sprayed for insects and diseases. The test plots were cleared of all weeds and debris, re-leveled and bunds repaired. The plots were sprayed with a pre-emergent herbicide to prevent further weed growth. The average radius and area of each test plot was calculated by measuring the distance from the base of the tree to six different locations on the bund. Determination of the amount of water required per irrigation was based on the computed area and a predetermined irrigation depth.

The high water table in the test area early in the season had caused the access tubes to partially fill with water. This problem was corrected as mentioned earlier. Four additional access tubes were installed, without the rubber stoppers, at plots 1, 9, 10 and 16 to observe the water table level (Table IV).

The tensiometers were tested for air leaks and replaced if faulty. The manometer tubing was replaced with new tubing and mercury reservoirs were refilled with mercury. The tensiometers were then refilled with distilled water and primed.

The pipeline was inspected and damaged sections were replaced. A larger double-screen filter was installed in the pipeline to filter out sand particles and a 24-hr time clock was installed to aid in shutting off the pump at the end of the irrigation period.

Irrigation Treatments

The same 4 x 4 randomized block experiment was used as Said (1984) had used the previous year. Three levels of irrigation treatments plus a control treatment were used on the 16 trees. The trees were assigned into four blocks based on their locations relative to the Quapaw Creek, which bordered the test area to the north. Within each block, one plot was assigned at random to each treatment. Table V shows the setup of the randomized block experiment.

The irrigation treatment levels were based on Said's (1984) levels using the average cumulative moisture content within the root zone (taken as 120 cm (48 in)) as a basis. The cumulative moisture content was used by Said (1984) because he observed that the soil texture varied from plot to plot within the same treatment and that the soil profile

TABLE IV

DEPTH BELOW GROUND SURFACE TO WATER TABLE

Date	Depth Below Ground Surface (cm)			
	Plot 1	Plot 9	Plot 10	Plot 16
5/25	109	81	81	74
6/04	84	56	5	0
6/12	97	76	10	7
6/14	107	84	15	15
6/19	117	89	15	33
6/21	124	104	15	25
6/25	135	102	25	28
6/27	>150	102	33	35
7/02		104	109	94
7/05		107	117	99
7/09		109	119	99
7/11		112	124	124
7/13		117	127	134
7/16		124	130	137
7/18		127	132	104
7/20		>150	130	119
7/23			132	128
7/25			132	132
7/27			140	135
7/29			>150	>150
9/17				30
9/21				76

TABLE V

SETUP OF RANDOMIZED BLOCK EXPERIMENT

Plot No.	Row No./ Tree No.	Block	Irrigation Treatment	Plot Area (m^2)	Liters of Water per Irrigation
1	R13/T39	1	T3	89.4	9080
2	R13/T37	1	T1	84.3	--
3	R13/T35	1	T4	84.3	8560
4	R12/T34	1	T2	79.5	8080
5	R13/T33	2	T4	84.3	8560
6	R12/T32	2	T2	89.4	9080
7	R13/T31	2	T1	84.3	--
8	R12/T27	2	T3	76.6	7780
9	R13/T25	3	T3	88.7	9010
10	R13/T21	3	T2	88.2	8960
11	R13/T19	3	T4	79.5	8080
12	R13/T16	3	T1	89.1	--
13	R12/T14	4	T2	74.7	7590
14	R13/T13	4	T1	89.4	--
15	R12/T9	4	T3	89.4	9080
16	R12/T7	4	T4	89.4	9080

of many plots was not homogeneous. He stated that his irrigation treatments may have been set too high, possibly being harmful to the trees, and that the levels should be lowered. The irrigation treatment levels used, based on the cumulative moisture content over a root zone depth of 120 cm (48 in), were as follows:

T1 - No irrigation.

T2 - Irrigate when the cumulative moisture content reaches or falls below 25 cm (9.8 in), previously set at 27 cm (10.6 in).

T3 - Irrigate when the cumulative moisture content reaches or falls below 27.5 cm (10.8 in), previously set at 29 cm (11.4 in).

T4 - Irrigate when the cumulative moisture content reaches or falls below 30 cm (11.8 in), previously set at 31 cm (12.2 in).

Irrigation of Plots

Moisture readings were taken at 15 cm (6 in) intervals from the ground surface to the 120 cm (48 in) depth using a neutron probe. The volumetric moisture content and cumulative moisture content in the root zone were then calculated using a computer program (Appendix B). An error in the program was not discovered until August 1, and the cumulative moisture content in the high moisture treatment (T4) had dropped to 28.7 cm. The treatment was irrigated the next day.

The flow rate of the irrigation water to each individual plot was determined using a stopwatch and a bucket. The volume of the bucket was previously measured by weighing it in the laboratory. The amounts of irrigation water applied per irrigation were calculated based on a 10.2 cm (4 in) application over the plot area (Table V). Said (1984) had found 10.2 cm (4 in) to be an adequate amount of water to apply.

Table VI shows the cumulative moisture content of each plot within treatment T4 (wet treatment), the average cumulative moisture content for the treatment and the rainfall during the period in which irrigation was scheduled. Similarly, Tables VII, VIII and IX show these values for treatments T3, T2 and T1, respectively. Graphically, the scheduling of the irrigation treatments is shown in Figures 3 through 6.

The irrigation period was considered to be from June 1 (Julian date of 153) to September 20 (Julian date of 264), when nut filling should be complete. Treatment T4 received four 10.2-cm (4-in) irrigation applications. The site also received 29.8 cm (11.7 in) of rainfall. Thus, each plot within treatment T4 received a total of 70.6 cm (27.8 in) of water. Each plot within treatment T3 received two irrigations plus the rainfall for a total of 50.2 cm (19.8 in) of water. The average cumulative moisture content of treatment T2 came close to its irrigation level on August 8 and September 8, but rainfall in the amounts of 4.67 cm (1.84 in) and 9.4 cm (3.7 in), respectively, fell the next

TABLE VI

CUMULATIVE MOISTURE CONTENT OF TREATMENT T4
DURING IRRIGATION PERIOD

		Cumulative Moisture Content				
Date	Rainfall (cm)	Plot 3 (cm)	Plot 5 (cm)	Plot 11 (cm)	Plot 16 (cm)	Average (cm)
6/04		41.2	39.9	40.0	45.0	41.6
6/06	1.70					
6/12		39.5	37.2	39.3	44.6	40.1
6/14		38.9	36.8	38.8	44.5	39.7
6/19		35.8	35.0	37.4	41.7	37.5
6/21		35.8	34.3	37.5	40.7	37.1
6/25	0.38	34.5	32.6	36.6	40.1	35.9
6/26	3.00					
6/29	1.32					
7/02		32.3	32.1	33.8	38.8	34.3
7/05		33.6	32.1	35.0	36.3	34.2
7/09		32.5	30.3	34.2	34.2	32.8
7/11		32.3	29.5	33.4	33.8	32.2
7/13		31.5	28.3	32.5	32.3	31.1
7/16		30.4	27.7	31.6	31.3	30.2
7/18		31.3	27.1	31.9	30.9	30.3
7/20		28.9	26.6	30.8	30.3	29.1
7/23		28.1	25.9	30.3	29.2	28.4
7/25		27.7	26.0	30.2	28.7	28.2
7/27	0.58	27.2	25.9	29.8	28.3	27.8
7/30		25.6	26.5	29.8	27.7	27.4
8/01		25.6	24.8	28.9	27.0	26.6
8/02 *		25.8	25.3	29.4	26.8	26.8
8/03		29.4	29.6	34.5	31.0	31.1
8/06		28.7	28.7	33.2	30.0	30.2
8/07 *		28.3	28.4	33.2	29.9	30.0
8/09	4.67	30.2	30.6	36.1	30.9	32.0
8/10	2.13					
8/13	1.65	31.9	31.9	36.6	32.1	33.1
8/15		31.7	31.5	36.1	31.1	32.6
8/17		31.0	30.6	35.5	30.1	31.8
8/20		30.2	29.5	35.1	28.9	30.9
8/22	1.04	29.7	28.5	34.5	28.1	30.2
8/23 *		29.6	28.5	34.2	28.2	30.1
8/27		30.8	29.3	35.8	28.7	31.2
8/29		30.5	28.5	35.6	27.9	30.7
8/30	0.76	30.0	28.2	35.5	27.6	30.3
8/31 *		29.9	28.0	35.3	27.0	30.0
9/04	2.57					
9/05		31.6	30.4	36.9	28.2	31.8
9/07		30.9	29.3	35.9	27.4	30.9

TABLE VI (Continued)

		Cumulative Moisture Content				
Date	Rainfall (cm)	Plot 3 (cm)	Plot 5 (cm)	Plot 11 (cm)	Plot 16 (cm)	Average (cm)
9/09	9.40					
9/11		31.4	29.4	34.6	37.2	33.2
9/14		30.8	28.2	34.3	37.9	32.8
9/17		30.2	27.4	33.6	35.2	31.6
9/18	0.41					
9/21		29.4	26.3	32.6	33.6	30.5
9/26	0.18					
9/28		27.9	25.0	31.6	30.9	28.8
10/04		27.4	23.6	30.9	29.7	27.9
10/11		29.4	22.8	30.1	28.7	27.8

* Denotes 10.2 cm (4 in) irrigation
(Cumulative moisture contents taken before irrigations)

TABLE VII

CUMULATIVE MOISTURE CONTENT OF TREATMENT T3
DURING IRRIGATION PERIOD

Date	Rainfall (cm)	Cumulative Moisture Content Plot 1 (cm)	Plot 8 (cm)	Plot 9 (cm)	Plot 15 (cm)	Average (cm)
6/04		40.1	41.5	40.8	43.1	41.4
6/06	1.70					
6/12		37.0	39.6	39.1	42.8	39.7
6/14		36.1	39.7	38.1	43.3	39.3
6/19		34.2	37.8	34.9	41.3	36.9
6/21		33.9	37.4	32.7	41.2	36.3
6/25	0.38	32.3	35.8	30.5	40.0	34.7
6/26	3.00					
6/29	1.32					
7/02		31.7	35.3	27.1	37.7	33.0
7/05		32.2	35.8	28.1	38.6	33.7
7/09		31.8	34.3	25.6	37.2	32.2
7/11		31.4	33.9	24.4	36.7	31.6
7/13		30.7	33.1	23.6	35.7	30.8
7/16		30.4	32.1	21.5	34.6	29.7
7/18		30.1	31.9	21.6	34.6	29.6
7/20		29.7	31.3	20.8	33.8	28.9
7/23		29.2	30.6	20.1	32.9	28.2
7/25		29.2	30.3	19.9	32.8	28.1
7/27	0.58	29.0	29.7	19.4	32.1	27.6
7/30		28.5	29.4	19.0	31.3	27.1
8/01		28.1	28.6	18.5	31.0	26.5
8/02		28.2	28.6	18.7	31.1	26.6
8/03 *		29.2	28.6	18.4	30.5	26.7
8/06		32.8	32.8	22.6	34.6	30.7
8/07		32.5	32.3	21.9	34.6	30.3
8/09	4.67	33.6	32.3	23.5	35.0	31.1
8/10	2.13					
8/13	1.65	34.2	33.4	25.2	35.7	32.1
8/15		33.3	33.3	24.6	35.1	31.6
8/17		32.8	32.9	23.1	34.5	30.8
8/20		31.9	32.3	22.4	33.7	30.1
8/22	1.04	31.4	32.3	21.4	33.4	29.6
8/23		31.9	31.9	21.0	33.2	29.5
8/27		30.8	30.8	20.0	32.0	28.4
8/29		30.3	30.4	19.2	31.8	27.9
8/30 *	0.67	29.9	29.7	19.1	31.3	27.5
8/31		35.3	32.1	21.8	33.2	30.6
9/04						
9/05		33.1	31.3	21.4	33.3	29.6
9/07		32.7	31.0	20.4	32.7	29.2

TABLE VII (Continued)

		Cumulative Moisture Content				
Date	Rainfall (cm)	Plot 1 (cm)	Plot 8 (cm)	Plot 9 (cm)	Plot 15 (cm)	Average (cm)
9/09	9.40					
9/11		34.5	31.2	20.7	36.1	30.6
9/14		33.1	30.7	19.3	37.5	30.2
9/17		32.3	30.0	18.9	36.9	29.5
9/18	0.41					
9/21		31.8	28.6	22.0	35.3	29.4
9/26	0.18					
9/28		30.6	28.4	17.9	34.2	27.8
10/04		30.0	27.9	16.9	32.8	26.9
10/11		29.4	27.8	16.1	32.4	26.4

* Denotes 10.2 cm (4 in) irrigation
(Cumulative moisture contents taken before irrigations)

TABLE VIII

CUMULATIVE MOISTURE CONTENT OF TREATMENT T2
DURING IRRIGATION PERIOD

Date	Rainfall (cm)	Plot 4 (cm)	Plot 6 (cm)	Plot 10 (cm)	Plot 13 (cm)	Average (cm)
		Cumulative Moisture Content (cm)				
6/04		42.5	41.4	43.4	42.1	42.3
6/06	1.70					
6/12		40.7	40.1	41.7	41.0	40.9
6/14		39.5	38.7	41.2	40.8	40.0
6/19		35.4	36.7	38.1	39.1	37.2
6/21		34.4	36.5	36.8	38.4	36.5
6/25	0.38	32.9	34.9	34.9	37.4	35.0
6/26	3.00					
6/29	1.32					
7/02		33.8	33.5	33.7	35.4	34.1
7/05		33.9	34.6	33.9	35.7	34.5
7/09		31.6	32.9	32.2	34.7	32.8
7/11		30.4	32.0	31.3	33.8	31.9
7/13		29.0	31.1	30.1	33.4	30.9
7/16		27.2	30.9	29.3	33.0	30.1
7/18		26.6	30.1	28.9	32.8	29.6
7/20		25.4	29.6	28.1	32.1	28.8
7/23		24.2	29.0	27.8	31.7	28.2
7/25		23.8	29.2	27.6	31.4	28.0
7/27	0.58	23.3	28.5	27.2	31.0	27.5
7/30		22.8	28.1	26.7	31.3	27.2
8/01		22.2	27.8	25.9	30.6	26.6
8/02		22.1	27.6	25.9	29.5	26.3
8/03		21.9	27.6	25.7	30.5	26.4
8/06		21.4	27.2	25.3	30.6	26.1
8/07		21.3	26.9	24.6	30.3	25.8
8/09	4.67	25.6	30.6	29.6	34.8	30.1
8/10	2.13					
8/13	1.65	33.8	32.6	32.3	33.6	33.1
8/15		31.9	31.6	30.7	34.5	32.2
8/17		30.1	30.7	29.6	33.2	30.9
8/20		28.8	29.7	28.4	32.5	29.9
8/22	1.04	27.4	29.6	28.1	31.8	29.2
8/23		27.2	29.3	27.6	32.1	29.0
8/27		24.9	28.2	26.3	30.2	27.4
8/29		23.9	29.1	25.1	30.6	27.2
8/30	0.76	23.5	27.0	25.3	29.9	26.4
8/31		23.1	27.2	24.9	30.0	26.3
9/04	2.57					
9/05		21.7	27.9	25.0	29.4	26.0
9/07		22.6	27.4	24.0	29.0	25.8

TABLE VIII (Continued)

Date	Rainfall (cm)	Plot 4 (cm)	Plot 6 (cm)	Plot 10 (cm)	Plot 13 (cm)	Average (cm)
		Cumulative Moisture Content (cm)				
9/09	9.40					
9/11		33.1	29.2	29.3	31.1	30.7
9/14		30.4	27.9	27.8	29.4	28.9
9/17		28.8	27.5	26.6	29.3	28.1
9/18	0.41					
9/21		26.7	26.4	25.8	28.6	26.9
9/26	0.18					
9/28		24.0	25.8	24.5	27.6	25.5
10/04		22.4	24.7	22.9	27.2	24.3
10/11		21.1	24.9	21.7	26.9	26.4

TABLE IX

CUMULATIVE MOISTURE CONTENT OF TREATMENT T1 DURING IRRIGATION PERIOD

		Cumulative Moisture Content				
Date	Rainfall (cm)	Plot 2 (cm)	Plot 7 (cm)	Plot 12 (cm)	Plot 14 (cm)	Average (cm)
6/04		41.0	39.8	45.7	42.2	42.2
6/06	1.70					
6/12		39.3	39.1	43.6	41.1	40.7
6/14		36.8	38.8	43.6	41.2	40.1
6/19		34.5	37.1	41.9	39.9	38.5
6/21		34.6	37.4	40.9	40.0	38.2
6/25	0.38	33.0	35.4	40.3	38.6	36.8
6/26	3.00					
6/29	1.32					
7/02		32.6	35.0	38.7	36.7	35.8
7/05		33.9	35.6	40.0	38.0	36.9
7/09		32.4	35.1	38.6	36.9	35.7
7/11		31.4	34.4	38.1	35.9	35.0
7/13		30.4	33.3	36.8	35.0	33.9
7/16		29.4	32.6	35.6	34.3	33.0
7/18		28.8	32.0	35.0	33.9	32.5
7/20		28.1	31.4	33.9	33.0	31.6
7/23		27.4	30.6	32.1	32.0	30.5
7/25		27.0	30.4	32.3	32.1	30.5
7/27	0.58	26.6	29.7	31.7	31.7	29.9
7/30		26.2	29.2	30.9	31.2	29.4
8/01		25.4	28.2	30.1	30.3	28.5
8/02		25.6	28.5	30.6	30.3	28.7
8/03		25.2	28.0	29.6	30.2	28.3
8/06		24.9	27.3	29.3	29.8	27.8
8/07		25.0	27.0	29.2	29.9	27.8
8/09	4.67	28.5	30.7	34.2	32.6	31.5
8/10	2.13					
8/13	1.65	30.0	32.8	33.8	32.9	32.4
8/15		29.0	32.2	30.9	32.2	31.1
8/17		27.7	31.9	32.0	31.7	30.8
8/20		26.4	30.9	31.6	31.5	30.1
8/22	1.04	25.9	30.3	30.9	31.3	29.6
8/23		25.9	30.3	31.1	31.5	29.7
8/27		24.7	28.9	29.7	30.5	28.5
8/29		24.0	28.4	29.5	30.2	28.0
8/30	0.76	23.8	28.0	29.0	30.0	27.7
8/31		24.1	28.0	28.7	29.8	27.7
9/04	2.57					
9/05		25.3	28.0	30.0	29.8	28.3
9/07		24.4	27.4	29.1	29.8	27.7

TABLE IX (CONTINUED)

Date	Rainfall (cm)	Cumulative Moisture Content Plot 2 (cm)	Plot 7 (cm)	Plot 12 (cm)	Plot 14 (cm)	Average (cm)
9/09	9.40					
9/11		28.8	31.5	32.6	30.4	30.8
9/14		24.9	30.2	30.6	30.5	29.0
9/17		24.0	29.6	30.3	30.7	28.6
9/18	0.41					
9/21		23.7	29.0	30.0	29.9	28.1
9/26	0.18					
9/28		22.8	27.4	28.9	29.7	27.2
10/04		22.6	26.4	27.6	28.7	26.3
10/11		22.3	25.2	27.0	28.7	25.8

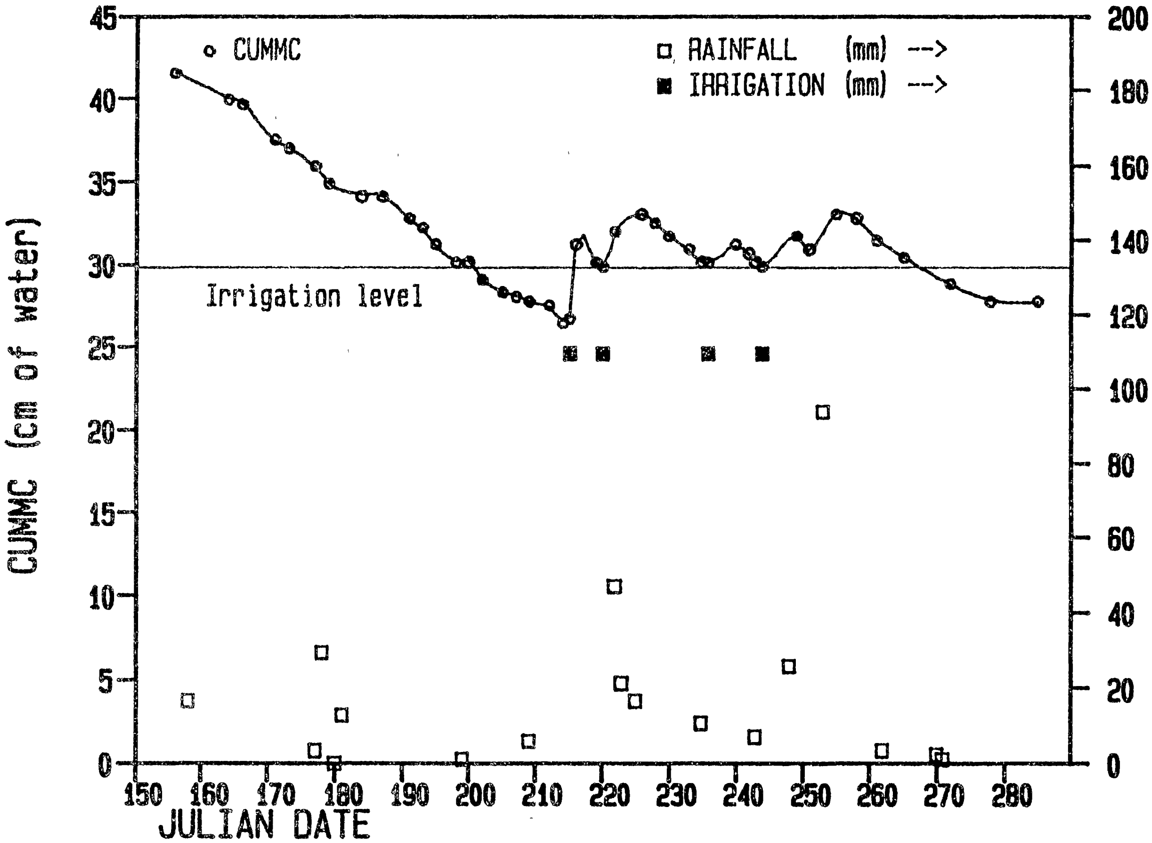

Figure 3. Irrigation Schedule for Treatment T4

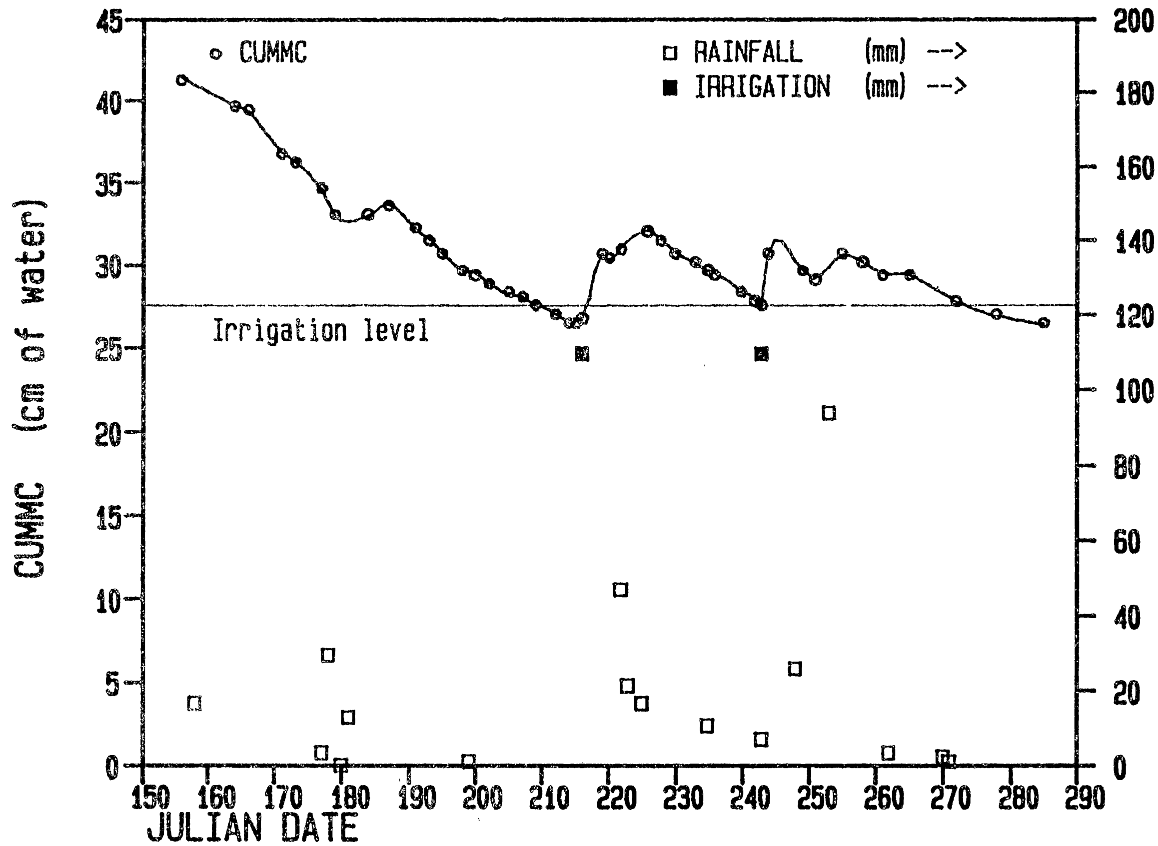

Figure 4. Irrigation Schedule for Treatment T3

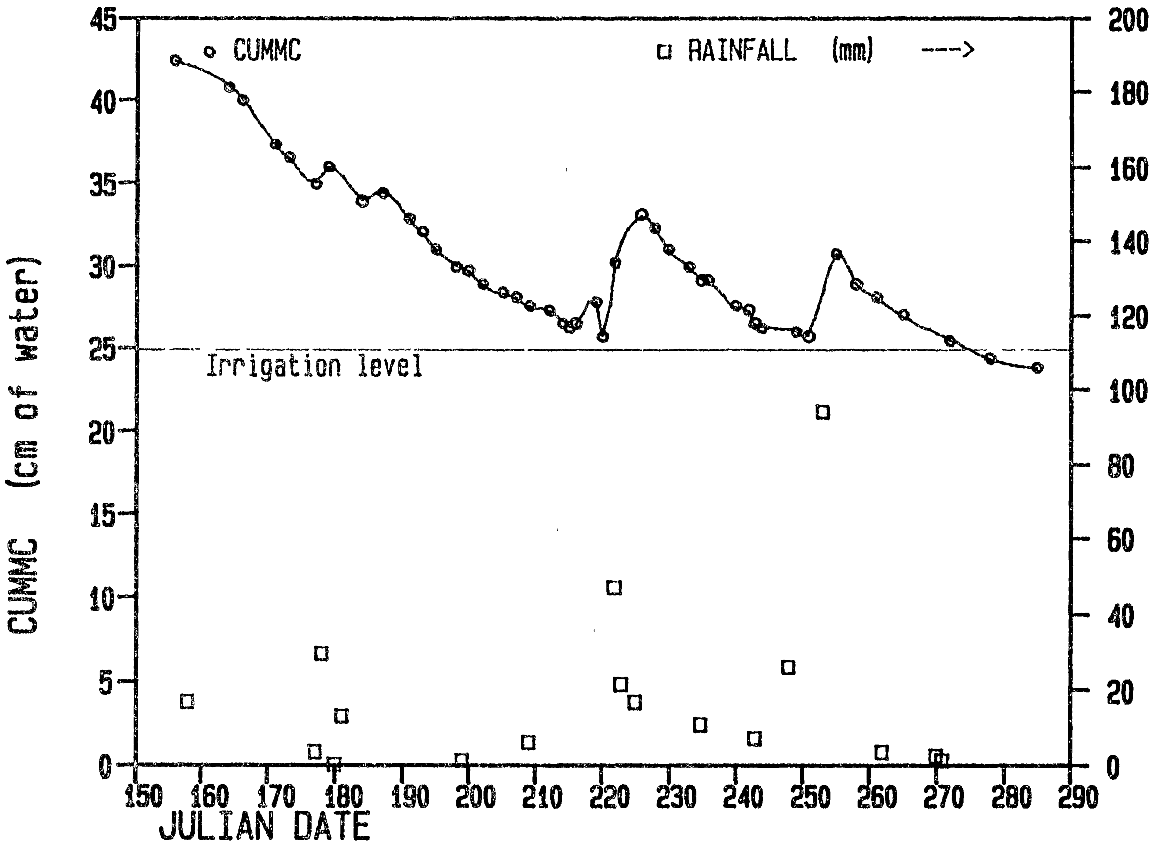

Figure 5. Irrigation Schedule for Treatment T2

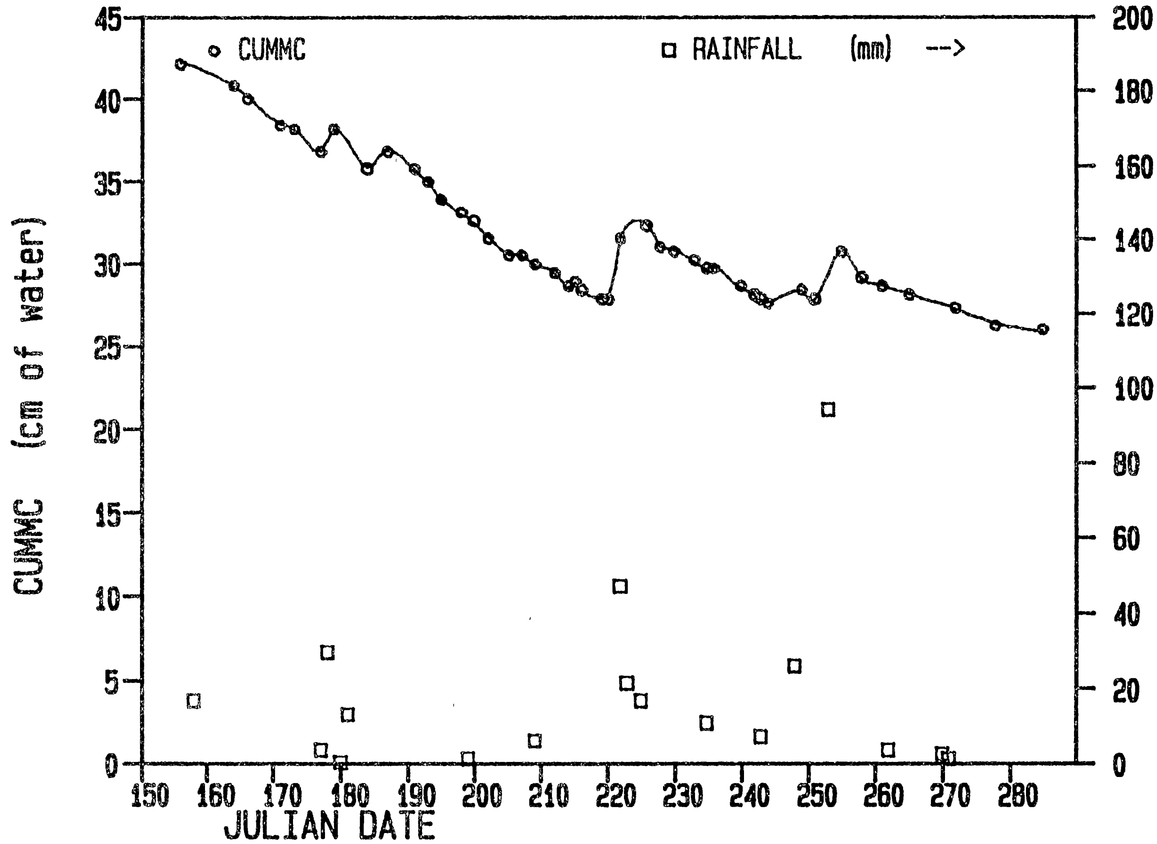

Figure 6. Irrigation Schedule for Treatment T1

days, flooding the orchard on the latter date. Therefore, the plots of treatment T2 and the control treatment T1 received only the rainfall of 29.8 cm (11.7 in) of water.

Measuring of Trees

When the trees for the irrigation studies were chosen by Said (1984), the trees were thought to be of nearly the same size. However, this author believed that some of the tree sizes varied too much for there not to be any significant differences between the trees. Therefore, the tree's canopy area, canopy volume and trunk diameter were measured and later used in analyzing consumptive water use and nut yield.

The canopy area was estimated as being the area of the shadow cast by the tree while the sun was directly overhead. Six diameters of the shadow were measured and the average diameter was used in calculating the canopy area. The canopy volume was estimated as being a cylinder, with the volume being calculated as the canopy area multiplied by the canopy height. The canopy height was considered as the distance from the first limb-break of the tree to the top of the tree and was measured using a transit. The trunk diameter was measured at a distance of 60 cm (2 ft) from the ground level. Table X shows the dimensions of each test tree.

TABLE X

DIMENSIONS OF TEST TREES

Tree No.	Trunk Diameter (cm)	Canopy Area (m^2)	Canopy Volume (m^3)
1	22.8	52	369
2	24.6	68	607
3	23.8	67	560
4	26.1	92	807
5	27.5	77	637
6	26.2	77	686
7	24.2	88	801
8	25.8	86	812
9	25.2	89	804
10	30.6	91	546
11	26.4	84	890
12	25.8	84	695
13	29.1	88	787
14	22.8	72	599
15	23.8	77	627
16	24.3	72	616

Leaf Analysis

Leaf samples (approximately 100 of the middle leaflets from the middle leaves of the current season's growth) were collected from each test plot on September 14, 1984. The samples were analyzed for their elemental concentrations by a Laboratory Technician at the Horticulture Research Laboratory, Oklahoma State University.

Nut Yield and Nut Size

Harvesting of the nuts occurred during late November. Each tree was harvested separately and the nut yield per tree was recorded.

Two 10-nut samples from each tree were brought to the Horticulture Research Laboratory for the determination of the nut weight, kernel weight and percent kernel.

Soil Sampling

Because of the variability of the soil texture from plot to plot and the non-homogeniety of the soil profiles within the plots, soil samples were taken in several plots. Samples were taken from at least one plot in each block and treatment. The plots sampled were plots 2, 4, 6, 9, 11 and 14. Plots 9 and 4 were sampled mainly because they remained at a lower cumulative moisture content than the rest of the trees in the experiment during the season.

The soil samples were taken at the 15 cm (6 in), 30 cm

(12 in), 60 cm (24 in), 90 cm (36 in) and, if possible, 120 cm (48 in) depths. The samples were taken approximately 120 cm (48 in) north of the access tubes. A hole was dug to 2.5 cm (1 in) above the desired depth with post-hole diggers and two samples per depth were taken with a standard core sampler. The samples, in the brass retaining cylinders, were sealed in metal containers and taken back to the laboratory for analysis.

Field capacity for each sample was determined using the 1-bar ceramic pressure plate in the pressure plate extractor at a pressure of 1/3 bar. The permanent wilting point was determined for each sample using the 15-bar ceramic pressure plates in the pressure plate extractor at a pressure of 15 bars. The bulk density of each sample was also determined by oven drying a known soil volume.

The amount of available water for each sampling depth was calculated as the difference between field capacity and permanent wilting point. An equivalent depth of cumulative moisture over the 120 cm (48 in) soil profile was determined by multiplying the incremental depth of the individual samples by their amount of available water (volumetric basis).

The soil textural class was determined for each sample using the USDA method previously discussed. All of the soil analysis experiments were performed at the Agricultural Engineering Laboratory, Oklahoma State University.

CHAPTER V

RESULTS AND DISCUSSION

Water-Use Rates of Pecan Trees

The water-use rates of the pecan trees for the various irrigation treatments can be calculated from Tables VI through IX. The difference in the average cumulative moisture contents for a given time period divided by that time period will give the daily water-use rate in terms of cm per day. When the difference in the cumulative moisture content was negative (when the soil profile moisture content increased because of rain or irrigation), the interval was not used for the water-use rate.

Tensiometers were used at the 120 cm and 150 cm depth to determine if the soil moisture was moving upward or downward in the root zone. If the total head (the sum of the pressure potential, or tension, and the gravitational potential) at the 120 cm depth was less (more negative) than the total head at the 150 cm depth, the water would be moving upward into the root zone. The tensiometer data and values of total head and suction for the irrigation period are given in Appendix C. During most of the season, there was little or no water movement into or out of the root zone at the 120 cm depth.

Due to the difference in relative tree sizes within the experimental plots, the water-use rates were also calculated based on tree canopy area in cm per square meter of canopy area per day and based on tree canopy volume in cm per cubic meter of canopy volume per day. Tables XI through XIII give water-use rates over 10-day intervals based on the three different principles.

During the 10-day interval from August 3 to 12, the water-use rates for treatments T1 and T2 were lower than average. During the same time period, treatments T3 and T4 had average to higher than average water-use rates. This was probably due to limited water availability in treatments T1 and T2 while the trees in treatments T3 and T4 were irrigated during this period, increasing available water. During August 13 to 22, rainfall increased available water and the trees of treatments T1 and T2 had higher water-use rates.

The first of June through the last of September is the period of highest water use by the trees. There were no significant treatment differences in the average water-use rate for this period. This was true for all of the three bases, per tree, canopy area and canopy volume. The average water-use rate of treatment T2 was the highest at 0.31 cm per day per tree, with treatments T1, T3 and T4 having average water-use rates of 0.27 cm per day per tree.

Since there were no significant differences in the water-use rates of the different irrigation treatments, the average water-use rate over all 16 experimental plots was

TABLE XI

AVERAGE WATER-USE RATES IN CM PER DAY PER TREE USING 10-DAY INTERVALS

Time Interval	Average Use Rate (cm/day)			
	TRT 1	TRT 2	TRT 3	TRT 4
6/04 - 6/13	0.21	0.23	0.21	0.18
6/14 - 6/23	0.29	0.46	0.43	0.35
6/24 - 7/03	0.34	0.36	0.41	0.28
7/04 - 7/13	0.37	0.43	0.37	0.26
7/14 - 7/23	0.31	0.26	0.30	0.37
7/24 - 8/02	0.27	0.20	0.20	0.21
8/03 - 8/12	0.12	0.17	0.37	0.30
8/13 - 8/22	0.31	0.40	0.26	0.30
8/23 - 9/01	0.26	0.34	0.29	0.28
9/02 - 9/11	0.40	0.27	0.24	0.33
9/12 - 9/21	0.28	0.35	0.13	0.28
9/22 - 10/01	0.14	0.22	0.20	0.20
Average:	0.27	0.31	0.27	0.27

TABLE XII

AVERAGE WATER-USE RATES IN CM PER SQUARE METER OF CANOPY AREA PER DAY USING 10-DAY INTERVALS

Time Interval	Average Use Rate x 10^3 (cm/m^2/day)			
	Trt 1	Trt 2	Trt 3	Trt 4
6/04 - 6/13	2.69	2.65	2.76	2.40
6/14 - 6/23	3.71	5.29	5.65	4.66
6/24 - 7/03	4.35	4.14	5.39	3.73
7/04 - 7/13	4.74	4.95	4.86	3.46
7/14 - 7/23	3.97	2.99	3.96	4.92
7/24 - 8/02	3.46	2.30	2.63	2.79
8/03 - 8/12	1.54	1.96	4.86	3.99
8/13 - 8/22	3.97	4.60	3.42	3.99
8/23 - 9/01	3.33	3.91	3.81	3.73
9/02 - 9/11	5.12	3.11	3.16	4.39
9/12 - 9/21	3.58	4.03	1.71	3.73
9/22 - 10/02	1.79	2.53	2.63	2.66
Average:	3.48	3.60	3.51	3.65

Note: Use rates were based on average canopy areas for treatments 1, 2, 3 and 4 of 78, 87, 76 and 75 m^2 respectively.

TABLE XIII

AVERAGE WATER-USE RATES IN CM PER CUBIC METER OF CANOPY VOLUME PER DAY USING 10-DAY INTERVALS

Time Interval	Average Use Rate x 10^3 ($cm/m^3/day$)			
	Trt 1	Trt 2	Trt 3	Trt 4
6/04 - 6/13	0.31	0.33	0.32	0.27
6/14 - 6/23	0.43	0.65	0.66	0.52
6/24 - 7/03	0.50	0.51	0.57	0.41
7/04 - 7/13	0.55	0.61	0.57	0.38
7/14 - 7/23	0.46	0.37	0.46	0.55
7/24 - 8/02	0.40	0.28	0.31	0.31
8/03 - 8/12	0.18	0.24	0.57	0.44
8/13 - 8/22	0.46	0.57	0.40	0.44
8/23 - 9/01	0.39	0.48	0.44	0.41
9/02 - 9/11	0.59	0.38	0.37	0.49
9/12 - 9/21	0.41	0.50	0.20	0.41
9/22 - 10/01	0.21	0.31	0.31	0.30
Average:	0.40	0.44	0.41	0.41

Note: Use rates were based on average canopy volumes for treatments 1, 2, 3 and 4 of 676, 706, 653 and 676 m^3, respectively.

determined for the months of June, July, August and September, as well as for the overall season (Table XIV). The seasonal average water-use rates on a per tree basis were 0.28 cm per day, 3.57 x 10^{-3} cm per m^2 of canopy area per day and 0.41 x 10^{-3} cm per m^3 of canopy volume per day.

The water-use rates were also determined on a volume of water used per day (Table XV). These were determined by multiplying the use rate in cm per day by the average canopy area of the trees (assuming that this is the area of the greatest uptake of water by the roots). The seasonal average water-use rates on a water volume per tree basis were 221 liters per day, 0.28 liters per m^2 of canopy area per day and 0.32 liters per m^3 of canopy volume per day. Figures 7, 8 and 9 show a graphical representation of the average monthly water-use rates on water-volume bases.

The peak water-use rate of the pecan trees occurred in July with use rates per tree of 0.30 cm (237 liters) per day, 3.85 x 10^{-3} cm (0.30 liters) per m^2 of canopy area per day and 0.45 x 10^{-3} cm (0.036 liters) per m^3 of canopy volume per day.

Irrigation Effects on Nut Yield

The nut yield was determined in kilograms per tree and in grams per cubic meter of canopy volume (Table XVI). The yield based on tree canopy volume was used because of the variability between tree sizes (Table X). Statistical

TABLE XIV

AVERAGE MONTHLY WATER-USE RATES IN CM PER DAY PER TREE

Month	Basis		
	Tree (cm/day)	Canopy Area ($cm/m^2/day$) ($x10^3$)	Canopy Volume ($cm/m^3/day$) ($x10^3$)
June	0.29	3.73	0.44
July	0.30	3.85	0.45
August	0.29	3.67	0.43
September	0.24	2.98	0.35
Average	0.28	3.57	0.41

TABLE XV

AVERAGE MONTHLY WATER-USE RATES IN LITERS (GALLONS) PER DAY PER TREE

Month	Basis: Tree (L/day) [gal/day]	Basis: Canopy Area ($L/m^2/day$) [$gal/ft^2/day$] [$x10^3$]	Basis: Canopy Volume ($L/m^3/day$) [$gal/ft^3/day$] [$x10^3$]
June	229 [61]	0.29 [7.1]	0.035 [0.26]
July	237 [63]	0.30 [7.4]	0.036 [0.27]
August	229 [61]	0.29 [7.1]	0.034 [0.25]
September	190 [50]	0.24 [5.9]	0.028 [0.21]
Average	221 [58]	0.28 [6.9]	0.032 [0.24]

Note: Use rates were based on an average canopy area of 79 m^2.

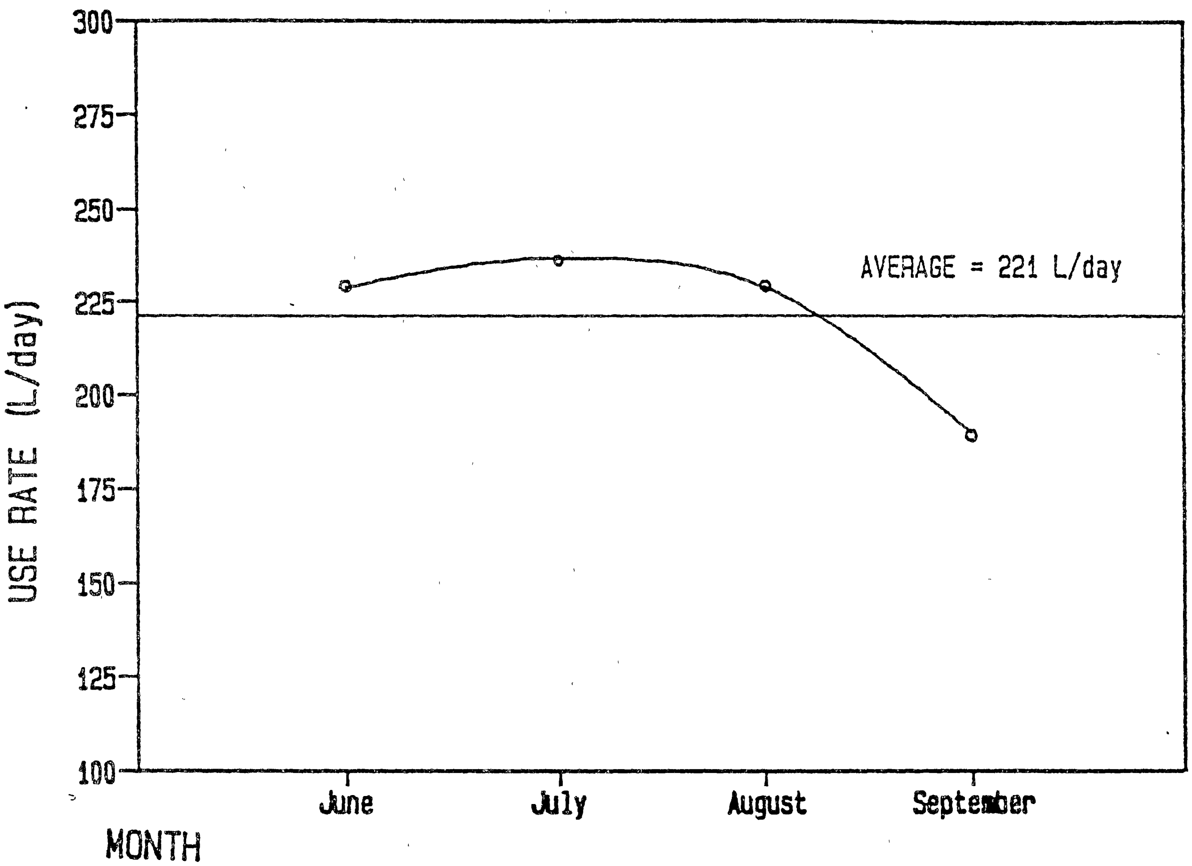

Figure 7. Average Monthly Water-Use Rate of a Pecan Tree in Liters Per Day

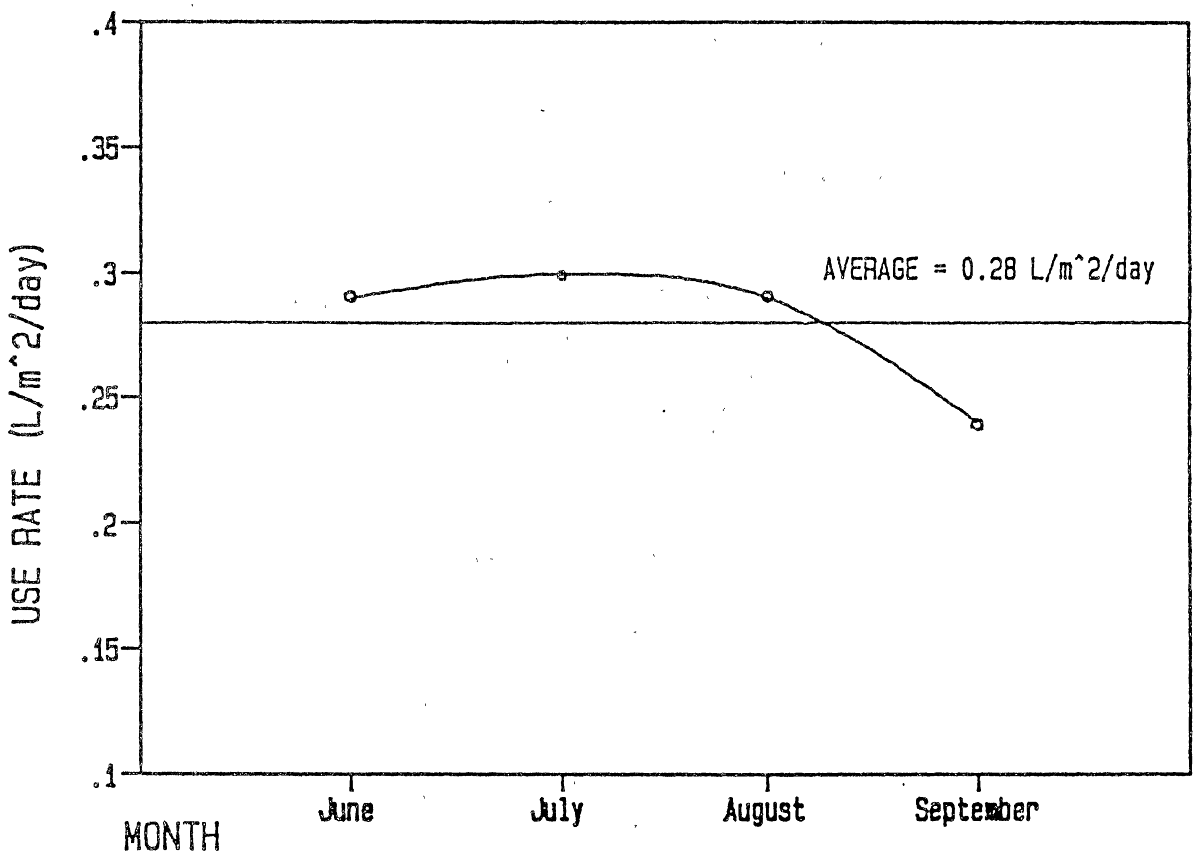

Figure 8. Average Monthly Water-Use Rate of a Pecan Tree in Liters Per Square Meter of Tree Canopy Area Per Day

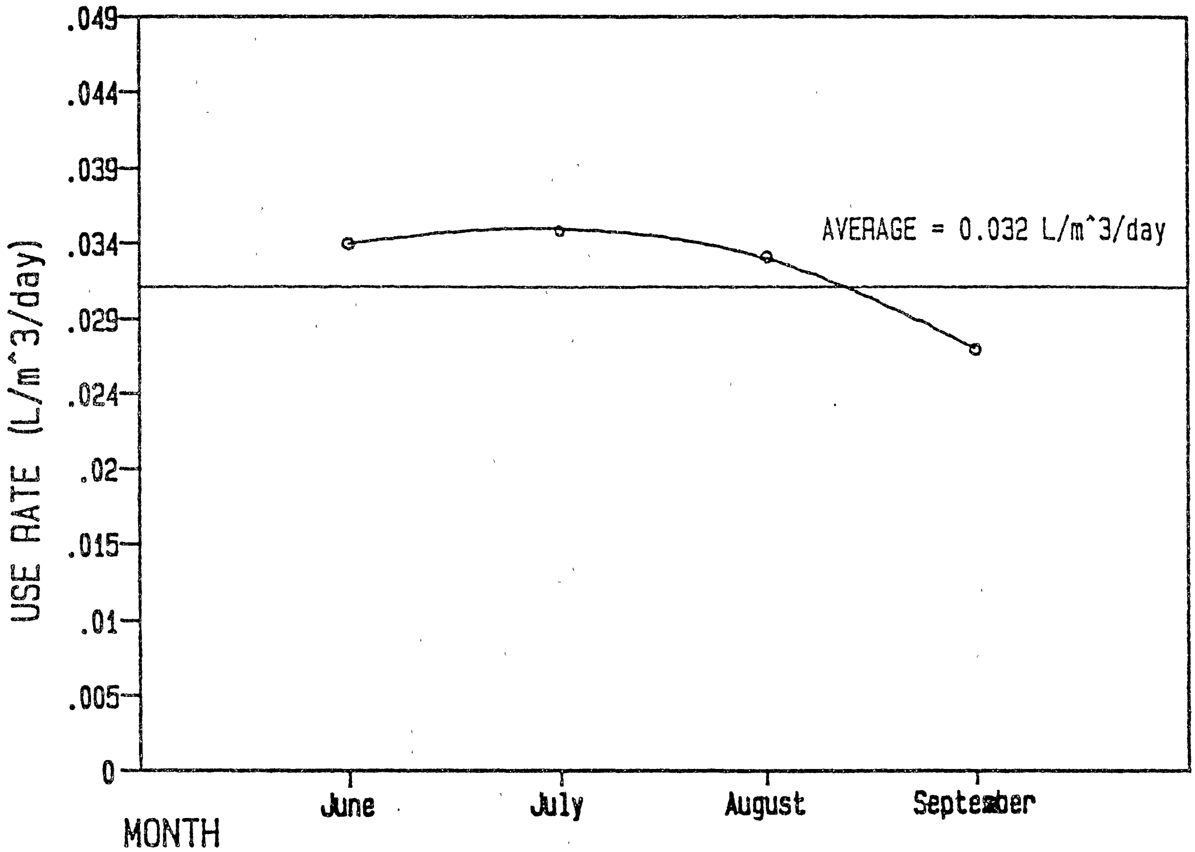

Figure 9. Average Monthly Water-Use Rate of a Pecan Tree in Liters Per Cubic Meter of Tree Canopy Volume Per Day

TABLE XVI

NUT YIELD IN KG PER TREE AND GRAMS PER CUBIC METER OF CANOPY VOLUME

Treatment	Block	Yield	
		Kg	g/m^3
T1	1	16.6	27.3
	2	23.2	28.9
	3	21.8	31.4
	4	24.4	40.6
T2	1	24.6	30.5
	2	27.1	39.5
	3	17.6	32.3
	4	25.9	33.0
T3	1	10.7	29.0
	2	26.8	33.0
	3	15.3	19.0
	4	35.4	56.5
T4	1	13.6	24.2
	2	27.2	42.8
	3	27.8	31.3
	4	24.9	40.4

analyses were performed for each basis and are shown in Appendix D.

When using the yield in kilograms per tree, the irrigation treatment was insignificant (Pr>F = 0.9226). The blocking effect was significant (Pr>F = 0.0646), however. From the Duncan's Multiple Range Test it was found that the average yield of block no. 1 was significantly lower than the average yields of the other blocks.

When using the nut yield in grams per cubic meter of canopy volume, the irrigation treatment was insignificant (Pr>F = 0.9641). The blocking effect was still significant (Pr>F = 0.0725) for this basis. The average nut yield of block no. 4 was significantly greater than the average nut yield of the other blocks. This was possibly due to the greater availability of water in this area due to the higher water table and higher clay content (discussed later).

Analysis of 1983 and 1984 yield data (Table XVII), when using kilograms per tree and grams per cubic meter of canopy volume, indicated that the treatment (irrigation level) by year interaction was not significant in either case (Pr>F = 0.1865 and 0.1919, respectively, Appendix D). The yield values for 1983 were obtained from Said (1984), assuming the tree volumes were the same last year as they were this year.

Irrigation Effects on Nut Characteristics

The percent kernel was determined on 20-nut samples by

TABLE XVII

COMPARISON BETWEEN 1983 AND 1984
AVERAGE PECAN CROP YIELDS

Treatment/ Block	Year			
	1983		1984	
	Average Yield			
	Kg/tree	g/m^3	Kg/tree	g/m^3
		Treatments		
T1	16.9	25.5	21.5	32.1
T2	19.6	30.2	23.8	33.8
T3	16.4	22.3	22.0	34.4
T4	12.1	17.7	23.4	34.7
		Blocks		
1	12.5	19.9	16.4	27.8
2	15.3	20.7	26.1	36.0
3	24.7	35.4	20.6	28.5
4	12.5	18.9	27.6	42.6

Source: Said (1984)

dividing the weight of the kernel by the weight of the unshelled nut. Table XVIII shows the weight of the 20-nut sample (NUTWT), the kernel weight (KERWT), weight per nut (WTNUT) and the percent kernel (PERKER).

Appendix E shows the results of the analysis of the experimental effects on pecan nut characteristics. There were no significant irrigation treatment effects on nut weight, kernel weight, weight per nut or percent kernel. However, there were some significant differences between the blocks. The nut weight, kernel weight and weight per nut for block no. 4 were significantly lower than those of the other blocks. This was possibly caused by poor soil aeration in the block. The water table in block no. 4 was higher for a longer period, and when the orchard would flood this area would remain under water longer than the rest of the experimental blocks.

Leaf Analysis

The nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg) concentrations are expressed in percentages, while zinc (Zn), iron (Fe) and manganese (Mn) concentrations are expressed in parts per million (ppm) (Table XIX).

Nitrogen was the only element that was significantly different between treatments or blocks. The leaf nitrogen concentration of treatment T3 was significantly higher than that of treatment T4. The leaf nitrogen concentration of

TABLE XVIII

NUT CHARACTERISTICS OF 20-NUT SAMPLES

Treatment	Block	NUTWT (gm)	KERWT (gm)	WTNUT (gm)	PERKER (%)
T1	1	217.38	129.55	10.87	59.60
	2	230.37	138.12	11.52	59.97
	3	246.48	141.06	12.33	57.23
	4	215.06	128.66	10.76	59.83
T2	1	214.20	120.35	10.71	56.19
	2	227.47	137.54	11.38	60.47
	3	210.26	123.77	10.52	58.84
	4	185.90	101.55	9.30	60.01
T3	1	209.13	124.68	10.46	59.62
	2	232.18	133.25	11.61	57.39
	3	232.37	137.43	11.62	59.14
	4	185.97	104.80	9.30	56.35
T4	1	236.73	143.90	11.84	60.78
	2	221.10	132.31	11.06	59.85
	3	220.36	130.16	11.02	59.07
	4	179.72	101.44	8.99	56.64

Table XIX

ELEMENTAL CONCENTRATIONS OF THE LEAF SAMPLES

OBS	PLOT	TRT	BLOCK	N	P	K	CA	MG	ZN	FE	MN
1	2	1	1	2.32	0.108	0.44	2.09	0.28	11	48	1492
2	7	1	2	2.27	0.104	0.53	2.21	0.33	11	53	1129
3	12	1	3	2.40	0.108	0.40	1.53	0.30	15	49	537
4	14	1	4	2.16	0.106	0.50	1.69	0.27	16	48	907
5	4	2	1	2.28	0.104	0.51	1.74	0.26	13	51	1024
6	6	2	2	2.38	0.115	0.50	1.78	0.23	19	53	1324
7	10	2	3	2.32	0.115	0.69	1.97	0.27	14	56	700
8	13	2	4	2.12	0.111	0.55	2.01	0.35	12	55	781
9	1	3	1	2.35	0.104	0.60	1.07	0.27	11	46	1486
10	8	3	2	2.33	0.104	0.61	1.77	0.28	11	50	791
11	9	3	3	2.38	0.111	0.80	2.13	0.28	15	58	1481
12	15	3	4	2.34	0.104	0.45	1.70	0.29	15	49	482
13	3	4	1	2.19	0.110	0.77	2.11	0.29	12	60	1276
14	5	4	2	2.32	0.106	0.61	2.06	0.27	12	50	761
15	11	4	3	2.18	0.109	0.67	2.01	0.30	14	54	1031
16	16	4	4	2.00	0.093	0.43	1.55	0.25	11	55	857

block no. 4 was significantly lower than the other blocks. This was probably also due to the presence of excess water in block 4. Nitrogen is very mobile in the soil and will leach easier than the other elements. A complete statistical analysis of the elemental concentrations of the pecan leaves is given in Appendix F.

Soil Analysis

The field capacity, permanent wilting point and amount of available water were determined for each soil sample in the sampled plots (Table XX). These values were determined using the average values for the two samples from each depth.

The percentages of sand, silt and clay were determined and used in finding the soil textural class for each sample (Table XXI). The soils in the upper 60 cm (24 in) of the plots were generally sandy clay loam or sandy loam. The soils below 60 cm (24 in) varied from sand in plot no. 9 to clay in plot no. 4, with sandy clay in plots 2 and 6. Plot no. 14 consisted of clay from 60 cm (24 in) and deeper, which was observed to be true for all of the plots in block no. 4.

The soil survey conducted by the Department of Agronomy, Oklahoma State University (Appendix A), established the soil of the test plots to be Port silty clay loam with layers of fine sandy loam, silty clay, clay loam and light clay in some of the profiles. This author did not find any silty clay loam or very much silt in any of the

TABLE XX

SOIL CHARACTERISTICS OF VARIOUS TEST PLOTS

Plot	Depth (cm)	Bulk Density (g/cm^3)	Permanent Wilting (%)*	Field Capacity (%)*	Available Water (%)*
2	15	1.56	18.8	25.7	6.9
	30	1.46	20.9	26.9	4.0
	60	1.56	14.5	21.8	4.7
	90	1.62	23.9	32.0	8.1
4	15	1.71	18.2	23.1	4.9
	30	1.53	16.5	23.2	6.7
	60	1.49	13.9	21.8	7.9
	90	1.60	19.1	37.8	8.7
6	15	1.75	14.7	27.9	13.2
	30	1.70	10.4	25.6	15.2
	60	1.61	14.7	31.7	17.0
	90	1.59	11.1	23.8	12.7
9	15	1.69	11.3	20.8	9.5
	30	1.59	22.9	31.5	8.6
	60	1.59	8.4	16.0	7.6
	90	1.46	3.8	6.6	2.8
	120	1.41	4.5	7.5	3.0
11	15	1.68	20.8	30.5	9.7
	30	1.62	23.3	34.5	11.2
	60	1.62	13.9	25.8	11.9
	90	1.60	15.0	28.8	13.8
14	15	1.72	13.9	25.2	11.3
	30	1.66	11.4	28.9	17.5
	60	1.56	24.3	37.5	13.2
	90	1.52	29.7	44.2	14.5

* Determined on a volume basis.

TABLE XXI

SOIL TEXTURAL CLASSES OF VARIOUS TEST PLOTS

Plot	Depth (cm)	% Sand	% Silt	% Clay	Textural Class
2	15	55.0	16.0	29.0	Sandy Clay Loam
	30	61.0	8.3	30.7	Sandy Clay Loam
	60	77.3	4.5	18.2	Sandy Loam
	90	48.8	10.8	40.4	Sandy Clay
4	15	70.5	6.8	22.7	Sandy Clay Loam
	30	75.5	4.3	20.2	Sandy Clay Loam
	60	77.5	7.0	15.5	Sandy Loam
	90	27.8	18.0	54.2	Clay
6	15	72.5	6.0	21.5	Sandy Clay Loam
	30	79.3	1.3	19.5	Sandy Loam
	60	67.5	7.5	25.0	Sandy Clay Loam
	90	79.0	2.2	18.8	Sandy Loam
9	15	66.3	11.5	22.7	Sandy Clay Loam
	30	46.0	5.8	48.3	Sandy Clay
	60	66.3	13.8	20.0	Sandy Clay Loam
	90	96.3	1.2	2.5	Sand
	120	98.8	0.7	0.5	Sand
11	15	69.8	7.2	23.0	Sandy Clay Loam
	30	52.8	12.4	34.8	Sandy Clay Loam
	60	62.3	8.4	29.3	Sandy Clay Loam
	90	69.5	6.2	24.3	Sandy Clay Loam

TABLE XXI (Continued)

Plot	Depth (cm)	% Sand	% Silt	% Clay	Textural Class
14	15	67.5	3.5	17.5	Sandy Loam
	30	76.3	2.9	20.8	Sandy Clay Loam
	60	42.3	9.7	48.0	Clay
	90	19.8	10.7	69.5	Clay

plots, however.

Rawls, Brakensiek and Saxton (1982) estimated the soil properties for various soil textures and classes. They used a comprehensive search of the literature and sources of hydraulic conductivity and related soil-water data obtained from all over the United States. Table XXII shows an excerpt of their results. They used the 1/3-bar percentage for field capacity and the 15-bar percentage for the permanent wilting point, as used in this study. The data collected from this study compares very well with their results.

The equivalent depth of water, or cumulative moisture content, for a soil depth of 120 cm (48 in) was calculated for field capacity, permanent wilting point and available water for each plot (Table XXIII). The 1/3-bar and 15-bar percentages are only used as estimates of field capacity and permanent wilting point, and these values can vary widely from actual field conditions. This is especially true for sandier soils where the field capacity is sometimes considered to be closer to the 1/10-bar percentage. Therefore, the values determined in this study may be lower than the actual values.

Field capacity can be considered as the moisture content of the soil two to three days after a heavy rainfall or irrigation. When comparing the data from the moisture contents in Appendix B after a large rainfall such as on May 29 (5.0 cm) and September 9 (9.4 cm) with the field capacity

TABLE XXII

SOIL PROPERTIES CLASSIFIED BY SOIL TEXTURE

Texture Class	Water Retained at 0.33 bar tension (cm^3/cm^3)	Water Retained at 15 bar tension (cm^3/cm^3)
Sand	0.091 (0.018-0.164)	0.033 (0.007-0.059)
Loamy sand	0.125 (0.060-0.190)	0.055 (0.019-0.091)
Sandy loam	0.207 (0.126-0.288)	0.095 (0.031-0.159)
Loam	0.270 (0.195-0.345)	0.117 (0.069-0.165)
Silt loam	0.330 (0.258-0.402)	0.133 (0.078-0.188)
Sandy clay loam	0.330 (0.186-0.324)	0.133 (0.085-0.211)
Clay loam	0.318 (0.250-0.368)	0.192 (0.115-0.279)
Silty clay loam	0.366 (0.304-0.428)	0.208 (0.138-0.278)
Sandy clay	0.339 (0.245-0.435)	0.239 0.162-0.316)
Silty Clay	0.387 (0.332-0.442)	0.250 (0.193-0.307)
Clay	0.396 (0.326-0.466)	0.272 (0.208-0.336)

Source: Rawls, Brakensiek and Saxton (1982)

TABLE XXIII

EQUIVALENT DEPTHS OF WATER FOR SOIL CHARACTERISTICS OF VARIOUS TEST PLOTS

Plot	Equivalent Depths of Water in 120 cm Soil Profile		
	Field Capacity (cm)	Permanent Wilting (cm)	Available Water (cm)
2	32.0	23.4	8.6
4	32.8	23.9	8.9
6	32.8	15.3	17.5
9	19.7	12.1	7.6
11	35.1	20.8	14.3
14	42.8	25.9	16.9

values found in Table XX, it can be seen that the values from the field were usually higher than the laboratory values. Another example of this is plot no. 9 where the estimated field capacity was 19.7 cm (Table XXIII), but as seen in Table VI, the cumulative moisture content remained above this value most of the season.

The values determined for permanent wilting point may also be different than the actual values. For instance, the estimated permanent wilting point for plot no. 4 was 23.9 cm (Table XXIII), but from Table VIII the cumulative moisture content droppped below this value from the period of July 25 to August 7, from August 30 to September 7 and after October 4.

The soil differences between the plots can also be seen when considering the depletion of available water at the irrigation levels. The percent depletion of available water can be calculated as amount of water at field capacity minus the cumulative moisture content being considered, divided by the amount of available water. Plots no. 4 and 6 were both in treatment T2, which was to be irrigated when the cumulative moisture content fell below 25 cm, but the percent depletion for plot no. 4 was 88% at the time of irrigation while the percent depletion of plot no. 6 was 45% at the time of irrigation. Plot no. 9 was in treatment T3, which was to be irrigated when the cumulative moisture content fell below 27.5 cm, but its estimated field capacity was lower than the irrigation level. Plot no. 11 was in treatment T4, which was to be irrigated when the cumulative moisture content fell below 30 cm, and its percent depletion was 36% at the time of irrigation. Plots no. 2 and 14 were in treatment T1 and were not to be irrigated.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Summary

This research was conducted primarily to determine the water-use rates of mature (12-year old) pecan trees and to determine if there were any carry-over effects due to the previous year's irrigation. The same 4 x 4 randomized block experimental plots were used in this study as were used by Said (1984) in the previous year. The irrigation treatment levels were based on the average cumulative moisture contents within the root zone, taken as 120 cm (4 ft) deep, and were lowered slightly from the levels used by Said (1984). The following irrigation treatment levels were used:

T1 - No irrigation.

T2 - Irrigate when the average cumulative moisture content falls below 25 cm (9.8 in).

T3 - Irrigate when the average cumulative moisture content falls below 27.5 cm (10.8 in).

T4 - Irrigate when the average cumulative moisture content falls below 30 cm (11.8 in).

A neutron moisture gauge was used to measure the soil moisture content of each plot at a point 3 meters to the west side of the tree. The daily water-use rate of the tree was computed based on the change in the cumulative moisture content over a given time period.

Results were determined for irrigation treatment and blocking effects on:

1. elemental absorption
2. nut characteristics
   a. nut weight
   b. kernel weight
   c. percent kernel
3. nut yield per tree and per tree canopy volume

The nut yield data from the previous year's study was also statistically compared with this year's yield data to determine if there were any interactions between the irrigation treatments and years.

The soil of the test area was not homogeneous between experimental blocks and within the profile of the plots themselves. Therefore, soil samples were taken at different locations and depths in the experimental area and analyzed to determine:

1. field capacity
2. permanent wilting point
3. amount of available water
4. soil textural class

Conclusions

The following conclusions were made from the study:

1. There was not any correlation between the average

water-use rate of a pecan tree and the level of the irrigation treatment. Therefore, the average water-use rate for all 16 experimental plots was determined for the period from June through September. The average water-use rates for this period on a per tree basis were 0.28 cm (221 liters) per day, 3.57 x 10^{-3} cm (0.28 liters) per m^2 of tree canopy area per day and 0.41 x 10^{-3} cm (0.032 liters) per m^3 of tree canopy volume per day.

The peak water use occurred in July with use rates on a per tree basis of 0.30 cm (237 liters) per day, 3.85 x 10^{-3} cm (0.30 liters) per m^2 of canopy area per day and 0.45 x 10^{-3} cm (0.036 liters) per m^3 of canopy volume per day.

2. Leaf nitrogen concentrations were significantly lower in block no. 4 and treatment T4. This was possibly caused by leaching of the nitrogen due to excess water during certain periods in the year.

3. Irrigation treatments did not effect nut weight, kernel weight or percent kernel. However, the nut weight and kernel weight were significantly lower in block no. 4 than the other blocks, caused possibly by poor soil aeration in the block.

4. Irrigation treatments did not affect the yield in kilograms per tree ($Pr>F = 0.9226$) or yield in grams per cubic meter of tree canopy volume ($Pr>F = 0.9641$).

5. The differences in nut yields between the experimental blocks were significant when using yield in

kilograms per tree and grams per cubic meter of canopy volume (Pr>F = 0.0646 and Pr>F = 0.0725, respectively). The average yield of block no. 1 was significantly lower than the average yield of the rest of the trees when considering the nut yield in kilograms per tree. The average yield of block no. 4 was significantly higher than the average yield of the other trees when considering the yield in grams per cubic meter of tree volume.

6. There were no interactions between the irrigation treatments and years for yield in kilograms per tree or grams per cubic meter of canopy volume (Pr>F = 0.1865 and Pr>F = 0.1919, respectively).

7. The soils of the test plots were mainly a sandy clay loam for the upper 60 cm (24 in) with layers of sand, sandy loam, sandy clay and clay for 60 cm (24 in) to 120 cm (48 in). The deeper soils in block no. 4 contained a higher clay content than the soils of the other plots.

Recommendations for Future Research

1. Investigate the effects of the presence of a high water-table on growth and development of pecan roots. Also perform a feasible study on the drainage requirements of the area.

2. Perform statistical analyses on the next year's (1985) crop to determine if irrigation can help eliminate alternate bearing of pecan trees.

3. Conduct a similar irrigation study on pecan trees at a different location where there is a lower water

table and not as much variability in soils, possibly setting the irrigation treatment levels at different water depletion values.

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APPENDIXES

APPENDIX A

EXCERPT OF A DETAILED SOIL SURVEY OF
THE PECAN RESEARCH STATION,
SPARKS, OKLAHOMA

A-1 Port Silty Clay Loam (0-1% slopes) occupies slightly depressed areas through which flow the small side drainageways. Here water has a tendency to pond or run very slowly during overflow periods, allowing very fine sediments to settle out so that textures are generally finer throughout the profile than in Port silt loam. These areas lie from 1 to 2 feet below adjacent areas.

The forest on these areas include a higher proportion of pecan than were on Port silt loam. Many pecans were left and now occur in groves or as single trees on this land. Thinning and spacing studies are being conducted on the thick stand of pecans in the southeast corner of this area.

This soil was described at a point 1300 feet north and 1000 feet west of the southeast corner Section 13, T 13 N, R 4 E west of Quapaw Creek. It is from a level area where the surface is weak, concave and has a gradient of about 1/2 percent. A scattering of native pecan trees and a thick stand of vetch was on the land at the time of sampling.

Profile:

A_{1p} 0-6" Redish brown (5 YR 4/3; 3/3, when moist) heavy silty clay loam; moderate subangular blocky to coarse granular; firm; crumbly when moist; hard when dry and sticky when wet; permeable; pH 6.5; peds contain many pores and worm holes; grades shortly to the layer below.

A_1	6-12"	Dark reddish-brown (3.5 YR 4/3; 3/3, when moist) heavy silty clay loam; weak fine blocky; very firm; hard dry; slowly permeable; pH 6.5; sides of peds are slightly darker than above and have faintly shiny films; grades to the layer below.
C_1	12-22"	Reddish-brown (2.5 YR 5/4; 4/4, when moist) heavy silty clay loam or light silty clay; weak blocky; very firm; slowly permeable; pH 7.0 at 22 inches; very fine pores; numerous fine roots penetrate the peds; grades to the layer below.
C_2	22-50"	Red (1 YR 4/4; 3/4. when moist) heavy silty clay loam weakly stratified with silty clay seams; weakly irregular blocky; very firm; slowly permeable; sides of peds faintly shiny when moist; pH 7.5 at 36 and 52 inches.

Variations: Variations are chiefly in the nature and stratification of soil materials. Profiles with fine sandy loam strata occur from 10 to 20 inches over clay loam to light clay. Silty clay layers commonly occur below 18 inches. In some profiles the surface 10 to 14 inches is a heavy silt loam weakly stratified with clay loams, and the subsurface material is of clay loam stratified with silty clays. Reactions range from neutral to weak alkaline below

24 inches.

If desired the surface drainage could be speeded by the use of shallow ditches.

APPENDIX B

A COMPUTER PROGRAM USING SAS TO CALCULATE THE VOLUMETRIC MOISTURE CONTENT OF SOIL

```
* COMPUTER PROGRAM TO CALCULATE MOISTURE CONTENTS OF THE SOIL;
*;
DATA MOISTURE;
*;
* READING DATA;
*;
INFILE READINGS;
INPUT  DATE $ PLOT TRT STDC M6 M12 M18 M24 M30 M36 M42 M48;
*;
* CALCULATING THE MOISTURE CONTENT (P) AT DIFFERENT DEPTHS;
* (IN INCHES) FROM CALIBRATION EQUATION USING THE STANDARD;
* COUNT (STDC) AND MEASURED COUNT (M);
*;
         P6=0.00422+0.6094*M6/STDC;
         P12=-0.0215+0.5909*M12/STDC;
         P18=-0.0215+0.5909*M18/STDC;
         P24=-0.0215+0.5909*M24/STDC;
         P30=-0.0215+0.5909*M30/STDC;
         P36=-0.0215+0.5909*M36/STDC;
         P42=-0.0215+0.5909*M42/STDC;
         P48=-0.0215+0.5909*M48/STDC;
*;
* CALCULATING THE CUMULATIVE MOISTURE CONTENT (CUMMC);
*;
        CUMMC=22.86*P6+15.24*(P12+P18+P24+P30+P36+P42)+7.62*P48;
CARDS;
*;
* SORTING THE DATA;
*;
PROC SORT;
         BY DATE TRT;
*;
* PRINTING THE DATA;
*;
PROC PRINT;
         BY DATE ;
         VAR TRT PLOT P6 P12 P18 P24 P30 P36 P42 P48 CUMMC;
TITLE SOIL MOISTURE DATA;
```

SOIL MOISTURE DATA

DATE=06/04

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
1	1	2	0.295277	0.290119	0.304398	0.307758	0.334636	0.350175	0.444248	0.429549	40.9807
2	1	7	0.297875	0.293059	0.313217	0.319517	0.341775	0.352275	0.364034	0.364454	39.8209
3	1	12	0.368907	0.321617	0.345135	0.416950	0.387972	0.386712	0.398052	0.383353	45.7425
4	1	14	0.337289	0.316577	0.324977	0.361094	0.345555	0.347655	0.382513	0.364034	42.1587
5	2	4	0.293977	0.304398	0.348075	0.339676	0.353535	0.352275	0.450548	0.396372	42.4839
6	2	6	0.297875	0.295579	0.317837	0.316997	0.348915	0.398472	0.400571	0.387972	41.4401
7	2	10	0.341621	0.300198	0.345975	0.382933	0.373273	0.351855	0.383353	0.393432	43.3842
8	2	13	0.343353	0.301458	0.304398	0.341355	0.387972	0.356474	0.363614	0.378313	42.0541
9	3	1	0.276219	0.256101	0.312797	0.344295	0.338836	0.373273	0.360674	0.456848	40.0618
10	3	8	0.317799	0.279200	0.300198	0.348495	0.361094	0.368234	0.390912	0.395952	41.4956
11	3	9	0.284882	0.312797	0.299778	0.344295	0.373693	0.372433	0.365714	0.366974	40.8359
12	3	15	0.352015	0.330436	0.350595	0.337156	0.367814	0.352695	0.366134	0.391332	43.1066
13	4	3	0.300041	0.290539	0.301458	0.321617	0.351015	0.342195	0.451388	0.390492	41.2016
14	4	5	0.293977	0.279200	0.299358	0.314477	0.370753	0.372013	0.362774	0.363614	39.9494
15	4	11	0.297442	0.306918	0.327496	0.309858	0.342195	0.358154	0.355214	0.360674	40.0254
16	4	16	0.332958	0.338836	0.377473	0.387552	0.346815	0.366554	0.382513	0.513544	45.0487

DATE=06/12

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
17	1	2	0.278666	0.264730	0.284846	0.294904	0.315020	0.340164	0.448286	0.426913	39.3102
18	1	7	0.289903	0.274788	0.303285	0.314601	0.336393	0.358604	0.361537	0.358604	39.0657
19	1	12	0.354365	0.310042	0.331865	0.338580	0.375091	0.388101	0.395236	0.377190	43.5720
20	1	14	0.320173	0.299970	0.320953	0.357465	0.345294	0.346973	0.365439	0.360403	41.0955
21	2	4	0.268726	0.272274	0.316696	0.318372	0.343936	0.355251	0.456249	0.406379	40.6764
22	2	6	0.282124	0.282332	0.292389	0.307476	0.330945	0.399673	0.404702	0.382491	40.1109
23	2	10	0.337486	0.282763	0.291576	0.375931	0.366278	0.341098	0.387262	0.369216	41.6927
24	2	13	0.327531	0.286540	0.294934	0.331445	0.386842	0.357045	0.352849	0.376350	40.9823
25	3	1	0.251438	0.215279	0.265988	0.318791	0.324658	0.339745	0.363214	0.452477	37.0495
26	3	8	0.301140	0.252996	0.279817	0.316696	0.359861	0.359023	0.384587	0.392130	39.6355
27	3	9	0.263907	0.288639	0.291576	0.305006	0.371734	0.370475	0.358724	0.367117	39.0993
28	3	15	0.339650	0.328508	0.355786	0.340258	0.358304	0.355367	0.367117	0.393137	42.8455
29	4	3	0.283420	0.258444	0.280655	0.305381	0.346450	0.340583	0.440743	0.384587	39.4667
30	4	5	0.279530	0.250901	0.276884	0.290294	0.330106	0.338907	0.354413	0.362795	37.2191
31	4	11	0.281653	0.306685	0.315498	0.311301	0.334803	0.345294	0.356626	0.365858	39.2524
32	4	16	0.328397	0.331026	0.370895	0.383485	0.353268	0.370055	0.376350	0.491341	44.5518

DATE=06/14

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
33	1	2	0.267546	0.257234	0.280636	0.291084	0.311560	0.324933	0.335380	0.418959	36.7532
34	1	7	0.284354	0.270607	0.291084	0.302367	0.336634	0.349589	0.384692	0.368812	38.7996
35	1	12	0.356454	0.310271	0.338308	0.331086	0.365070	0.390133	0.400329	0.377814	43.5679
36	1	14	0.319654	0.293703	0.319191	0.364220	0.347228	0.348503	0.368893	0.370168	41.2441
37	2	4	0.253324	0.265174	0.287740	0.308635	0.343320	0.350006	0.448629	0.418123	39.5105
38	2	6	0.275304	0.278547	0.291919	0.303620	0.344992	0.337470	0.378841	0.378005	38.6692
39	2	10	0.334111	0.273313	0.264817	0.366345	0.367194	0.350202	0.386310	0.394381	41.2476
40	2	13	0.320092	0.287756	0.286057	0.324714	0.390133	0.352751	0.362946	0.379938	40.7588
41	3	1	0.246859	0.206669	0.253473	0.305710	0.317411	0.336216	0.355439	0.450301	36.1243
42	3	8	0.297284	0.246369	0.272696	0.339141	0.352932	0.368394	0.387617	0.388453	39.7353

SOIL MOISTURE DATA

DATE=06/14

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
43	3	9	0.250871	0 283508	0 282658	0.278835	0.364220	0 371867	0 361672	0.363796	38.1147
44	3	15	0.334549	0.325139	0.358698	0 350627	0.366345	0 366769	0.374416	0.396505	43.3131
45	4	3	0.271856	0 260577	0.274368	0.301949	0.339141	0.342484	0.428988	0.390542	38.8706
46	4	5	0.268408	0 243862	0 271025	0 292755	0.331201	0.332037	0.360454	0 360454	36 7920
47	4	11	0.280662	0.282658	0.311970	0.307297	0.330661	0.344680	0.360822	0 371017	38.7796
48	4	16	0 326225	0.318767	0.331936	0 386735	0.358273	0.368893	0.378239	0 580020	44 5342

DATE=06/19

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
49	1	2	0 247116	0.236652	0.277303	0 277303	0 299514	0 316277	0 320049	0.362491	34 8846
50	1	7	0.273912	0 258025	0.288618	0.290294	0 318791	0.333878	0.356508	0 353575	37.0907
51	1	12	0.346270	0.306354	0.326263	0.314402	0 349136	0 359302	0 378787	0 396154	41 9363
52	1	14	0 293412	0.273738	0.306778	0.351678	0 344053	0 348713	0 374128	0.359726	39.9146
53	2	4	0.234582	0 239167	0 261797	0.292809	0 335554	0.333459	0.326754	0.366566	35 4284
54	2	6	0 257488	0 250482	0.277722	0.294485	0.339745	0 307057	0 359442	0 382072	36.6705
55	2	10	0.319623	0.250865	0.189021	0 285175	0.349560	0 355066	0 392342	0.397848	38 1059
56	2	13	0.296470	0.249170	0.252559	0.325415	0 386835	0.355066	0 360573	0.383023	39.1033
57	3	1	0.245387	0.196001	0.227851	0 274369	0 312505	0.332202	0.346450	0.367823	34.1585
58	3	8	0 281691	0.228690	0.255511	0.328849	0 333040	0 345193	0.371176	0.388358	37.7826
59	3	9	0.224390	0.269502	0 266114	0.205118	0.280092	0.351254	0.364809	0.366927	34 3957
60	3	15	0 310012	0.298306	0.342359	0 337276	0 346171	0.357184	0 366927	0.394883	41 3108
61	4	3	0.257488	0 247129	0 264730	0 289875	0.329268	0.334716	0 304124	0.389196	35 8243
62	4	5	0.238904	0 211088	0.253415	0.278560	0.325497	0.335974	0.351060	0 362795	34 9811
63	4	11	0.260649	0.298306	0.302966	0.281786	0 308472	0 336005	0.353796	0.369045	37.4420
64	4	16	0 302149	0 297883	0.304660	0 334734	0 353372	0 369892	0 380058	0.486801	41.7153

DATE=06/21

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
65	1	2	0.245631	0.237045	0.270787	0 276270	0.297780	0.318869	0.306637	0 382978	34 5540
66	1	7	0.274339	0.258977	0.284705	0 295249	0 314229	0.334474	0.353875	0.398161	37.3700
67	1	12	0.342435	0.296677	0.322165	0.306872	0.340007	0 349352	0 368044	0.376540	40 9200
68	1	14	0 287234	0.268640	0.303899	0 355300	0.348078	0 349777	0 373991	0.384186	39 9689
69	2	4	0 226492	0.196555	0 251385	0.284283	0.331100	0 332365	0 322243	0 392678	34 3511
70	2	6	0.253461	0 249698	0.274583	0 294406	0.338692	0 307059	0.358515	0.379182	36 4653
71	2	10	0.315711	0.247825	0 174759	0 254621	0 339582	0.345529	0.379938	0 391833	36.7549
72	2	13	0 289424	0.243577	0 244426	0 317067	0 381213	0 354450	0.357424	0.371442	38 3745
73	3	1	0.240411	0 192337	0 226923	0 279644	0 315073	0.328991	0 347971	0 344597	33 8915
74	3	8	0.282604	0.218909	0.248011	0.328147	0 334052	0 336583	0.364420	0.393944	37 3532
75	3	9	0 213195	0.259294	0.263118	0.185379	0 238054	0.340007	0 358273	0.364220	32 7055
76	3	15	0.300377	0.296677	0 337458	0.349352	0 350202	0 352751	0 369318	0.396930	41.2210
77	4	3	0.256940	0.244215	0.259399	0 286392	0 331522	0.331522	0.321821	0.379182	35.8121
78	4	5	0 229972	0 205412	0 243793	0 274583	0.326039	0 322243	0 352188	0 358937	34 2700
79	4	11	0 258757	0.297102	0.278835	0 310271	0 325139	0.328962	0 352751	0 361247	37 5181
80	4	16	0.286796	0 284358	0 303049	0.327687	0.345104	0 365070	0.372292	0 486564	40 7066

SOIL MOISTURE DATA

DATE=06/25

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
81	1	2	0.226802	0.231623	0.261378	0.259701	0.289456	0.307476	0.296580	0.362795	33.0375
82	1	7	0.270454	0.239586	0.271016	0.285684	0.309572	0.316277	0.339326	0.307895	35.3734
83	1	12	0.346293	0.295693	0.313599	0.297825	0.325963	0.337900	0.364759	0.380960	40.3198
84	1	14	0.274625	0.247517	0.296972	0.353675	0.339179	0.330226	0.372007	0.369023	38.6490
85	2	4	0.206921	0.214441	0.210250	0.270178	0.325497	0.325078	0.307895	0.389616	32.8960
86	2	6	0.241929	0.220308	0.258025	0.284427	0.333459	0.305381	0.339745	0.376205	34.9353
87	2	10	0.308041	0.226201	0.153297	0.204884	0.326816	0.341737	0.372007	0.405687	34.8973
88	2	13	0.280780	0.233875	0.225774	0.297398	0.389060	0.344722	0.356233	0.377123	37.4415
89	3	1	0.225938	0.184686	0.215698	0.256768	0.303285	0.318791	0.338907	0.330526	32.3439
90	3	8	0.266997	0.206478	0.223661	0.317115	0.322144	0.323401	0.353994	0.400512	35.7766
91	3	9	0.204715	0.253912	0.247944	0.162677	0.191667	0.302514	0.351543	0.366465	30.4886
92	3	15	0.296169	0.293561	0.332784	0.324684	0.335769	0.345148	0.351543	0.395455	40.0122
93	4	3	0.240200	0.230785	0.254672	0.276045	0.326754	0.321306	0.301190	0.381653	34.4710
94	4	5	0.216862	0.177981	0.227432	0.270597	0.312086	0.310829	0.337650	0.356089	32.6123
95	4	11	0.245606	0.288872	0.305499	0.268834	0.298251	0.329800	0.356659	0.374565	36.6309
96	4	16	0.280341	0.273950	0.297825	0.312320	0.344722	0.365612	0.366038	0.494365	40.0532

DATE=07/02

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
97	1	2	0.219734	0.277030	0.244334	0.261867	0.279399	0.301197	0.281769	0.331998	32.6318
98	1	7	0.244168	0.273713	0.282243	0.297406	0.305462	0.304040	0.316360	0.305935	35.0283
99	1	12	0.299059	0.310762	0.312196	0.297854	0.316977	0.320323	0.346139	0.369565	38.6734
100	1	14	0.256164	0.271560	0.268213	0.311240	0.325104	0.320323	0.353788	0.369565	36.8695
101	2	4	0.253942	0.240069	0.235331	0.257128	0.303566	0.325364	0.300723	0.351900	33.8182
102	2	6	0.230485	0.252863	0.223010	0.261393	0.313043	0.312096	0.309252	0.361851	33.5022
103	2	10	0.306455	0.292595	0.178813	0.137699	0.283990	0.317933	0.348530	0.378648	33.6585
104	2	13	0.239894	0.248612	0.194112	0.246222	0.365740	0.359525	0.347573	0.402552	35.4010
105	3	1	0.251010	0.183206	0.194579	0.228697	0.291720	0.320151	0.324890	0.323942	31.7255
106	3	8	0.290105	0.234857	0.191736	0.289824	0.327733	0.325837	0.326785	0.369432	35.3057
107	3	9	0.171854	0.220884	0.250524	0.167339	0.140089	0.249568	0.309806	0.359047	27.0589
108	3	15	0.260602	0.276340	0.298810	0.337534	0.328450	0.334665	0.328929	0.360003	37.7286
109	4	3	0.210448	0.208795	0.221589	0.259971	0.298828	0.343844	0.286507	0.366589	32.2859
110	4	5	0.250521	0.219219	0.195053	0.231066	0.287455	0.316360	0.316834	0.331998	32.1224
111	4	11	0.173333	0.271082	0.315064	0.260086	0.283033	0.306459	0.341837	0.363350	33.8212
112	4	16	0.269970	0.254349	0.271560	0.297376	0.322714	0.353310	0.358091	0.568444	38.8098

DATE=07/05

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
113	1	2	0.277669	0.242385	0.269741	0.257957	0.284472	0.299623	0.282367	0.342552	33.8987
114	1	7	0.287218	0.263849	0.287418	0.291626	0.284051	0.305936	0.323613	0.302569	35.6403
115	1	12	0.357514	0.303665	0.310881	0.292203	0.315975	0.319796	0.357576	0.378376	40.0135
116	1	14	0.287468	0.245084	0.276921	0.344841	0.324465	0.320645	0.366066	0.367764	37.9950
117	2	4	0.252060	0.227654	0.215870	0.277738	0.321508	0.316879	0.299202	0.369908	33.8617
118	2	6	0.267252	0.219237	0.241964	0.279000	0.323192	0.286576	0.334134	0.372012	34.6098
119	2	10	0.336501	0.242113	0.134290	0.170373	0.310032	0.324041	0.351208	0.379650	33.9339
120	2	13	0.275210	0.209851	0.185655	0.289232	0.381348	0.334229	0.346964	0.362670	35.6834
121	3	1	0.232962	0.177992	0.207032	0.252907	0.307199	0.322350	0.333293	0.325296	32.2000
122	3	8	0.294162	0.194827	0.219237	0.321508	0.323192	0.321508	0.340868	0.379167	35.8440

SOIL MOISTURE DATA

DATE=07/05

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
123	3	9	0.200787	0.253574	0.228104	0.129621	0.164854	0.251452	0.333380	0.358000	28.0594
124	3	15	0.283091	0.278619	0.336776	0.315975	0.330408	0.333380	0.331257	0.366915	38.6259
125	4	3	0.233830	0.213345	0.238176	0.268479	0.329084	0.319825	0.293360	0.372012	33.5893
126	4	5	0.252928	0.183884	0.195668	0.247856	0.305094	0.305094	0.321929	0.333713	32.0920
127	4	11	0.251132	0.286260	0.284138	0.244235	0.286685	0.278619	0.354604	0.364368	34.9518
128	4	16	0.266455	0.253150	0.284138	0.308759	0.327437	0.360547	0.288383	0.313428	36.2531

DATE=07/09

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
129	1	2	0.251203	0.229390	0.257689	0.247552	0.277540	0.304572	0.269937	0.327380	32.4181
130	1	7	0.277775	0.253043	0.282186	0.284721	0.304994	0.318933	0.296969	0.291478	35.1015
131	1	12	0.345292	0.298236	0.301193	0.281764	0.302883	0.304994	0.339629	0.370040	38.5825
132	1	14	0.265143	0.226855	0.272894	0.343008	0.323156	0.320200	0.358213	0.352723	36.8565
133	2	4	0.218969	0.194755	0.191798	0.260223	0.316398	0.315131	0.284721	0.362437	31.5879
134	2	6	0.237700	0.203625	0.223899	0.271627	0.321045	0.279652	0.320622	0.362860	32.8948
135	2	10	0.322206	0.220520	0.125486	0.147027	0.292323	0.316398	0.345120	0.361592	32.1713
136	2	13	0.262093	0.203625	0.182506	0.284298	0.371729	0.326958	0.335828	0.353145	34.6658
137	3	1	0.233344	0.179972	0.204047	0.247974	0.305839	0.312597	0.325691	0.326958	31.8457
138	3	8	0.281260	0.179972	0.208271	0.311752	0.313442	0.306684	0.329070	0.362437	34.3250
139	3	9	0.188913	0.247129	0.215029	0.116616	0.144915	0.221365	0.292323	0.312597	25.5582
140	3	15	0.262093	0.262335	0.328225	0.304150	0.322734	0.326535	0.328225	0.357369	37.2470
141	4	3	0.218098	0.205314	0.234880	0.259801	0.323156	0.309218	0.285988	0.369618	32.4660
142	4	5	0.221147	0.160543	0.179127	0.240371	0.309218	0.296547	0.309218	0.327380	30.3342
143	4	11	0.234651	0.282609	0.278385	0.225588	0.272894	0.308796	0.343008	0.360748	34.1929
144	4	16	0.245105	0.237837	0.269515	0.299081	0.318510	0.357369	0.265291	0.263179	34.2420

DATE=07/11

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
145	1	2	0.231927	0.223827	0.262318	0.234402	0.268663	0.302078	0.265279	0.315613	31.4289
146	1	7	0.272059	0.244130	0.276276	0.286005	0.299963	0.288120	0.309269	0.284736	34.3543
147	1	12	0.340982	0.294041	0.303770	0.277968	0.305039	0.288543	0.335070	0.368063	38.0990
148	1	14	0.252866	0.220020	0.259780	0.340569	0.322381	0.314344	0.348183	0.344799	35.9203
149	2	4	0.205754	0.181529	0.171378	0.252590	0.312229	0.302924	0.286005	0.353258	30.3568
150	2	6	0.221022	0.189143	0.219174	0.269086	0.318574	0.271201	0.322804	0.358757	32.0176
151	2	10	0.310011	0.212407	0.118083	0.143461	0.288543	0.314767	0.332109	0.357488	31.2897
152	2	13	0.233236	0.203947	0.175185	0.274584	0.371869	0.332955	0.332955	0.350297	33.7794
153	3	1	0.234108	0.177723	0.200140	0.239900	0.302078	0.308846	0.322381	0.317728	31.4111
154	3	8	0.270314	0.173070	0.198025	0.315190	0.306308	0.316036	0.328303	0.360872	33.8761
155	3	9	0.178272	0.248360	0.216214	0.114276	0.140501	0.212830	0.265279	0.278814	24.4491
156	3	15	0.249376	0.257242	0.323227	0.305039	0.323650	0.324073	0.322381	0.360026	36.7237
157	4	3	0.210552	0.203947	0.232287	0.257665	0.328303	0.314767	0.283044	0.362564	32.2650
158	4	5	0.211425	0.149383	0.171378	0.230172	0.300809	0.297848	0.307154	0.321535	29.4840
159	4	11	0.216223	0.277968	0.273739	0.222135	0.263587	0.302078	0.348183	0.360449	33.4099
160	4	16	0.234544	0.238208	0.276276	0.299117	0.310115	0.344799	0.263164	0.262741	33.7546

SOIL MOISTURE DATA

DATE=07/13

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
161	1	2	0.221154	0.221886	0.254504	0.229413	0.257013	0.298832	0.253250	0 294650	30.3879
162	1	7	0.260401	0.238613	0.262868	0.282105	0.299669	0.287541	0.287541	0.269977	33.2830
163	1	12	0 332425	0.288796	0.296323	0.265377	0.293814	0.282105	0.313469	0 358215	36.8447
164	1	14	0.244443	0.203485	0.247395	0 335633	0.314723	0.310123	0.350269	0 340651	35.0310
165	2	4	0.194415	0 166267	0.155394	0.236104	0.306360	0.305941	0.269559	0.340233	28.9768
166	2	6	0.214254	0.178394	0.208504	0.261613	0.315978	0.271232	0.308869	0.347342	31.0841
167	2	10	0.297060	0.199722	0 113575	0 136575	0.279596	0.305941	0.321414	0.349015	30.1283
168	2	13	0.250050	0.198049	0.166267	0.276668	0.368670	0.315142	0 322669	0.338560	33.4033
169	3	1	0.221154	0.171703	0.192612	0.227740	0.300505	0.310541	0.319742	0.315142	30.6651
170	3	8	0.259538	0.170030	0.188849	0.316396	0.306360	0.305523	0.318487	0.358633	33.1359
171	3	9	0.174145	0.244050	0.211431	0.106884	0.126120	0 203067	0.251995	0.280014	23.5423
172	3	15	0.236680	0.244886	0.322251	0.296323	0.314723	0.318069	0.315560	0.353615	35.7171
173	4	3	0.206922	0.199303	0.226067	0.254922	0.323087	0.305523	0.273741	0 349015	31.5092
174	4	5	0.196140	0.139921	0.163339	0 221886	0.300505	0.287959	0.291305	0.314305	28.2897
175	4	11	0.213391	0.273323	0.265377	0.208504	0.261195	0.298414	0.328524	0.349851	32.4665
176	4	16	0.218998	0.228577	0.261613	0.288796	0.295905	0.331451	0.260359	0.247813	32.2951

DATE=07/16

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
177	1	2	0.211970	0 218133	0.256324	0.213937	0 241635	0.294094	0.250029	0.274370	29.4024
178	1	7	0.254386	0.226107	0.259261	0 282343	0 287799	0 277727	0.295353	0.262199	32.6330
179	1	12	0 330561	0.288639	0.293255	0.257163	0.278147	0.268075	0.283602	0.336062	35.5511
180	1	14	0.243132	0.190855	0.239537	0.333124	0 311721	0.303327	0.340258	0.338580	34.3328
181	2	4	0 181673	0.146789	0.132940	0.203025	0.295773	0.299970	0.266396	0.330606	27.1684
182	2	6	0 214567	0.179943	0.200927	0.262199	0.315498	0 269753	0 303327	0.350750	30.9200
183	2	10	0.286847	0.192114	0.110697	0.131261	0.264717	0.303327	0.323052	0.336062	29.3137
184	2	13	0.242700	0.190015	0 164835	0.273530	0.365019	0.317176	0 318016	0.338999	32.9510
185	3	1	0 222790	0.169451	0.186238	0.221071	0.294934	0.315498	0.317596	0.310042	30 3885
186	3	8	0 253520	0.161478	0 174487	0 306265	0.300389	0.301648	0.309203	0.348232	32.1239
187	3	9	0.143153	0.241215	0 213517	0 101884	0.123287	0.190015	0.225688	0.201766	21.5070
188	3	15	0.227551	0.236599	0 319694	0.291996	0 305425	0.294934	0 309622	0.343616	34 6162
189	4	3	0.195956	0.196730	0 218133	0.242894	0.318435	0.304166	0.263878	0.318016	30.4370
190	4	5	0.186867	0.132520	0.152245	0.218133	0.303327	0.289478	0.290317	0.306265	27.7285
191	4	11	0.206776	0.269753	0.260940	0.197569	0 240376	0.290317	0.331865	0.345714	31.6054
192	4	16	0.208507	0.218553	0 250029	0.285281	0.290317	0 314239	0.258002	0.246252	31.2772

DATE=07/18

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
193	1	2	0.213701	0.216874	0.243734	0.206383	0.236599	0.290317	0.239117	0.272271	28.7992
194	1	7	0.251789	0.220651	0.251288	0.275629	0.287799	0.272271	0.289898	0.255484	32.0491
195	1	12	0.321543	0 285346	0.299696	0 255379	0.284080	0.262976	0.267197	0.322066	35.0219
196	1	14	0.231004	0 187847	0.235964	0 333462	0.309826	0.303495	0.340637	0.338105	33 9363
197	2	4	0.176479	0 135038	0.123707	0 197989	0.301648	0.305425	0 260520	0.308363	26 5668
198	2	6	0.203314	0.175327	0.197150	0 253386	0.314658	0.260101	0.299550	0.341937	30.1159
199	2	10	0.279321	0.189958	0.105543	0.127491	0 265931	0.300963	0.321644	0.336417	28 9365
200	2	13	0 238404	0.192068	0.168854	0.271840	0.369338	0.311092	0 312781	0.342326	32.8383
201	3	1	0.220193	0.169032	0 183720	0 219812	0 296612	0.307944	0 312140	0 305006	30.0541
202	3	8	0.248759	0.157700	0 178264	0 302068	0.296193	0 297032	0.314239	0.346134	31 8775

SOIL MOISTURE DATA

DATE=07/18

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
203	3	9	0.166582	0.239340	0.202620	0.108498	0.120738	0.181094	0.216126	0.196711	21.5897
204	3	15	0.219686	0.232587	0.316579	0.292521	0.306449	0.308982	0.312781	0.341481	34.5974
205	4	3	0.226253	0.214356	0.237858	0.311721	0.305845	0.240376	0.254225	0.297452	31.2799
206	4	5	0.180375	0.129163	0.151405	0.207642	0.295773	0 281504	0.290317	0.299970	27.0716
207	4	11	0.207498	0.270151	0.268463	0.198399	0.247359	0.295898	0.323754	0.353299	31.8809
208	4	16	0.209675	0.215704	0.258755	0.274372	0.293787	0.299274	0.251580	0.240184	30.9079

DATE=07/20

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
209	1	2	0.214239	0.214276	0.248912	0.195080	0.218866	0.284800	0.231802	0.258927	28.1111
210	1	7	0.244795	0.220953	0.245573	0.266856	0.280210	0.270194	0.286469	0.239314	31.3503
211	1	12	0.322261	0.273533	0.293981	0.250164	0.274785	0.247660	0.254337	0.299405	33.9479
212	1	14	0.216391	0.186734	0.228047	0.335711	0.307334	0.295650	0.321522	0.327782	32.9714
213	2	4	0.170342	0.126642	0.116627	0.182144	0.289807	0.297319	0.248495	0.296067	25.3682
214	2	6	0 197885	0.169207	0.196749	0 253502	0.310673	0.256423	0.290225	0.336963	29.5974
215	2	10	0.269757	0.182978	0.102021	0.120800	0.256006	0.298154	0.310673	0.331538	28.0574
216	2	13	0.232745	0.189238	0.157523	0.268108	0.363670	0.303578	0.308169	0.335711	32.1146
217	3	1	0.217252	0.165869	0.181309	0.211772	0.290642	0.310255	0.313176	0.302744	29.7222
218	3	8	0.238770	0.152515	0.172128	0.308169	0 292729	0.291894	0.305248	0.340718	31.2602
219	3	9	0.160443	0.242235	0.202174	0.098683	0.117462	0 169207	0.202174	0.182144	20.7824
220	3	15	0.208214	0.225126	0.312759	0.285217	0.303161	0.311090	0.297736	0.342805	33.8147
221	4	3	0.182822	0.193411	0.210937	0.232637	0.312342	0.293981	0.242235	0.270194	28.8779
222	4	5	0.176367	0.125808	0.147507	0.206764	0.292311	0.278958	0.283548	0.295232	26.6252
223	4	11	0.193582	0.266856	0.262266	0.192993	0.228464	0 289807	0.320688	0.337380	30.7869
224	4	16	0.205632	0.213858	0.250581	0.274785	0.282713	0.289390	0.243487	0.244739	30 2610

DATE=07/23

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
225	1	2	0.206491	0.213104	0.247395	0.183830	0.202649	0.286705	0.231922	0.239449	27.3568
226	1	7	0.237543	0.211849	0.243213	0.265795	0.278759	0.268304	0.271232	0.231086	30.6478
227	1	12	0.314311	0.270395	0.283777	0.244468	0.266632	0.242377	0.195540	0.259104	32.0681
228	1	14	0.203041	0.173376	0.223977	0.327269	0.305941	0.291723	0.313051	0.319323	31.9973
229	2	4	0.162500	0.115248	0.102702	0.165012	0 282941	0.300505	0.241122	0.268304	24 1620
230	2	6	0.197003	0 166267	0.185503	0.246559	0.308032	0.254504	0.281268	0.333542	29.0232
231	2	10	0.270320	0.179649	0.100611	0.121939	0.253250	0.291305	0.311796	0.323505	27.8249
232	2	13	0.229349	0.188012	0.156648	0.263704	0.359469	0.299250	0.300923	0.332705	31.6746
233	3	1	0.210372	0.164176	0.174630	0.206831	0.291723	0.303014	0.313887	0.293396	29 2077
234	3	8	0.231936	0.147866	0.163339	0.300923	0.290050	0.296741	0.300923	0.323087	30.6216
235	3	9	0.161206	0.239449	0.195958	0.094338	0.111066	0.157903	0.195122	0.165012	20.0886
236	3	15	0.200022	0.216867	0.308032	0.281686	0.299250	0.306778	0.291305	0.315560	32.9448
237	4	3	0.178889	0.178394	0.211431	0.230249	0.310960	0.294232	0.234431	0.233177	28.1120
238	4	5	0.169401	0.119429	0.142430	0.200976	0.289214	0.272905	0.279596	0.284196	25.9194
239	4	11	0.187946	0.268304	0.259523	0.181321	0.224395	0.280850	0.323087	0.333960	30 2724
240	4	16	0.205628	0.205158	0.243631	0.267886	0.274577	0.263286	0.235268	0.236522	29 2076

SOIL MOISTURE DATA

DATE=07/25

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
241	1	2	0.205613	0.210474	0.253072	0.182637	0.199929	0.278379	0.220596	0.233671	26.9800
242	1	7	0.237802	0.204569	0.242106	0.261086	0.277113	0.265725	0.273739	0.224392	30.3769
243	1	12	0.317837	0.275426	0.285549	0.244637	0.264038	0.236623	0.216800	0.243793	32.3351
244	1	14	0.212138	0.170827	0.222705	0.341222	0.303685	0.283440	0.306215	0.322664	32.1203
245	2	4	0.161681	0.115154	0.099970	0.155222	0.287236	0.290610	0.241685	0.254338	23.7678
246	2	6	0.203439	0.164922	0.185589	0.245481	0.309590	0.251385	0.283018	0.335318	29.1511
247	2	10	0.270425	0.175467	0.095752	0.117262	0.247589	0.293141	0.310011	0.326039	27.5521
248	2	13	0.232582	0.180950	0.154378	0.247168	0.364841	0.296515	0.299045	0.333209	31.3696
249	3	1	0.208223	0.161970	0.172514	0.202882	0.293141	0.309168	0.312964	0.297358	29.1641
250	3	8	0.227362	0.148473	0.161126	0.304528	0.283862	0.296936	0.293562	0.318025	30.3054
251	3	9	0.165596	0.242950	0.194025	0.095330	0.105031	0.158174	0.184746	0.158596	19.9331
252	3	15	0.200829	0.213848	0.311698	0.283018	0.295249	0.310433	0.290188	0.294828	32.8131
253	4	3	0.174730	0.180106	0.209630	0.225657	0.311277	0.292719	0.227344	0.213004	27.6656
254	4	5	0.173425	0.121902	0.138351	0.196977	0.292297	0.277957	0.274583	0.286814	25.9935
255	4	11	0.194739	0.266991	0.256868	0.181793	0.214270	0.280487	0.319290	0.339113	30.1960
256	4	16	0.203004	0.206678	0.244215	0.266569	0.271208	0.254759	0.226501	0.223970	28.7491

DATE=07/27

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
257	1	2	0.203747	0 217714	0.247930	0.180363	0.191694	0.279406	0.215615	0.219812	26.6433
258	1	7	0.231879	0.199668	0.233242	0.260101	0.273530	0.256324	0.268914	0.212258	29.6529
259	1	12	0.311532	0.276482	0.284502	0.238918	0.260444	0.233009	0.206419	0.226256	31.7022
260	1	14	0.202275	0.175185	0.213172	0.331774	0.306027	0.284924	0.307294	0.322066	31.7422
261	2	4	0.162629	0.110697	0.096428	0.145110	0.281504	0.290317	0.239956	0.243314	23.3113
262	2	6	0.196389	0.160638	0.182042	0.244993	0.305425	0.245412	0.276048	0.324311	28.5186
263	2	10	0.268003	0.172653	0.096680	0.116517	0.241873	0.291255	0.305183	0.315735	27.1887
264	2	13	0.233180	0.156614	0.153660	0.270151	0.360897	0.289989	0.291677	0.323754	31.0078
265	3	1	0.209373	0.157281	0.172809	0.200507	0.297452	0.307104	0.313399	0.284862	29.0328
266	3	8	0.227551	0.141333	0.158120	0.295773	0.282343	0.290737	0.287799	0.308783	29.7458
267	3	9	0.161331	0.239117	0.191274	0.089713	0.105661	0.149307	0.177845	0.154763	19.3898
268	3	15	0.195310	0.208951	0.308560	0.276904	0.300963	0.301807	0.279015	0.280703	32.1490
269	4	3	0.172584	0.175327	0.202606	0.225688	0.309203	0.291157	0.226107	0.196310	27.2357
270	4	5	0.173450	0.120350	0.140494	0.200087	0.294094	0.272271	0.270593	0.278147	25.8644
271	4	11	0.195310	0.248204	0.257911	0.181938	0.213172	0.272262	0.323332	0 334306	29.8237
272	4	16	0.202275	0.208529	0.241873	0.264242	0.263398	0.236808	0.227100	0.219081	28.2687

DATE=07/30

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
273	1	2	0.203731	0.219580	0.244026	0.172797	0.183756	0.278586	0.208622	0.206515	26.1552
274	1	7	0.234592	0.191342	0.232225	0.256670	0.271843	0.252455	0.258356	0.204408	29.2148
275	1	12	0.305860	0.272254	0.286243	0.237072	0.252756	0.224355	0.194683	0.205704	30.9220
276	1	14	0.200942	0.168402	0.214606	0.330751	0.302774	0.287938	0.283699	0.311252	31.1690
277	2	4	0.153310	0.110841	0.089768	0.144137	0.284908	0.289544	0.229274	0.230539	22.7641
278	2	6	0.194169	0.162682	0.176591	0.244447	0.304296	0.241497	0.262149	0.320733	28.0916
279	2	10	0.261707	0.167978	0.095493	0.109058	0.237072	0.290482	0.300655	0.314219	26.6762
280	2	13	0.228046	0.185357	0.154837	0.273102	0.359575	0.286243	0.291329	0.328632	31.3461
281	3	1	0.203296	0.158467	0.163947	0.190921	0.292495	0.308932	0.310196	0.285330	28.5379
282	3	8	0.223291	0.144980	0.154253	0.297974	0.277322	0.289966	0.279851	0.300503	29.4061

SOIL MOISTURE DATA

DATE=07/30

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
283	3	9	0.158091	0.239390	0.196821	0.091875	0.098197	0.140344	0.170690	0.144559	19.0002
284	3	15	0.184767	0.203161	0.307013	0.273950	0.288786	0.301079	0.271407	0.259114	31..2740
285	4	5	0.174174	0.118428	0.138658	0.192606	0.288701	0.269735	0.269735	0.275636	25.5566
286	4	3	0.165481	0.173219	0.198928	0.215787	0.313147	0.285330	0.216630	0.181227	26.5462
287	4	11	0.194384	0.262929	0.248941	0.181119	0.212062	0.274374	0.323969	0.323545	29.8207
288	4	16	0.200067	0.205280	0.234105	0.262081	0.261657	0.228170	0.217573	0.210791	27.6509

DATE=08/01

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
289	1	2	0.193523	0.215279	0.246291	0.169180	0.178400	0.268083	0 202288	0.199354	25.4429
290	1	7	0.212972	0.188877	0.223661	0.250482	0.264730	0.255511	0.246291	0.203545	28.2059
291	1	12	0.305030	0.266826	0.280655	0.227851	0.245034	0.217794	0.186363	0.192230	30.1475
292	1	14	0.194387	0.159542	0.208155	0.328849	0.301190	0.276464	0.271855	0.306219	30.3390
293	2	4	0.154625	0.105900	0.088298	0.140683	0.275626	0.282751	0.221146	0.220308	22.1970
294	2	6	0.192659	0.157865	0.180496	0.237909	0.300771	0.240005	0.260959	0.315020	27.8054
295	2	10	0.257488	0.164571	0.090394	0.106319	0.225756	0.281493	0.291551	0.302866	25.8737
296	2	13	0.228099	0.182172	0.154094	0.260959	0.352737	0.279817	0.277722	0.317953	30.6114
297	3	1	0.200870	0.154513	0.159542	0.192230	0.291551	0.301190	0.309153	0.273531	28.1368
298	3	8	0.217726	0.134816	0.154932	0.287780	0.271436	0.284008	0.271855	0.287780	28.5796
299	3	9	0.155057	0.241681	0.189296	0.088718	0.095004	0.138169	0.155351	0.144874	18.4898
300	3	15	0.186608	0.195163	0.307476	0.268921	0.284846	0.305800	0.265149	0.250063	30.9722
301	4	3	0.164566	0.170019	0.194325	0.209412	0.299933	0.285265	0.194325	0.164990	25.6432
302	4	5	0.161540	0.118472	0.134816	0.186363	0.284427	0.259701	0.267664	0.269340	24.8172
303	4	11	0.187904	0.256349	0.241681	0.174209	0.200611	0.270178	0.315020	0.319210	28.9485
304	4	16	0.200438	0.203545	0.233299	0.260540	0.252158	0.213184	0.206898	0.201030	26.9869

DATE=08/02

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
305	1	2	0.201251	0.206322	0.239291	0.173776	0.179693	0.274373	0.201673	0.203363	25.5832
306	1	7	0.221302	0.188147	0.230837	0.249858	0.270569	0.251126	0.248589	0.198291	28.5022
307	1	12	0.314587	0.275218	0.284517	0.232951	0.249858	0.212662	0.182229	0.190683	30.5510
308	1	14	0.187302	0.163632	0.209703	0.330166	0.301424	0.276486	0.272682	0.306073	30.2984
309	2	4	0.150249	0.104880	0.086282	0.140807	0.274373	0.288321	0.223229	0.212662	22.0919
310	2	6	0.185122	0.160673	0.175467	0.238023	0.303960	0.243940	0.259579	0.303960	27.6043
311	2	10	0.264457	0.151374	0.092200	0.109529	0.229569	0.279022	0.293816	0.294661	25.9008
312	2	13	0.228713	0.186034	0.150952	0.264228	0.273105	0.277331	0.276909	0.326362	29.4865
313	3	1	0.201251	0.150952	0.161941	0.189838	0.285362	0.309455	0.306919	0.282826	28.1598
314	3	8	0.216072	0.133199	0.146302	0.291702	0.269301	0.289166	0.279867	0.281135	28.5630
315	3	9	0.159839	0.244785	0.192796	0.089664	0.098117	0.134467	0.158560	0.139539	18.7135
316	3	15	0.185558	0.202941	0.311568	0.268878	0.280290	0.306496	0.265074	0.248167	31.0540
317	4	3	0.159839	0.164054	0.193219	0.216043	0.302692	0.286630	0.208013	0.165322	25.8024
318	4	5	0.165942	0.120519	0.140385	0.193642	0.287476	0.266342	0.265919	0.269301	25.2656
319	4	11	0.191225	0.265074	0.251548	0.173353	0.203786	0.264228	0.321712	0.324248	29.3928
320	4	16	0.194276	0.206745	0.229992	0.258734	0.256620	0.215621	0.203363	0.197868	26.8441

SOIL MOISTURE DATA

DATE=08/03

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
321	1	2	0.196116	0.211507	0.242938	0.164990	0.175467	0.264311	0.200192	0.194744	25.1605
322	1	7	0.217726	0.186782	0.223661	0.250482	0.267664	0.244195	0.243776	0.193487	28.0400
323	1	12	0.301573	0.267245	0.279398	0.226175	0.238747	0.208155	0.177143	0.190973	29.6374
324	1	14	0.186176	0.163732	0.212346	0.340164	0.299933	0.272693	0.260959	0.302866	30.1832
325	2	4	0.151600	0.100033	0.091651	0.136492	0.272693	0.286941	0.216117	0.208155	21.8756
326	2	6	0.198277	0.155351	0.175886	0.234138	0.304543	0.245872	0.249224	0.301609	27.6337
327	2	10	0.259217	0.161637	0.091651	0.107576	0.219889	0.279398	0.282332	0.304962	25.6609
328	2	13	0.226370	0.186782	0.154513	0.255930	0.349384	0.274788	0.279398	0.322563	30.5049
329	3	1	0.203896	0.149065	0.158704	0.188458	0.283589	0.303705	0.324658	0.401769	29.1832
330	3	8	0.215565	0.135235	0.152836	0.292809	0.273950	0.281493	0.275626	0.286103	28.6260
331	3	9	0.155057	0.240005	0.196840	0.088718	0.094585	0.133978	0.150322	0.141102	18.4036
332	3	15	0.180125	0.192230	0.314181	0.266826	0.277722	0.295742	0.260120	0.242938	30.4568
333	4	3	0.290768	0.234557	0.195582	0.205221	0.296580	0.281912	0.203126	0.156189	29.4319
334	4	5	0.297683	0.222822	0.151998	0.187201	0.283589	0.259282	0.260959	0.264311	29.6347
335	4	11	0.302869	0.316696	0.287780	0.214860	0.229109	0.283589	0.320049	0.310829	34.4698
336	4	16	0.319293	0.288618	0.249224	0.255930	0.252577	0.210250	0.205640	0.191392	31.0420

DATE=08/06

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
337	1	2	0.194739	0.211739	0.244215	0.162392	0.173358	0.266991	0.191072	0.186433	24.9188
338	1	7	0.207788	0.180106	0.215535	0.247168	0.267834	0.239576	0.236202	0.186433	27.2997
339	1	12	0.298263	0.269521	0.283018	0.222283	0.236202	0.200351	0.170827	0.180950	29.2619
340	1	14	0.186475	0.161126	0.207521	0.336583	0.291032	0.274161	0.259821	0.294406	29.8271
341	2	4	0.149502	0.099970	0.086051	0.135399	0.271630	0.274583	0.214270	0.202460	21.4485
342	2	6	0.186910	0.158596	0.176310	0.237045	0.302841	0.234093	0.245481	0.296936	27.1759
343	2	10	0.253461	0.165766	0.091113	0.102922	0.215535	0.276692	0.279222	0.297358	25.3002
344	2	13	0.238237	0.183902	0.153956	0.261930	0.354719	0.267413	0.271630	0.318447	30.6344
345	3	1	0.259550	0.202882	0.233249	0.265725	0.308746	0.308746	0.306637	0.275004	32.8089
346	3	8	0.301308	0.216378	0.225657	0.298624	0.271630	0.279644	0.268678	0.272896	32.7511
347	3	9	0.282604	0.310433	0.221440	0.091534	0.095330	0.126120	0.147630	0.132446	22.5951
348	3	15	0.303483	0.291875	0.307902	0.261508	0.279222	0.305372	0.260242	0.224392	34.6488
349	4	3	0.260420	0.223127	0.199086	0.207943	0.302841	0.281331	0.202882	0.148473	28.6828
350	4	5	0.275644	0.202038	0.153956	0.190229	0.283018	0.253072	0.255603	0.266569	28.7223
351	4	11	0.284779	0.305372	0.274583	0.199929	0.216378	0.278800	0.322664	0.311277	33.2313
352	4	16	0.300438	0.274161	0.239576	0.255603	0.250964	0.201616	0.197820	0.200351	30.0315

DATE=08/07

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
353	1	2	0.195174	0.214270	0.251807	0.167875	0.172936	0.258134	0.192759	0.184324	25.0348
354	1	7	0.206918	0.179263	0.212582	0.240419	0.263617	0.241685	0.230297	0.190229	27.0259
355	1	12	0.303048	0.266991	0.281331	0.222705	0.234093	0.201195	0.169984	0.167875	29.1817
356	1	14	0.186071	0.161662	0.206065	0.334577	0.298286	0.276939	0.259007	0.296578	29.9303
357	2	4	0.143412	0.100392	0.081412	0.137086	0.272474	0.280066	0.213848	0.193181	21.2900
358	2	6	0.183430	0.158174	0.173780	0.237045	0.302419	0.229875	0.244215	0.288079	26.8939
359	2	10	0.236497	0.161126	0.086473	0.102500	0.211317	0.272052	0.281331	0.291032	24.6135
360	2	13	0.229102	0.186854	0.153535	0.265304	0.355984	0.260664	0.261508	0.315916	30.2584
361	3	1	0.253461	0.200773	0.226501	0.261930	0.308324	0.307902	0.308324	0.274161	32.4768
362	3	8	0.296088	0.211739	0.213426	0.298624	0.266991	0.283440	0.265725	0.270365	32.2975

SOIL MOISTURE DATA

DATE=08/07

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
363	3	9	0.266075	0.293889	0.215957	0 089847	0.094909	0.125276	0.149739	0.130337	21.9440
364	3	15	0.296151	0.287612	0.316645	0.267119	0.287612	0.297005	0.257726	0.223143	34.5874
365	4	3	0.256506	0.218065	0.199508	0.205412	0.301576	0.275004	0.202882	0.141303	28.3137
366	4	5	0.267380	0.195290	0.153113	0.191916	0.285549	0.251807	0.253494	0.264038	28.4113
367	4	11	0.280429	0.311698	0.270365	0.204147	0.211317	0.283862	0.320977	0.308324	33.1801
368	4	16	0.288665	0.273096	0.242356	0.260288	0.254310	0.209907	0.196245	0.186852	29.9104

DATE=08/09

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
369	1	2	0.338463	0.257013	0.243631	0.164594	0.167521	0.258268	0.182576	0.181321	28.5286
370	1	7	0.303960	0.264959	0.233595	0.213940	0.266214	0.265795	0.219376	0.183830	30.6588
371	1	12	0.367491	0.312875	0.307770	0.268207	0.279693	0.235875	0.199715	0.171638	34.1558
372	1	14	0.304752	0.177594	0.200992	0.327765	0.302240	0.275439	0.251190	0.295859	32.6178
373	2	4	0.288003	0.169612	0.098520	0.137412	0.266632	0.271650	0.208922	0.185503	25.5651
374	2	6	0.312155	0.232340	0.171285	0.226904	0.291723	0.232340	0.241959	0.280014	30.5530
375	2	10	0.354329	0.237577	0.141434	0 118887	0.215881	0.275014	0.277991	0.286925	29.5921
376	2	13	0.345554	0.271185	0.194610	0.262677	0.354566	0.267781	0.255444	0.320533	34.8213
377	3	1	0.281534	0.218122	0.232758	0.269141	0.302596	0.303850	0.308451	0.301341	33.6482
378	3	8	0.311292	0.202231	0.206413	0.294650	0 267050	0.277505	0.266632	0.274577	32.2891
379	3	9	0.308701	0.320958	0.229494	0.093362	0.094213	0.129947	0.144411	0.138456	23.5407
380	3	15	0.329321	0.286074	0.317130	0.257146	0.275439	0.300113	0.253743	0.219710	34.9527
381	4	3	0.300941	0.257432	0.229413	0.203067	0.292978	0.279177	0.194703	0.153303	30.2489
382	4	5	0.309998	0.256595	0.181739	0.188431	0.280432	0.246559	0.254504	0.264959	30.5674
383	4	11	0.321424	0.343080	0.291605	0.255870	0.236726	0.282671	0.321384	0.314152	36.1271
384	4	16	0.326250	0.298837	0.245660	0.253743	0 251616	0.204395	0.193334	0.185677	30.9341

DATE=08/13

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
385	1	2	0.332092	0.303558	0.295999	0.179246	0.168747	0.256101	0.175887	0.177147	29.9656
386	1	7	0.312602	0.279620	0.295579	0.295999	0.269120	0.230903	0.222503	0.181766	32.8195
387	1	12	0.376270	0.319517	0.318677	0.270800	0.271220	0.209904	0.178826	0.166227	33.7789
388	1	14	0.312602	0.217044	0.200665	0 327496	0.293059	0.267440	0.238882	0.292219	32.9123
389	2	4	0.289646	0.260721	0.277520	0.298098	0.328336	0.291799	0.224603	0.203185	33.7892
390	2	6	0.323430	0.280040	0.223343	0.233423	0.306078	0.233003	0.236363	0.277940	32.5582
391	2	10	0.354181	0.258621	0.156148	0.177567	0.285499	0.293059	0.274580	0.282139	32.2755
392	2	13	0.347684	0.274580	0.218724	0.258621	0.259041	0.261141	0.255681	0.316997	33.6471
393	3	1	0.261926	0,212844	0.252741	0.302298	0 314897	0.320357	0.311117	0.274580	34.2052
394	3	8	0.312602	0.235103	0.254841	0.296838	0.264501	0.272900	0.262401	0.273320	33.4083
395	3	9	0.309137	0.317417	0.255261	0.125910	0.133050	0.150688	0.141449	0.131370	25.1942
396	3	15	0.329493	0.308178	0.340096	0.259461	0.273740	0.299778	0.256101	0.222923	35.7082
397	4	3	0.297009	0.257781	0.264921	0.281719	0.295579	0.276680	0.200245	0.141029	31.8966
398	4	5	0.306105	0.256101	0.267860	0.209904	0 280880	0.251062	0.248542	0.244342	31.9381
399	4	11	0.308703	0.330856	0.301458	0.267860	0.275000	0.291379	0.316577	0.311117	36.6026
400	4	16	0.327328	0.302298	0.275840	0.262821	0.260721	0.218724	0.200665	0 192266	32.1289

SOIL MOISTURE DATA

DATE=08/15

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
401	1	2	0.313040	0.286777	0.282151	0.177009	0.166074	0.255235	0.174065	0.177850	28.9529
402	1	7	0.297860	0.272057	0.293086	0.291824	0.273319	0.227477	0.215281	0.181214	32.1631
403	1	12	0.274004	0.314956	0.316217	0.264067	0.259440	0.210654	0.168177	0.166074	30.8999
404	1	14	0.291354	0.209393	0.204346	0.334302	0.285516	0.257338	0.240935	0.285936	32.1842
405	2	4	0.266197	0.233786	0.250608	0.297292	0.317900	0.284254	0.214860	0.191729	31.9104
406	2	6	0.302197	0.269113	0.218225	0.231683	0.294768	0.229159	0.241356	0.275001	31.6245
407	2	10	0.353378	0.244720	0.140840	0.147148	0.256917	0.280048	0.274160	0.282992	30.7147
408	2	13	0.334294	0.262384	0.214860	0.269955	0.346498	0.257758	0.253132	0.312012	34.4734
409	3	1	0.251450	0.202243	0.241356	0.287619	0.316638	0.309909	0.309068	0.276263	33.2558
410	3	8	0.311739	0.232944	0.272057	0.307385	0.257758	0.277525	0.237991	0.264487	33.3072
411	3	9	0.297860	0.310750	0.246823	0.120652	0.129064	0.151354	0.144625	0.129484	24.6096
412	3	15	0.315209	0.304441	0.335563	0.259020	0.277104	0.296030	0.248506	0.218225	35.0915
413	4	3	0.280077	0.251029	0.259440	0.283413	0.314535	0.276263	0.206449	0.139578	31.7149
414	4	5	0.290920	0.244300	0.261123	0.214439	0.283833	0.252291	0.247244	0.256496	31.5142
415	4	11	0.297860	0.322946	0.297712	0.260281	0.274160	0.294768	0.316638	0.311591	36.1050
416	4	16	0.317378	0.286777	0.263646	0.266590	0.250608	0.210234	0.195514	0.188785	31.1479

DATE=08/17

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
417	1	2	0.292929	0.273531	0.273531	0.166247	0.158704	0.250901	0.173790	0.169180	27.7473
418	1	7	0.294225	0.270178	0.292389	0.289875	0.269340	0.226594	0.212346	0.176305	31.8548
419	1	12	0.358623	0.302866	0.308733	0.253834	0.251320	0.195582	0.167923	0.161218	31.9858
420	1	14	0.279530	0.205221	0.199773	0.331364	0.294485	0.249643	0.237490	0.281074	31.6658
421	2	4	0.235014	0.221146	0.222822	0.280655	0.314601	0.280655	0.211088	0.184267	30.1085
422	2	6	0.286878	0.252158	0.218213	0.230366	0.296580	0.224499	0.226175	0.274369	30.7161
423	2	10	0.340038	0.236652	0.130625	0.136911	0.247129	0.273112	0.268502	0.279398	29.6066
424	2	13	0.315403	0.244615	0.208155	0.269340	0.320887	0.250063	0.254672	0.311667	33.1724
425	3	1	0.247548	0.198935	0.231204	0.286522	0.312924	0.313343	0.305800	0.266407	32.8156
426	3	8	0.300276	0.227432	0.256768	0.305800	0.259701	0.272274	0.258025	0.261378	32.9352
427	3	9	0.273912	0.262635	0.243357	0.115539	0.124758	0.146969	0.145712	0.130625	23.0909
428	3	15	0.300276	0.296580	0.336812	0.257187	0.273531	0.295323	0.248805	0.213603	34 5255
429	4	3	0.260514	0.236652	0.253415	0.279398	0.309153	0.308314	0.192649	0.132721	31.0395
430	4	5	0.265268	0.233299	0.250482	0.215698	0.286103	0.252996	0.246291	0.255930	30.6436
431	4	11	0.292929	0.318791	0.287360	0.252158	0.269759	0.290713	0.320049	0.308314	35.5455
432	4	16	0.298115	0.272274	0.257187	0.255511	0.253415	0.203964	0.195163	0.186782	30.1459

DATE=08/20

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	F48	CUMMC
433	1	2	0.261976	0.248662	0.263835	0.166897	0.163525	0.246554	0.167318	0.170690	26.4429
434	1	7	0.279363	0.254141	0.277743	0.283644	0.268892	0.227588	0.206515	0.174062	30.8549
435	1	12	0.347605	0.299660	0.309775	0.254562	0.246976	0.196821	0.161839	0.158467	31.5510
436	1	14	0.267627	0.195978	0.203565	0.330005	0.292916	0.263413	0.230960	0.294181	31.4762
437	2	4	0.229376	0.200193	0.198928	0.271843	0.308089	0.273107	O 202722	0.181227	28.7969
438	2	6	0.263715	0.230960	0.206515	0.233489	0.299238	0.223795	0.226324	0.270578	29.7360
439	2	10	0.328045	0.222109	0.121800	0.128122	0.228853	0.270157	0.264678	0.274371	28.4222
440	2	13	0.297619	0.220002	0.187970	0.276057	0.348972	0.242340	0.251612	0.314411	32.4701
441	3	1	0.242851	0.192185	0.219159	0.273950	0.303031	0.304296	O 304717	0.268892	31.9440
442	3	8	0.290229	0.215787	0.251612	0.311461	O 255405	0.270157	0.251191	0.256248	32 2948

SOIL MOISTURE DATA

DATE=08/20

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
443	3	9	0.241547	0.274793	0.228853	0.109155	0.144980	0.144980	0.142452	0.130229	22.4432
444	3	15	0.288491	0.287016	0.331691	0.255405	0.266785	0.292073	0.245712	0.206093	33.7484
445	4	3	0.249371	0.228431	0.252034	0.280272	0.315254	0.276479	0.186706	0.130229	30.1500
446	4	5	0.250675	0.208201	0.229274	0.214523	0.293759	0.243183	0.242761	0.254562	29.4893
447	4	11	0.281971	0.315675	0.284487	0.245290	0.264678	0.289966	0.324948	0.310196	35.0992
448	4	16	0.271104	0.262992	0.246976	0.252034	0.246133	0.198086	0.190078	0.183756	28.8772

DATE=08/22

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
449	1	2	0.253283	0.241918	0.256248	0.161418	0.162261	0.246976	0.166897	0.162261	25.8588
450	1	7	0.278928	0.248662	0.276479	0.277743	0.264678	0.218316	0.202300	0.166475	30.3247
451	1	12	0.347605	0.301346	0.297552	0.241918	0.241075	0.187549	0.156782	0.153831	30.8541
452	1	14	0.270670	0.189656	0.206936	0.332956	0.289544	0.262149	0.230117	0.275214	31.3177
453	2	4	0.215032	0.174905	0.174905	0.265942	0.302610	0.272264	0.199350	0.174905	27 4316
454	2	6	0.259803	0.218316	0.201879	0.238968	0.302188	0.228010	0.226745	0.268471	29.5663
455	2	10	0.326307	0.213258	0.117163	0.130650	0.222531	0.267206	0.261727	0.282379	28.0902
456	2	13	0.293272	0.215787	0.183756	0.276479	0.349393	0.237282	0.236018	0.296288	31.8023
457	3	1	0.235027	0.189235	0.215787	0.265942	0.305139	0.307246	0.305560	0.241918	31.4311
458	3	8	0.288056	0.203986	0.249505	0.316940	0.262149	0.279008	0.252455	0.241497	32.2612
459	3	9	0.232854	0.273950	0.214101	0.104519	0.115478	0.142030	0.143295	0.126857	21.4287
460	3	15	0.277624	0.278586	0.333377	0.248662	0.277322	0.298395	0.238547	0.201457	33.4069
461	4	3	0.245894	0.221688	0.245712	0.277322	0.307668	0.273529	0.189656	0.126014	29.6787
462	4	5	0.239374	0.190921	0.224217	0.212837	0.286173	0.238547	0.238968	0.240232	28.5116
463	4	11	0.275451	0.314411	0.273107	0.236861	0.257091	0.290387	0.320733	0.311461	34.4652
464	4	16	0.261542	0.249083	0.244026	0.255827	0.241918	0.193028	0.173640	0.185020	28.0773

DATE=08/23

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
465	1	2	0.251132	0.239990	0.258668	0.166128	0.162307	0.253999	0.161458	0.165279	25.9368
466	1	7	0.277837	0.246358	0.271828	0.276921	0.265460	0.220463	0.203483	0.170373	30.2736
467	1	12	0.349738	0.303688	0.305399	0.242929	0.242929	0.188160	0.156925	0.152219	31.1010
468	1	14	0.267661	0.182170	0.208699	0.333211	0.309250	0.263039	0.231376	0.181010	31.5429
469	2	4	0.208229	0.169948	0.168250	0.260791	0.309183	0.275223	0.199239	0.173769	27.1556
470	2	6	0.264266	0.210700	0.197541	0.237019	0.296024	0.226406	0.225133	0.262064	29.2647
471	2	10	0.321616	0.204757	0.116037	0.121556	0.220463	0.269281	0.257395	0.275223	27.5771
472	2	13	0.291490	0.214261	0.182598	0.285289	0.355033	0.245068	0.236083	0.304971	32.1267
473	3	1	0.234058	0.190749	0.220463	0.272252	0.310032	0.313853	0.304938	0.262489	31 9220
474	3	8	0.281339	0.206030	0.245084	0.313853	0.260366	0.272677	0.249329	0.251027	31.9257
475	3	9	0.234934	0.271403	0.197541	0.102878	0.111368	0.142780	0.133866	0.131319	20.9991
476	3	15	0.271632	0.278443	0.337490	0.250203	0.271169	0.292991	0.241645	0.201852	33.2280
477	4	3	0.237561	0.223859	0.244660	0.274374	0.318098	0.275648	0.185655	0.127074	29.5987
478	4	5	0.239312	0.188626	0.216643	0.214945	0.287958	0.245084	0.237868	0.239566	28.4969
479	4	11	0.273021	0.306212	0.274374	0.228953	0.261215	0.293901	0.321069	0.305787	34.2618
480	4	16	0.256629	0.243785	0.247208	0.257477	0.245924	0.192867	0.187305	0.182170	28 2030

SOIL MOISTURE DATA

DATE=08/27

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
481	1	2	0.238303	0.227033	0.248589	0.152642	0.161941	0.238023	0.159405	0.155178	24.7296
482	1	7	0.265765	0.230414	0.268455	0.270569	0.257043	0.208013	0.186456	0.157714	28.9325
483	1	12	0.338562	0.297197	0.292548	0.225765	0.230837	0.179693	0.143766	0.145879	29.7270
484	1	14	0.250072	0.177157	0.206745	0.340733	0.287898	0.251548	0.224074	0 271414	30.4643
485	2	4	0.192097	0.141230	0.135313	0.229992	0.292970	0.264651	0.196600	0.167013	24.8779
486	2	6	0.242662	0.191106	0.185188	0.246053	0.290434	0.221538	0.221538	0.255775	28.1595
487	2	10	0.308484	0.191951	0.108261	0.117983	0.198714	0.261692	0.252816	0.268033	26.3372
488	2	13	0.267509	0.194064	0.167013	0 278599	0.347495	0.227456	0.220270	0.290012	30.1930
489	3	1	0.231328	0.179271	0.203363	0.248167	0.298465	0.311145	0.301847	0.260847	30.7798
490	3	8	0.270124	0.182229	0.235909	0.311991	0.251548	0.267610	0.244785	0.242672	30.7939
491	3	9	0.209097	0.260424	0.199982	0.097272	0.106571	0.132354	0.137849	0.126436	19.9844
492	3	15	0.254431	0.263383	0.325516	0.240981	0.261692	0.284940	0.245208	0.196600	32.0294
493	4	3	0.267945	0.244363	0.259579	0.285362	0.314104	0.265496	0.188147	0.123478	30.7956
494	4	5	0.275791	0.213930	0.210126	0.211817	0.286630	0.235909	0.229992	0.241827	29.3066
495	4	11	0.304125	0.325939	0.283249	0.249858	0.275641	0.288744	0.320867	0.301424	35.8322
496	4	16	0.308048	0.245208	0.233796	0 246899	0.240559	0.190260	0.179271	0.169549	28.6945

DATE=08/29

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
497	1	2	0.225503	0.219253	0.244595	0.152940	0.158009	0.237415	0.151251	0.150406	24.0323
498	1	7	0.262529	0.229390	0.261912	0.269515	0 250508	0.201513	0.182506	0.152940	28.4319
499	1	12	0.341808	0.292323	0.283876	0.227700	0.224321	0.178705	0.147449	0.142803	29.5425
500	1	14	0.241620	0.173636	0.207426	0.342586	0.281342	0.252198	0.221365	0.276695	30.1650
501	2	4	0.184122	0.126753	0.126753	0.214607	0.290634	0.261068	0.187152	0.164767	23.8587
502	2	6	0.232908	0.291901	0.184618	0.245017	0.296125	0.206159	0.213339	0.249664	29.1290
503	2	10	0.281695	0.178705	0.105212	0.116194	0.193066	0.245862	0.251775	0.263179	25.0690
504	2	13	0.273854	0.193910	0.166034	0.301615	0.352300	0.223054	0 216718	0.280497	30.5511
505	3	1	0.227681	0.173214	0.201091	0.243750	0.299504	0.301193	0.302038	0.255154	30.3259
506	3	8	0.266449	0.179550	0.224321	0.311330	0.249664	0.272894	0.239104	0.236992	30.4043
507	3	9	0.204159	0.256422	0.190531	0.093808	0.103522	0.125486	0.125908	0.119573	19.2283
508	3	15	0.252946	0.258533	0.327803	0.241216	0.261912	0.289367	0.233613	0.190954	31.8111
509	4	3	0.261222	0.235725	0.258956	0.283876	0.318088	0.270782	0.184196	0.119995	30.5326
510	4	5	0.262965	0.205314	0.204047	0.209116	0.281764	0.233613	0.227700	0.234036	28.5448
511	4	11	0.306960	0.333293	0.277118	0.249241	0.271627	0.291056	0.319355	0.304572	35.8813
512	4	16	0.288665	0.237837	0.228545	0.248819	0.233613	0.184618	0.179550	0.167301	27.8836

DATE=08/30

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
513	1	2	0.221832	0.215197	0.243415	0.150758	0.159603	0.235834	0.152022	0.149916	23.8435
514	1	7	0.254843	0.219830	0.268264	0.264895	0.248048	0.196666	0.178134	0.152864	27.9583
515	1	12	0.330855	0.294377	0.281320	0.221936	0.219409	0.173922	0.142335	0.142335	28.9674
516	1	14	0.242814	0.174193	0.211549	0.337625	0.278195	0.253150	0.218765	0.264187	30.0196
517	2	4	0.177528	0.123382	0.122540	0.208458	0.289744	0.258156	0.189927	0.160866	23.4533
518	2	6	0.228782	0.174344	0.181503	0.239204	0.285111	0.214776	0.212670	0.245942	27.0320
519	2	10	0.303056	0.176871	0.104430	0.112853	0.189927	0.245100	0.246363	0.256893	25.2767
520	2	13	0.263828	0.185230	0.168250	0.287534	0.346115	0.228953	0.211973	0.279893	29.9275
521	3	1	0.218791	0.169711	0.198771	0.240888	0.297325	0.300273	0.301115	0.254366	29 9230
522	3	8	0.259621	0.168447	0.221093	0.306169	0.247627	0.265737	0.235834	0.231201	29.7171

SOIL MOISTURE DATA

DATE=08/30

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
523	3	9	0.202720	0.250154	0.185294	0.092637	0.104430	0.125067	0.127173	0.123382	19.0580
524	3	15	0.241501	0.254423	0.326588	0.234472	0.258244	0.284987	0.237868	0.185655	31.2673
525	4	3	0.253540	0.229938	0.253523	0.284690	0.315856	0.267001	0.177292	0.120855	30.0081
526	4	5	0.254408	0.193717	0.202983	0.213091	0.287217	0.227411	0.226147	0.232886	28.1730
527	4	11	0.303491	0.325122	0.271634	0.245942	0.266580	0.289744	0.317120	0.310381	35.4569
528	4	16	0.275648	0.233623	0.230227	0.245084	0.234472	0.187353	0.180136	0.167826	27.5582

DATE=08/31

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
529	1	2	0.220769	0.226653	0.248711	0.149874	0.160903	0.236833	0.151995	0.146056	24.0662
530	1	7	0.259704	0.218593	0.259740	0.265678	0.249983	0.201201	0.176598	0.151570	27.9979
531	1	12	0.335301	0.286314	0.277787	0.222790	0.215116	0.169924	0.137949	0.145623	28.7372
532	1	14	0.232855	0.174188	0.211705	0.340458	0.276082	0.255191	0.217674	0.262865	29.8096
533	2	4	0.173522	0.119756	0.118908	0 202474	0.291554	0.254649	0.191020	0.160479	23.1478
534	2	6	0.223394	0.178295	0.182537	0.247862	0 290706	0.213503	0.213503	0.249135	27.2196
535	2	10	0.296015	0.168962	0.102364	0.110848	0.186778	0.250407	0.242772	0.255073	24.8974
536	2	13	0.268030	0.185699	0.166940	0.293135	0.349411	0.224495	0.208294	0.274376	29.9802
537	3	1	0.274578	0.233440	0.278404	0.312339	0.316581	0.319126	0.311491	0.266527	35.3037
538	3	8	0.309576	0.215624	0.239803	0.307673	0.248711	0 266951	0.241499	0.239378	32.0697
539	3	9	0.304083	0.274803	0.183141	0.095742	0.107253	0.126865	0.129423	0.120043	21.8446
540	3	15	0.328266	0.260307	0.327668	0.230890	0.261586	0.283329	0.231743	0.186125	33.2382
541	4	3	0.249205	0.227501	0.255073	0.285615	0.319975	0.264406	0.177022	0.121029	29.9300
542	4	5	0.252705	0.191445	0.193566	0.216048	0.283919	0.233864	0.222835	0.230470	27.9801
543	4	11	0.296889	0.323368	0.271617	0.247862	0.263133	0.290706	0.317430	0.309370	35.2674
544	4	16	0.267150	0.228332	0.228332	0.241549	0.229611	0.183993	0.175893	0 169072	27.0201

DATE=09/05

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
545	1	2	0.301362	0.230606	0.234794	0.148944	0.153969	0.226837	0.142243	0.140568	25.2941
546	1	7	0.294884	0.228931	0.244007	0.259083	0.237307	0.191660	0.165276	0.139312	28.0149
547	1	12	0.354485	0.298030	0.285466	0.240657	0.232700	0.171558	0.137218	0.137637	29.9645
548	1	14	0.264219	0.168208	0.209667	0.338233	0.268296	0.246101	0.202967	0.253220	29.8157
549	2	4	0.151927	0.122142	0.104553	0.181190	0.283791	0.244845	0.182446	0.151457	21.6802
550	2	6	0.285382	0.169045	0.177840	0.243170	0.284210	0.200454	0.206736	0.239819	27.8806
551	2	10	0.320797	0.177002	0.097434	0.109997	0.171977	0.238982	0.236469	0.250289	24.9662
552	2	13	0.284086	0.176583	0.163601	0.288398	0.339908	0.208411	0.194172	0.262015	29.3859
553	3	1	0.246943	0.214692	0.241494	0.290073	0.315619	0.311012	0.303055	0.251126	33.1001
554	3	8	0.306545	0.207992	0.233956	0.298030	0.245682	0.262434	0.230606	0.228512	31.2843
555	3	9	0.294020	0.293842	0.185797	0.086545	0.096177	0.121304	0.120467	0.117117	21.3927
556	3	15	0.319501	0.303893	0.327345	0.229769	0.251126	0.279604	0.222231	0.178677	33.2622
557	4	3	0.281927	0.249033	0.273322	0.293423	0.318131	0.266621	0.186634	0.121723	31.5608
558	4	5	0.290133	0.243588	0.245682	0.225162	0.282535	0.225581	0.220137	0.232700	30.3921
559	4	11	0.313455	0.334045	0.282535	0.272484	0.287142	0.305568	0.318131	0.303474	36 9086
560	4	16	0.323820	0.241076	0.217205	0.244426	0.226000	0.180352	0.174071	0.160251	28.1785

SOIL MOISTURE DATA

DATE=09/07

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
561	1	2	0.269478	0.222677	0.231503	0.143666	0.158376	0.228141	0.145768	0.134000	24.4045
562	1	7	0.283348	0.219315	0.242009	0.254197	0.241589	0.187374	0.160057	0.134420	27.3828
563	1	12	0.347495	0.286138	0.279414	0.231923	0.225619	0.170143	0.131058	0.132319	29.1343
564	1	14	0.256475	0.173085	0.214272	0.333628	0.267226	0.242009	0.211330	0.251676	29.7500
565	2	4	0.222234	0.116349	0.101219	0.176447	0.277732	0.235285	0.169723	0.149550	22.6296
566	2	6	0.269911	0.165941	0.174346	0.245372	0.287399	0.202504	0.198722	0.235705	27.3863
567	2	10	0.313254	0.162578	0.094074	0.105842	0.165520	0.234445	0.223938	0.238647	24.0122
568	2	13	0.276413	0.173926	0.165941	0.292862	0.336150	0.205026	0.189476	0.249574	28.9985
569	3	1	0.243906	0.202924	0.241169	0.290341	0.313455	0.307151	0.303789	0.247053	32.7388
570	3	8	0.296784	0.202504	0.243270	0.300007	0.241589	0.257980	0.226880	0.229822	30.9725
571	3	9	0.275113	0.270168	0.175607	0.088611	0.095755	0.114668	0.123073	0.119711	20.4278
572	3	15	0.303285	0.294123	0.323962	0.229401	0.250415	0.285297	0.217214	0.181070	32.7031
573	4	3	0.269911	0.245792	0.270588	0.294543	0.318919	0.260501	0.173505	0.121392	30.9282
574	4	5	0.269045	0.226880	0.236966	0.230242	0.279834	0.220576	0.212591	0.230242	29.3488
575	4	11	0.298084	0.326904	0.272689	0.257139	0.278993	0.299586	0.323122	0.304209	35.9308
576	4	16	0.302852	0.234024	0.216793	0.244531	0.222257	0.178549	0.166361	0.157955	27.3675

DATE=09/11

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
577	1	2	0.326792	0.283672	0.243940	0.279022	0.162786	0.227033	0.135313	0.131931	28.7719
578	1	7	0.309356	0.284517	0.299311	0.292548	0.281981	0.223229	0.159405	0.128550	31.5361
579	1	12	0.376050	0.310723	0.297620	0.271837	0.265919	0.203786	0.152220	0.140385	32.5583
580	1	14	0.280586	0.172085	0.216889	0.339042	0.265496	0.240981	0.202095	0.272259	30.3824
581	2	4	0.277535	0.263383	0.285785	0.265074	0 336083	0 290434	0.219848	0.188570	33.0890
582	2	6	0.306305	0.204209	0.193642	0.248589	0.284094	0.205477	0.205054	0.235064	29.2311
583	2	10	0.352511	0.208013	0.126859	0.180539	0.265074	0.259579	0.231260	0.240136	29.2632
584	2	13	0.350767	0.208435	0.172931	0.287476	0.338197	0.201673	0.181384	0.247321	31.0882
585	3	1	0.256611	0.217734	0.269301	0.309455	0.324248	0.318754	0.309032	0.263383	34.5206
586	3	8	0.302381	0.195755	0.258311	0.301847	0.231682	0.261270	0.232951	0.229569	31.2446
587	3	9	0.305433	0.264228	0.164054	0.082901	0.096004	0.117560	0.115869	0.120519	20.7115
588	3	15	0.321997	0.293816	0.330588	0.247744	0.280713	0.284094	0.290857	0.317908	36.1152
589	4	3	0.294099	0.251971	0.266765	0.293393	0.320444	0.254507	0.174199	0.119251	31.4257
590	4	5	0.291920	0.211817	0.224497	0.227878	0.287476	0.218580	0.208013	0.226610	29.4047
591	4	11	0.314587	0.322558	0.175044	0.247321	0.274373	0.299733	0.325939	0.305651	34.5898
592	4	16	0.324177	0.233796	0.226610	0.287476	0.306496	0.321290	0.372856	0.418082	37.2440

DATE=09/14

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
593	1	2	0.277325	0.258842	0.237438	0.142592	0.161478	0.217294	0.136297	0.127484	24.8971
594	1	7	0.286678	0.269553	0.278347	0.284629	0.274578	0.218043	0.164020	0.128005	30.2238
595	1	12	0.344551	0.293842	0.286304	0.253220	0.246101	0.193335	0.141825	0.146850	30.5543
596	1	14	0.260332	0.168208	0.215949	0.332370	0.259921	0.249870	0.236050	0.293005	30.4704
597	2	4	0.240968	0.218973	0.240796	0.294934	0.318435	0.275629	0.201347	0.168192	30.4139
598	2	6	0.268236	0.189176	0.187078	0.256743	0.278986	0.198409	0.201347	0.226947	27.8521
599	2	10	0.335049	0.177840	0.107903	0.158157	0.248195	0.259083	0.247357	0.240657	27.7587
600	2	13	0.302658	0.200035	0.169045	0.284629	0.336558	0.194172	0.174071	0.234375	29.4084
601	3	1	0.240103	0.204284	0.251707	0.299130	0.312980	0.312560	0.303747	0.258422	33 1283
602	3	8	0.287541	0.200035	0.262852	0.298449	0.231444	0.251964	0.226418	0.219299	30.6648

SOIL MOISTURE DATA

DATE=09/14

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
603	3	9	0.268970	0.258664	0 157319	0.081101	0.091571	0.109997	0.109997	0.109578	19.3075
604	3	15	0.300498	0.297192	0.329020	0.294261	0.307243	0.306824	0.308918	0.337395	37.5346
605	4	3	0 268668	0.245412	0.266816	0 286540	0.323891	0.257583	0.176166	0 122448	30.7945
606	4	5	0.272131	0.200927	0.213517	0.227786	0.275209	0.215615	0.199248	0 222330	28 2194
607	4	11	0.296179	0.313944	0.232700	0.234794	0.262852	0.292167	0.323576	0.295517	34.3214
608	4	16	0.310000	0.236888	0.271228	0.293005	0.321063	0 326088	0.362941	0 417801	37.8731

DATE=09/17

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
609	1	2	0.253599	0.240843	0 233299	0.141940	0.157446	0.220308	0 134397	0 129368	23.9773
610	1	7	0.284285	0 263892	0.278141	0.277303	0.263892	0.208155	0 157446	0.131044	29.5775
611	1	12	0.351708	0.285684	0 272274	0.233299	0.254253	0.195582	0.141102	0.155770	30.2917
612	1	14	0.253185	0.164812	0 222430	0.337666	0.270796	0.251870	0.240515	0.286777	30.6515
613	2	4	0.219887	0.200611	0.219470	0 283170	0 303705	0.271436	0.193097	0 166666	28 7983
614	2	6	0.253166	0 185525	0 182172	0 266826	0 273531	0.200192	0.198516	0 237490	27.5121
615	2	10	0 327937	0 170438	0 110510	0.147388	0.222403	0.248386	0.232461	0 246291	26.6188
616	2	13	0.300708	0.174629	0.177981	0 302028	0.343936	0.188877	0.167085	0 237071	29.3238
617	3	1	0.234582	0.200611	0.237909	0 286522	0 312086	0.302028	0.300352	0 255091	32.2925
618	3	8	0.274344	0.189715	0.254253	0.290713	0 228690	0 250482	0.232042	0.227851	30.0432
619	3	9	0.246251	0.253834	0.157446	0.080755	0.091232	0.117634	0.117215	0 110510	18.9395
620	3	15	0 293522	0 284254	0 321264	0 287619	0.309488	0 314114	0.301077	0.322946	36.8743
621	4	3	0 251005	0.238747	0.264730	0.289037	0.319210	0.259701	0.177143	0.115539	30 2186
622	4	5	0.255327	0.183848	0 198516	0.223661	0.285684	0.211926	0.198935	0 218632	27.3539
623	4	11	0.288607	0.294485	0.235814	0.232461	0 259701	0 280655	0.317115	0.305800	33.6201
624	4	16	0 305667	0.250608	0 272899	0.298974	0.306965	0 334722	0.245982	0.282151	35 2002

DATE=09/21

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
625	1	2	0.217662	0.231079	0.251353	0.165611	0 149139	0 228123	0.138157	0 130554	23.7017
626	1	7	0.267321	0.241216	0.267403	0.280919	0.271205	0.209116	0.166456	0 130132	28.9920
627	1	12	0.339630	0.287677	0.288944	0 234458	0.236570	0 185885	0.148294	0.148294	29 9530
628	1	14	0.243363	0.165189	0.195177	0.310063	0 289789	0.264024	0.231079	0 281764	29.8894
629	2	4	0.204159	0.175748	0.166034	0.251775	0 299926	0 268248	0 203625	0 166456	26.7435
630	2	6	0.221583	0.186308	0.186308	0.209538	0.293590	0 212917	0.198979	0.229390	26.4370
631	2	10	0.310445	0.205314	0 117883	0.105634	0 191798	0.253887	0.231079	0.243750	25.8034
632	2	13	0.272983	0.201935	0.163077	0.259378	0.338362	0.218830	0 167301	0 239527	28.6226
633	3	1	0.246847	0.190109	0.216718	0 254310	0.307529	0.313020	0.302038	0.259378	31 7553
634	3	8	0.275597	0.182929	0.205314	0.220520	0.243750	0.260223	0.235303	0 228545	28 5858
635	3	9	0.215049	0.258111	0.202358	0.301615	0 083249	0 108591	0.114504	0 101833	21.9748
636	3	15	0.257302	0.269515	0.316398	0.284298	0 298236	0 307529	0.295280	0.323579	35.3415
637	4	3	0.234651	0.220520	0.245017	0.272049	0.315976	0 285565	0.177438	0.118728	29.3813
638	4	5	0.242491	0.174904	0.188419	0 204470	0 280074	0.223476	0 189264	0.205314	26 3195
639	4	11	0.241620	0.291901	0.274584	0.207849	0 241216	0 291478	0.316398	0 309641	32.6239
640	4	16	0 287794	0.248819	0.255999	0.284721	0.295702	0.316398	0.251353	0.245017	33.6376

SOIL MOISTURE DATA

DATE=09/28

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
641	1	2	0.202189	0.216780	0.242652	0.159192	0.145838	0.224708	0.138744	0.126642	22.7765
642	1	7	0.249631	0.220251	0.253523	0.266580	0.261526	0.193717	0.163393	0 129278	27.4027
643	1	12	0.328683	0 280899	0.280478	0.223199	0 222778	0.180661	0.146546	0.133069	28.8664
644	1	14	0.225741	0.165499	0.200877	0.321332	0.286796	0 261526	0.229938	0.288059	29 6968
645	2	4	0.181871	0.136017	0.131384	0.210985	0.291850	0.257735	0.196666	0.157497	24 0212
646	2	6	0.209236	0.165920	0.176871	0.223199	0.291007	0.208458	0 201298	0.218566	25.7539
647	2	10	0.296541	0.179819	0.111168	0.106957	0.174765	0.245942	0.220251	0.242994	24.4634
648	2	13	0.254843	0.189084	0.154970	0 259420	0.340705	0.207195	0.165499	0.225726	27 6149
649	3	1	0.231454	0.178388	0.198836	0.235975	0.300657	0.311925	0.314428	0.243487	30.6192
650	3	8	0.256146	0.165078	0.179819	0.294798	0.240046	0 256050	0.229096	0.224884	28.3700
651	3	9	0.197074	0.248890	0.197508	0.082529	0.083371	0.102324	0.112432	0.100218	17.8731
652	3	15	0.235731	0.260262	0.317962	0.283426	0.293113	0.308696	0.285111	0.287638	34.2288
653	4	3	0.209936	0.206764	0 226378	0.265604	0.308586	0.270194	0.177553	0 116627	27 8632
654	4	5	0.220529	0.154549	0 176028	0.202983	0.277530	0.221936	0.176449	0.195823	24.9659
655	4	11	0.216185	0.289744	0.268685	0.197087	0.229517	0.287638	0.325122	0 296483	31 5516
656	4	16	0.239206	0.240046	0 245942	0.277109	0.276266	0.279636	0.230780	0.242573	30.9353

DATE=10/04

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
657	1	2	0.202004	0.213178	0.242618	0 153036	0 146728	0.224113	0.134531	0.126120	22.5593
658	1	7	0.236332	0 214362	0.243014	0 257963	0.252565	0.193184	0.149998	0.127159	26.3524
659	1	12	0.312988	0.275403	0.272081	0.211040	0.214777	0.170345	0.131727	0.137541	27.6397
660	1	14	0.211065	0.164532	0.196091	0.323157	0.283708	0.250488	0.219345	0 262115	28.7270
661	2	4	0.172951	0.127159	0.116778	0.193184	0.282463	0.240938	0.177404	0.149583	22 4355
662	2	6	0.191794	0.159964	0.167854	0.221006	0.283293	0 204811	0.185294	0.225989	24 7331
663	2	10	0.288578	0.163701	0.096431	0.100583	0.157888	0.229311	0.208133	0.229726	22.9176
664	2	13	0.250464	0.176574	0.157888	0.264192	0 333538	0.198582	0.165778	0.225158	27.2008
665	3	1	0.231064	0.174485	0.192990	0.226215	0.293086	0 309068	0.298133	0.254394	29.9888
666	3	8	0.241042	0.157473	0.190277	0.299903	0.230556	0 254641	0.224328	0.219345	27.8650
667	3	9	0 175948	0.242599	0.189447	0.076914	0.078990	0.099753	0.106397	0.101414	16.8970
668	3	15	0.214919	0.253395	0 318589	0.272081	0.289107	0 297827	0.267929	0 265022	32 8242
669	4	3	0.203305	0.201402	0 217383	0.256496	0.311591	0.271216	0 178691	0.114764	27.4186
670	4	5	0.182372	0.147922	0.169930	0.197336	0.274573	0.217268	0.171176	0.193184	23.5969
671	4	11	0.217060	0.293674	0.256302	0.191108	0.223912	0.276234	0.307378	0 301979	30 8639
672	4	16	0.237616	0 238031	0 239277	0.269175	0.262946	0 245090	0.219345	0.233463	29.6726

DATE=10/11

OBS	TRT	PLOT	P6	P12	P18	P24	P30	P36	P42	P48	CUMMC
673	1	2	0.197804	0.214187	0.241964	0 146848	0.150635	0.219658	0.130855	0 126225	22.3108
674	1	7	0.230792	0.200719	0.227234	0.249119	0.247435	0 180096	0.144743	0 118649	25.2200
675	1	12	0.309354	0.276896	0.269741	0.196510	0.194406	0.165787	0.135063	0 136326	26.9839
676	1	14	0.197370	0 165787	0.203665	0.337501	0.276054	0.252907	0.215449	0.274792	28.7246
677	2	4	0.157872	0.106023	0 103919	0.182621	0 277738	0 233547	0.171258	0.143481	21.0869
678	2	6	0.199541	0 156948	0.171258	0.235230	0.281105	0.198614	0.184305	0 219237	24.9386
679	2	10	0.274630	0.145585	0.093397	0.098869	0.150635	0 215870	0.197352	0.224708	21.7324
680	2	13	0 230792	0 168733	0.156528	0.282788	0.340868	0.198614	0.162420	0.222604	26 9358
681	3	1	0 212128	0 167049	0.185147	0 232705	0.294573	0.302569	0 304673	0 244489	29.3698
682	3	8	0.253796	0.146427	0 184305	0.293731	0 229338	0 252907	0 225971	0.220500	27.7920

APPENDIX C

SOIL MOISTURE TENSION AND TOTAL HEAD DATA

SOIL MOISTURE SUCTION AND TOTAL HEAD

OBS	DATE	PLOT	TUBE	L	TENS	THEAD
1	05/24	2	1	30	65.22	95.22
2	05/24	2	2	60	30.99	90.99
3	05/24	2	3	120	-30 23	89.77
4	05/24	2	4	150	-51 84	98 16
5	05/24	4	1	150	-57.79	92.21
6	05/24	4	2	120	-29.01	90.99
7	05/24	4	4	120	129.44	249.44
8	05/24	5	1	30	60 30	90.30
9	05/24	5	2	60	32.43	92.43
10	05/24	5	3	120	-29.94	90.06
11	05/24	5	4	150	-57 61	92.39
12	05/24	8	1	120	-39.78	80.22
13	05/24	8	2	150	-68 26	81.74
14	05/24	8	3	120	-37 04	82.96
15	06/04	2	1	30	43.80	73.80
16	06/04	2	2	60	17 13	77.13
17	06/04	2	3	120	-41 57	78.43
18	06/04	2	4	150	-69 48	80.52
19	06/04	4	1	150	-79.21	70.79
20	06/04	4	2	120	-51.69	68 31
21	06/04	4	3	150	-81.89	68.11
22	06/04	4	4	120	-48.22	71.78
23	06/04	5	1	30	28 80	58 80
24	06/04	5	2	60	2 19	62.19
25	06/04	5	3	120	-57.66	62 34
26	06/04	5	4	150	-85.33	64 67
27	06/04	8	1	120	-73.80	46 20
28	06/04	8	2	150	-98 50	51.50
29	06/04	8	3	120	-59.72	60.28
30	06/06	2	1	30	47 58	77.58
31	06/06	2	2	60	17 13	77.13
32	06/06	2	3	120	-44.09	75.91
33	06/06	2	4	150	-70.74	79.26
34	06/06	4	1	150	-80.47	69.53
35	06/06	4	2	120	-52.95	67.05
36	06/06	4	3	150	-80 63	69.37
37	06/06	4	4	120	-54.52	65.48
38	06/06	5	1	30	30.06	60.06
39	06/06	5	2	60	2.19	62.19
40	06/06	5	3	120	-57.66	62.34
41	06/06	5	4	150	-86.59	63.41
42	06/06	8	1	120	-59.94	60.06
43	06/06	8	2	150	-88.42	61.58
44	06/06	8	3	120	-57.20	62.80
45	06/06	8	4	150	-87.51	62.49
46	06/12	2	1	30	51.36	81.36
47	06/12	2	2	60	34.77	94.77
48	06/12	2	3	120	20.17	140.17
49	06/12	2	4	150	-46.80	103.20
50	06/12	4	1	150	-57 79	92.21
51	06/12	4	2	120	-30.27	89.73
52	06/12	4	3	150	-56.69	93 31
53	06/12	4	4	120	-31 84	88.16
54	06/12	5	1	30	50.22	80.22
55	06/12	5	2	60	28.65	88.65
56	06/12	5	3	120	-31.20	88.80

SOIL MOISTURE SUCTION AND TOTAL HEAD

OBS	DATE	PLOT	TUBE	L	TENS	THEAD
57	06/12	5	4	150	-61.39	88.61
58	06/12	8	1	120	-91.44	28.56
59	06/12	8	2	150	-72.04	77.96
60	06/12	8	3	120	-43 34	76.66
61	06/12	8	4	150	-101.37	48.63
62	06/14	2	1	30	52.62	82.62
63	06/14	2	2	60	42.33	102.33
64	06/14	2	3	120	-15.11	104.89
65	06/14	2	4	150	-43.02	106.98
66	06/14	5	1	30	54.00	84.00
67	06/14	5	2	60	28.65	88.65
68	06/14	5	3	120	-24.90	95.10
69	06/14	5	4	150	-55.09	94.91
70	06/14	4	1	150	-55.27	94.73
71	06/14	4	2	120	-27.75	92.25
72	06/14	4	3	150	-56.69	93.31
73	06/14	4	4	120	-26.80	93.20
74	06/14	8	1	120	-125.46	-5.46
75	06/14	8	2	150	-61.96	88.04
76	06/14	8	3	120	-30.74	89.26
77	06/14	8	4	150	-19.47	130.53
78	06/19	2	1	30	77.82	107.82
79	06/19	2	2	60	49.89	109.89
80	06/19	2	3	120	-1.25	118.75
81	06/19	2	4	150	-30.42	119.58
82	06/19	4	1	150	-40.15	109.85
83	06/19	4	2	120	-12.63	107.37
84	06/19	4	3	150	-40.31	109.69
85	06/19	4	4	120	-9.16	110.84
86	06/19	5	1	30	80.46	110.46
87	06/19	5	2	60	53.85	113.85
88	06/19	5	3	120	-7.26	112.74
89	06/19	5	4	150	-36.19	113.81
90	06/19	8	1	120	-82.62	37.38
91	06/19	8	2	150	-48.10	101.90
92	06/19	8	3	120	-9.32	110.68
93	06/19	8	4	150	-56.01	93.99
94	06/21	2	1	30	85.38	115.38
95	06/21	2	2	60	54.93	114.93
96	06/21	2	3	120	6 31	126.31
97	06/21	2	4	150	-19.08	130.92
98	06/21	4	1	150	-26.29	123.71
99	06/21	4	2	120	-0.03	119.97
100	06/21	4	3	150	-27.71	122.29
101	06/21	4	4	120	2.18	122.18
102	06/21	5	1	30	80.46	110.46
103	06/21	5	2	60	51.33	111.33
104	06/21	5	3	120	-6.00	114.00
105	06/21	5	4	150	-36.19	113.81
106	06/21	8	1	120	-85.14	34.86
107	06/21	8	2	150	-87.16	62.84
108	06/21	8	4	150	-39.63	110.37
109	06/25	2	1	30	109.32	139.32
110	06/25	2	2	60	63.75	123.75
111	06/25	2	3	120	17.65	137.65
112	06/25	2	4	150	-9.00	141.00

SOIL MOISTURE SUCTION AND TOTAL HEAD

OBS	DATE	PLOT	TUBE	L	TENS	THEAD
113	06/25	4	1	150	-25.03	124.97
114	06/25	4	2	120	3.75	123.75
115	06/25	4	3	150	-16.37	133.63
116	06/25	4	4	120	70.22	190.22
117	06/25	5	1	30	93.06	123.06
118	06/25	5	2	60	237.81	297.81
119	06/25	5	3	120	10.38	130.38
120	06/25	5	4	150	-21.07	128.93
121	06/25	8	1	120	-64.98	55.02
122	06/25	8	2	150	-26.68	123.32
123	06/25	8	4	150	-95.07	54.93
124	06/27	2	1	30	32.46	62.46
125	06/27	2	2	60	36.03	96.03
126	06/27	2	3	120	17.65	137.65
127	06/27	2	4	150	-10.26	139.74
128	06/27	4	1	150	-21.25	128.75
129	06/27	4	2	120	7.53	127.53
130	06/27	4	3	150	-13.85	136.15
131	06/27	4	4	120	13.52	133.52
132	06/27	5	1	30	55.26	85.26
133	06/27	5	2	60	286.95	346.95
134	06/27	5	3	120	12.90	132.90
135	06/27	5	4	150	-16.03	133.97
136	06/27	8	1	120	-67.50	52.50
137	06/27	8	2	150	-29.20	120.80
138	06/27	8	3	120	2.02	122.02
139	06/27	8	4	150	-27.03	122.97
140	07/02	2	1	30	41.28	71.28
141	07/02	2	2	60	44.85	104.85
142	07/02	2	3	120	22.69	142.69
143	07/02	2	4	150	-3.96	146.04
144	07/02	4	1	150	-16.21	133.79
145	07/02	4	2	120	13.83	133.83
146	07/02	4	3	150	-8.81	141.19
147	07/02	4	4	120	19.82	139.82
148	07/02	5	1	30	89.28	119.28
149	07/02	5	2	60	405.39	465.39
150	07/02	5	3	120	12.90	132.90
151	07/02	5	4	150	-16.03	133.97
152	07/02	8	1	120	-59.94	60.06
153	07/02	8	2	150	-17.86	132.14
154	07/02	8	3	120	12.10	132.10
155	07/02	8	4	150	-18.21	131.79
156	07/05	2	1	30	52.62	82.62
157	07/05	2	2	60	54.93	114.93
158	07/05	2	3	120	30.25	150.25
159	07/05	2	4	150	4.86	154.86
160	07/05	4	1	150	-6.13	143.87
161	07/05	4	2	120	22.65	142.65
162	07/05	4	3	150	-2.51	147.49
163	07/05	4	4	120	26.12	146.12
164	07/05	5	1	30	103.14	133.14
165	07/05	5	2	60	527.61	587.61
166	07/05	5	3	120	22.98	142.98
167	07/05	5	4	150	2.87	152.87
168	07/05	8	1	120	-46.08	73.92

SOIL MOISTURE SUCTION AND TOTAL HEAD

OBS	DATE	PLOT	TUBE	L	TENS	THEAD
169	07/05	8	2	150	-14.08	135.92
170	07/05	8	3	120	15.88	135.88
171	07/05	8	4	150	-14.43	135.57
172	07/09	2	1	30	76.56	106.56
173	07/09	2	2	60	71.31	131.31
174	07/09	2	3	120	42.85	162.85
175	07/09	2	4	150	14.94	164.94
176	07/09	4	1	150	5.21	155.21
177	07/09	4	2	120	33.99	153.99
178	07/09	4	3	150	7.57	157.57
179	07/09	4	4	120	37.46	157.46
180	07/09	5	1	30	124.56	154.56
181	07/09	5	2	60	745.59	805.59
182	07/09	5	3	120	34.32	154.32
183	07/09	8	1	120	-20.88	99.12
184	07/09	8	2	150	1.04	151.04
185	07/09	8	3	120	32.26	152.26
186	07/09	8	4	150	-1.83	148.17
187	07/11	2	1	30	91.68	121.68
188	07/11	2	2	60	78.87	138.87
189	07/11	2	3	120	47.89	167.89
190	07/11	2	4	150	21.24	171.24
191	07/11	4	1	150	1.43	151.43
192	07/11	4	2	120	39.03	159.03
193	07/11	4	3	150	15.13	165.13
194	07/11	4	4	120	43.76	163.76
195	07/11	5	1	30	137.16	167.16
196	07/11	5	2	60	803.55	863.55
197	07/11	5	3	120	58.26	178.26
198	07/11	8	1	120	-1.98	118.02
199	07/11	8	2	150	6.08	156.08
200	07/11	8	3	120	34.78	154.78
201	07/11	8	4	150	5.73	155.73
202	07/13	2	1	30	106.80	136.80
203	07/13	2	2	60	80.13	140.13
204	07/13	2	3	120	49.15	169.15
205	07/13	2	4	150	23.76	173.76
206	07/13	4	1	150	12.77	162.77
207	07/13	4	2	120	41.55	161.55
208	07/13	4	3	150	17.65	167.65
209	07/13	4	4	120	48.80	168.80
210	07/13	5	1	30	31.32	61 32
211	07/13	5	2	60	71.49	131.49
212	07/13	5	3	120	-60.18	59.82
213	07/13	5	4	150	-86 59	63.41
214	07/13	8	1	120	9.36	129.36
215	07/13	8	2	150	9.86	159.86
216	07/13	8	3	120	37.30	157.30
217	07/13	8	4	150	6.99	156.99
218	07/16	2	1	30	157.20	187.20
219	07/16	2	2	60	99.03	159.03
220	07/16	2	3	120	61.75	181.75
221	07/16	2	4	150	30.06	180.06
222	07/16	4	1	150	20 33	170.33
223	07/16	4	2	120	52.89	172.89
224	07/16	4	3	150	31.51	181.51

SOIL MOISTURE SUCTION AND TOTAL HEAD

OBS	DATE	PLOT	TUBE	L	TENS	THEAD
225	07/16	4	4	120	61.40	181.40
226	07/16	5	1	30	196.38	226.38
227	07/16	5	3	120	40 62	160.62
228	07/16	5	4	150	16.73	166.73
229	07/16	8	1	120	24.48	144.48
230	07/16	8	2	150	17 42	167.42
231	07/16	8	3	120	49.90	169.90
232	07/16	8	4	150	17.07	167.07
233	07/18	2	1	30	157.20	187.20
234	07/18	2	2	60	97.77	157.77
235	07/18	2	3	120	61.75	181.75
236	07/18	2	4	150	33.84	183.84
237	07/18	4	1	150	26 63	176.63
238	07/18	4	2	120	55.41	175.41
239	07/18	4	3	150	28.99	178.99
240	07/18	4	4	120	-2.86	117.14
241	07/18	5	1	30	202.68	232.68
242	07/18	5	2	60	629 67	689.67
243	07/18	5	3	120	54.48	174.48
244	07/18	5	4	150	6.65	156.65
245	07/18	8	1	120	30.78	150.78
246	07/18	8	2	150	23.72	173.72
247	07/18	8	3	120	54.94	174.94
248	07/18	8	4	150	32 19	182.19
249	07/20	2	1	30	193.74	223.74
250	07/20	2	2	60	105.33	165.33
251	07/20	2	3	120	68.05	188.05
252	07/20	2	4	150	42.66	192.66
253	07/20	4	1	150	32.93	182.93
254	07/20	4	2	120	61.71	181.71
255	07/20	4	3	150	34.03	184.03
256	07/20	5	1	30	237.96	267.96
257	07/20	5	3	120	49.44	169.44
258	07/20	5	4	150	20.51	170.51
259	07/20	8	1	120	38.34	158.34
260	07/20	8	2	150	26.24	176.24
261	07/20	8	4	150	25.89	175.89
262	07/23	2	1	30	258.00	288.00
263	07/23	2	2	60	121.71	181.71
264	07/23	2	3	120	73.09	193.09
265	07/23	2	4	150	43.92	193.92
266	07/23	4	1	150	35.45	185.45
267	07/23	4	2	120	62.97	182.97
268	07/23	4	3	150	39.07	189.07
269	07/23	5	1	30	198.90	228.90
270	07/23	5	2	60	420.51	480.51
271	07/23	5	3	120	70.86	190.86
272	07/23	8	1	120	54.72	174.72
273	07/23	8	2	150	27.50	177.50
274	07/23	8	3	120	51.16	171.16
275	07/23	8	4	150	33.45	183.45
276	07/25	2	1	30	294.54	324.54
277	07/25	2	2	60	131.79	191.79
278	07/25	2	3	120	76.87	196.87
279	07/25	2	4	150	48.96	198.96
280	07/25	4	1	150	39.23	189.23

SOIL MOISTURE SUCTION AND TOTAL HEAD

OBS	DATE	PLOT	TUBE	L	TENS	THEAD
281	07/25	4	2	120	69.27	189.27
282	07/25	4	3	150	45.37	195.37
283	07/25	5	1	30	318.60	348.60
284	07/25	5	3	120	74.64	194.64
285	07/25	8	1	120	66.06	186.06
286	07/25	8	2	150	30.02	180.02
287	07/25	8	3	120	9.58	129.58
288	07/25	8	4	150	160.71	310.71
289	07/27	2	1	30	365.10	395.10
290	07/27	2	2	60	146.91	206.91
291	07/27	2	3	120	84.43	204.43
292	07/27	2	4	150	52.74	202.74
293	07/27	4	1	150	45.53	195.53
294	07/27	4	2	120	74.31	194.31
295	07/27	4	3	150	57.97	207.97
296	07/27	5	1	30	374.04	404.04
297	07/27	5	3	120	83.46	203.46
298	07/27	8	1	120	68.58	188.58
299	07/27	8	2	150	28.76	178.76
300	07/27	8	4	150	37.23	187.23
301	07/30	2	1	30	434.40	464.40
302	07/30	2	2	60	158.25	218.25
303	07/30	2	3	120	86.95	206.95
304	07/30	2	4	150	57.78	207.78
305	07/30	4	1	150	51.83	201.83
306	07/30	4	2	120	80.61	200.61
307	07/30	4	3	150	56.71	206.71
308	07/30	5	1	30	438.30	468.30
309	07/30	5	3	120	97.32	217.32
310	07/30	8	1	120	81.18	201.18
311	07/30	8	2	150	32.54	182.54
312	07/30	8	3	120	75.10	195.10
313	07/30	8	4	150	44.79	194.79
314	08/01	2	1	30	491.10	521.10
315	08/01	2	2	60	172.11	232.11
316	08/01	2	3	120	90.73	210.73
317	08/01	2	4	150	59.04	209.04
318	08/01	4	1	150	55.61	205.61
319	08/01	4	2	120	84.39	204.39
320	08/01	4	3	150	59.23	209.23
321	08/01	5	1	30	503.82	533.82
322	08/01	5	3	120	109.92	229.92
323	08/01	8	1	120	87.48	207.48
324	08/01	8	2	150	33.80	183.80
325	08/01	8	3	120	78.88	198.88
326	08/02	2	1	30	516.30	546.30
327	08/02	2	2	60	182.19	242.19
328	08/02	2	3	120	97.03	217.03
329	08/02	2	4	150	61.56	211.56
330	08/02	4	1	150	58.13	208.13
331	08/02	4	3	150	63.01	213.01
332	08/02	5	1	30	534.06	564.06
333	08/02	5	3	120	191.82	311.82
334	08/02	8	1	120	88.74	208.74
335	08/02	8	2	150	47.66	197.66
336	08/02	8	3	120	81.40	201.40

SOIL MOISTURE SUCTION AND TOTAL HEAD

OBS	DATE	PLOT	TUBE	L	TENS	THEAD
337	08/02	8	4	150	49.83	199 83
338	08/03	2	1	30	546.54	576.54
339	08/03	2	2	60	184.71	244.71
340	08/03	2	3	120	95.77	215.77
341	08/03	2	4	150	59 04	209.04
342	08/03	4	1	150	59.39	209.39
343	08/03	4	3	150	63.01	213.01
344	08/03	5	3	120	121.26	241.26
345	08/03	8	1	120	92.52	212.52
346	08/03	8	2	150	48.92	198.92
347	08/03	8	3	120	81.40	201.40
348	08/03	8	4	150	51.09	201.09
349	08/06	2	2	60	203.61	263.61
350	08/06	2	3	120	23.95	143.95
351	08/06	4	1	150	65 69	215.69
352	08/06	4	3	150	63.01	213.01
353	08/06	5	3	120	172.92	292 92
354	08/06	8	1	120	101.34	221.34
355	08/06	8	2	150	50.18	200.18
356	08/06	8	3	120	86.44	206.44
357	08/06	8	4	150	57.39	207.39
358	08/07	2	1	30	172.32	202.32
359	08/07	2	2	60	141.87	201.87
360	08/07	2	3	120	76.87	196.87
361	08/07	2	4	150	57.78	207.78
362	08/07	4	1	150	66 95	216.95
363	08/07	4	2	120	91.95	211.95
364	08/07	4	3	150	66.79	216.79
365	08/07	5	1	30	70.38	100.38
366	08/07	5	3	120	159.06	279.06
367	08/07	5	4	150	72.17	222.17
368	08/07	8	1	120	102.60	222.60
369	08/07	8	2	150	52.70	202.70
370	08/07	8	3	120	85.18	205.18
371	08/07	8	4	150	56.13	206.13
372	08/09	2	1	30	31.20	61.20
373	08/09	2	2	60	93.99	153.99
374	08/09	2	3	120	119.71	239.71
375	08/09	2	4	150	-60.66	89.34
376	08/09	4	1	150	64 43	214.43
377	08/09	4	2	120	91.95	211.95
378	08/09	4	3	150	71.83	221.83
379	08/09	5	1	30	45.18	75.18
380	08/09	5	3	120	79.68	199.68
381	08/09	5	4	150	99.89	249.89
382	08/09	8	1	120	106.38	226.38
383	08/09	8	2	150	69.08	219.08
384	08/09	8	3	120	87.70	207.70
385	08/09	8	4	150	58.65	208.65
386	08/13	2	1	30	37.50	67.50
387	08/13	2	2	60	75.09	135.09
388	08/13	2	3	120	136.09	256.09
389	08/13	4	1	150	66.95	216.95
390	08/13	4	2	120	69.27	189.27
391	08/13	4	3	150	65.53	215.53
392	08/13	5	1	30	52.74	82.74

SOIL MOISTURE SUCTION AND TOTAL HEAD

OBS	DATE	PLOT	TUBE	L	TENS	THEAD
393	08/13	5	2	60	23.61	83.61
394	08/13	5	3	120	130.08	250.08
395	08/13	5	4	150	59.57	209.57
396	08/13	8	1	120	112.68	232.68
397	08/13	8	2	150	60.26	210.26
398	08/13	8	3	120	91.48	211.48
399	08/13	8	4	150	58.65	208.65
400	08/15	2	1	30	48.84	78.84
401	08/15	2	2	60	93.99	153.99
402	08/15	2	3	120	115.93	235.93
403	08/15	2	4	150	74.16	224.16
404	08/15	4	1	150	75.77	225.77
405	08/15	4	2	120	21.39	141.39
406	08/15	4	3	150	75.61	225.61
407	08/15	4	4	120	97.94	217.94
408	08/15	5	1	30	56.52	86.52
409	08/15	5	2	60	42.51	102.51
410	08/15	5	3	120	143.94	263.94
411	08/15	5	4	150	64.61	214.61
412	08/15	8	1	120	176.94	296.94
413	08/15	8	2	150	64.04	214.04
414	08/15	8	3	120	92.74	212.74
415	08/15	8	4	150	49.83	199.83
416	08/17	2	1	30	60.18	90.18
417	08/17	2	2	60	101.55	161 55
418	08/17	2	3	120	134.83	254.83
419	08/17	2	4	150	74.16	224.16
420	08/17	4	1	150	77.03	227.03
421	08/17	4	2	120	90.69	210.69
422	08/17	4	3	150	76.87	226.87
423	08/17	4	4	120	106.76	226.76
424	08/17	5	1	30	60.30	90.30
425	08/17	5	2	60	66.45	126.45
426	08/17	5	3	120	161.58	281.58
427	08/17	5	4	150	60.83	210.83
428	08/17	8	1	120	117.72	237.72
429	08/17	8	2	150	62.78	212.78
430	08/17	8	3	120	94 00	214.00
431	08/17	8	4	150	62.43	212.43
432	08/20	2	1	30	82.86	112.86
433	08/20	2	2	60	124.23	184.23
434	08/20	2	3	120	303.67	423.67
435	08/20	2	4	150	79.20	229.20
436	08/20	4	1	150	82.07	232.07
437	08/20	4	2	120	99.51	219.51
438	08/20	4	3	150	80.65	230.65
439	08/20	4	4	120	124.40	244.40
440	08/20	5	1	30	71.64	101.64
441	08/20	5	2	60	135.75	195.75
442	08/20	5	3	120	200.64	320.64
443	08/20	5	4	150	73.43	223.43
444	08/20	8	1	120	125.28	245.28
445	08/20	8	3	120	94.00	214.00
446	08/20	8	4	150	66.21	216 21
447	08/22	2	1	30	105.54	135.54
448	08/22	2	2	60	138.09	198.09

SOIL MOISTURE SUCTION AND TOTAL HEAD

OBS	DATE	PLOT	TUBE	L	TENS	THEAD
449	08/22	2	3	120	212.95	332.95
450	08/22	2	4	150	80.46	230.46
451	08/22	4	1	150	84.59	234.59
452	08/22	4	2	120	100.77	220.77
453	08/22	4	3	150	85.69	235.69
454	08/22	4	4	120	104.24	224.24
455	08/22	5	1	30	80.46	110.46
456	08/22	5	2	60	172.29	232.29
457	08/22	5	3	120	235.92	355.92
458	08/22	5	4	150	86.03	236.03
459	08/22	8	1	120	132.84	252.84
460	08/22	8	2	150	60.26	210.26
461	08/22	8	3	120	99.04	219.04
462	08/22	8	4	150	67.47	217.47
463	08/23	2	1	30	111.84	141.84
464	08/23	2	2	60	143.13	203.13
465	08/23	2	3	120	229.33	349.33
466	08/23	2	4	150	51.48	201.48
467	08/23	4	1	150	83.33	233.33
468	08/23	4	2	120	90.69	210.69
469	08/23	4	3	150	83.17	233.17
470	08/23	4	4	120	80.30	200.30
471	08/23	5	1	30	85.50	115.50
472	08/23	5	2	60	87.87	147.87
473	08/23	5	3	120	238.44	358.44
474	08/23	5	4	150	80.99	230.99
475	08/23	8	1	120	132.84	252.84
476	08/23	8	2	150	66.56	216.56
477	08/23	8	3	120	100.30	220.30
478	08/23	8	4	150	68.73	218.73
479	08/27	2	1	30	177.36	207.36
480	08/27	2	2	60	170.85	230.85
481	08/27	2	3	120	396.91	516.91
482	08/27	2	4	150	85.50	235.50
483	08/27	4	1	150	90.89	240.89
484	08/27	4	3	150	88.21	238.21
485	08/27	4	4	120	149.60	269.60
486	08/27	5	1	30	52.74	82.74
487	08/27	5	2	60	57.63	117.63
488	08/27	5	3	120	171.66	291.66
489	08/27	5	4	150	70.91	220.91
490	08/27	8	1	120	142.92	262.92
491	08/27	8	2	150	72.86	222.86
492	08/27	8	3	120	104.08	224.08
493	08/27	8	4	150	76.29	226.29
494	08/29	2	1	30	237.84	267.84
495	08/29	2	2	60	189.75	249.75
496	08/29	2	3	120	113.41	233.41
497	08/29	2	4	150	90.54	240.54
498	08/29	4	1	150	95.93	245.93
499	08/29	4	2	120	89.43	209.43
500	08/29	4	3	150	97.03	247.03
501	08/29	4	4	120	155.90	275.90
502	08/29	5	1	30	64.08	94.08
503	08/29	5	2	60	97.95	157.95
504	08/29	5	3	120	223.32	343.32

SOIL MOISTURE SUCTION AND TOTAL HEAD

OBS	DATE	PLOT	TUBE	L	TENS	THEAD
505	08/29	5	4	150	72.17	222.17
506	08/29	8	1	120	142.92	262.92
507	08/29	8	2	150	76.64	226.64
508	08/29	8	3	120	106.60	226.60
509	08/29	8	4	150	73.77	223.77
510	08/30	2	1	30	300.84	330.84
511	08/30	2	2	60	211.17	271.17
512	08/30	2	3	120	177.67	297.67
513	08/30	2	4	150	95.58	245.58
514	08/30	4	1	150	97.19	247.19
515	08/30	4	2	120	85.65	205.65
516	08/30	4	3	150	81.91	231.91
517	08/30	4	4	120	152.12	272.12
518	08/30	5	1	30	67.86	97.86
519	08/30	5	2	60	123.15	183.15
520	08/30	5	3	120	266.16	386.16
521	08/30	5	4	150	88.55	238.55
522	08/30	8	1	120	153.00	273.00
523	08/30	8	2	150	79.16	229.16
524	08/30	8	3	120	110.38	230.38
525	08/30	8	4	150	76.29	226.29
526	08/31	2	1	30	332.34	362.34
527	08/31	2	2	60	207.39	267.39
528	08/31	2	3	120	249.49	369 49
529	08/31	2	4	150	95.58	245.58
530	08/31	4	1	150	97.19	247.19
531	08/31	4	3	150	85.69	235 69
532	08/31	4	4	120	163.46	283.46
533	08/31	5	1	30	69.12	99.12
534	08/31	5	2	60	142.05	202.05
535	08/31	5	3	120	278.76	398.76
536	08/31	5	4	150	75.95	225.95
537	08/31	8	1	120	151.74	271.74
538	08/31	8	2	150	79.16	229.16
539	08/31	8	3	120	91.48	211.48
540	08/31	8	4	150	76.29	226.29
541	09/05	2	1	30	158.46	188 46
542	09/05	2	2	60	256.53	316.53
543	09/05	2	3	120	65.53	185 53
544	09/05	2	4	150	103.14	253.14
545	09/05	4	1	150	97.19	247.19
546	09/05	4	3	150	88.21	238.21
547	09/05	4	4	120	169.76	289.76
548	09/05	5	1	30	48.96	78.96
549	09/05	5	2	60	28.65	88.65
550	09/05	5	3	120	88.50	208.50
551	09/05	5	4	150	67.13	217.13
552	09/05	8	1	120	160.56	280.56
553	09/05	8	2	150	81.68	231.68
554	09/05	8	3	120	111.64	231 64
555	09/05	8	4	150	78.81	228 81
556	09/07	2	1	30	84.12	114 12
557	09/07	2	2	60	294.33	354 33
558	09/07	2	4	150	113.22	263.22
559	09/07	4	1	150	102.23	252.23
560	09/07	4	2	120	118.41	238.41

SOIL MOISTURE SUCTION AND TOTAL HEAD

OBS	DATE	PLOT	TUBE	L	TENS	THEAD
561	09/07	4	3	150	89 47	239 47
562	09/07	4	4	120	179.84	299.84
563	09/07	5	1	30	70.38	100.38
564	09/07	5	2	60	68.97	128.97
565	09/07	5	3	120	137.64	257.64
566	09/07	5	4	150	86.03	236.03
567	09/07	8	1	120	164.34	284.34
568	09/07	8	2	150	85 46	235.46
569	09/07	8	3	120	119.20	239.20
570	09/07	8	4	150	86.37	236.37
571	09/11	2	1	30	43.80	73 80
572	09/11	2	2	60	217 47	277.47
573	09/11	2	4	150	85 50	235 50
574	09/11	4	1	150	75.77	225.77
575	09/11	4	3	150	74 35	224 35
576	09/11	4	4	120	85 34	205.34
577	09/11	5	1	30	40.14	70.14
578	09/11	5	3	120	156.54	276 54
579	09/11	5	4	150	49.49	199 49
580	09/11	8	1	120	160.56	280.56
581	09/11	8	2	150	86 72	236.72
582	09/11	8	3	120	91.48	211.48
583	09/11	8	4	150	78 81	228.81
584	09/14	2	1	30	63.96	93 96
585	09/14	2	2	60	85.17	145 17
586	09/14	2	4	150	80.46	230.46
587	09/14	4	1	150	77.03	227 03
588	09/14	4	2	120	83.13	203.13
589	09/14	4	3	150	79.39	229.39
590	09/14	4	4	120	116.84	236.84
591	09/14	5	1	30	59.04	89.04
592	09/14	5	2	60	72.75	132.75
593	09/14	5	3	120	98.58	218.58
594	09/14	5	4	150	175.49	325.49
595	09/14	8	1	120	163.08	283.08
596	09/14	8	2	150	82.94	232.94
597	09/14	8	3	120	110.38	230.38
598	09/14	8	4	150	72.51	222.51
599	09/17	2	1	30	80.34	110.34
600	09/17	2	2	60	87.69	147.69
601	09/17	2	4	150	80.46	230.46
602	09/17	4	1	150	82.07	232.07
603	09/17	4	2	120	96.99	216.99
604	09/17	4	3	150	78.13	228.13
605	09/17	4	4	120	133.22	253.22
606	09/17	5	1	30	70.38	100.38
607	09/17	5	2	60	129.45	189 45
608	09/17	5	3	120	238.44	358.44
609	09/17	5	4	150	73 43	223.43
610	09/17	8	1	120	163 08	283.08
611	09/17	8	2	150	77.90	227.90
612	09/17	8	3	120	109.12	229.12
613	09/17	8	4	150	72.51	222.51
614	09/21	2	1	30	113.10	143.10
615	09/21	2	2	60	106.59	166.59
616	09/21	2	4	150	81.72	231.72

SOIL MOISTURE SUCTION AND TOTAL HEAD

OBS	DATE	PLOT	TUBE	L	TENS	THEAD
617	09/21	4	1	150	80.81	230.81
618	09/21	4	2	120	108.33	228.33
619	09/21	4	3	150	80.65	230.65
620	09/21	4	4	120	147.08	267.08
621	09/21	5	1	30	81.72	111.72
622	09/21	5	2	60	193.71	253.71
623	09/21	5	3	120	300.18	420.18
624	09/21	5	4	150	70.91	220.91
625	09/21	8	1	120	159.30	279.30
626	09/21	8	2	150	72.86	222.86
627	09/21	8	3	120	109.12	229.12
628	09/21	8	4	150	71.25	221.25
629	09/28	2	1	30	249.18	279.18
630	09/28	2	2	60	153.21	213.21
631	09/28	2	4	150	88.02	238.02
632	09/28	4	1	150	85.85	235.85
633	09/28	4	2	120	120.93	240.93
634	09/28	4	3	150	86.95	236.95
635	09/28	4	4	120	168.50	288.50
636	09/28	5	1	30	104.40	134.40
637	09/28	5	2	60	380.19	440.19
638	09/28	5	3	120	377.04	497.04
639	09/28	5	4	150	91.07	241.07
640	09/28	8	1	120	170.64	290.64
641	09/28	8	2	150	79.16	229.16
642	09/28	8	3	120	114.16	234.16
643	09/28	8	4	150	76.29	226.29
644	10/04	2	2	60	193.53	253.53
645	10/04	2	4	150	100.62	250.62
646	10/04	4	1	150	89.63	239.63
647	10/04	4	2	120	133.53	253.53
648	10/04	4	3	150	89.47	239.47
649	10/04	4	4	120	184.88	304.88
650	10/04	5	1	30	118.26	148.26
651	10/04	5	2	60	394.05	454.05
652	10/04	5	3	120	474.06	594.06
653	10/04	5	4	150	121.31	271.31
654	10/04	8	1	120	174.42	294.42
655	10/04	8	2	150	87.98	237.98
656	10/04	8	3	120	121.72	241.72
657	10/04	8	4	150	83.85	233.85
658	10/11	2	2	60	246.45	306.45
659	10/11	2	4	150	105.66	255.66
660	10/11	4	1	150	94.67	244.67
661	10/11	4	2	120	143.61	263.61
662	10/11	4	3	150	90.73	240.73
663	10/11	4	4	120	210.08	330.08
664	10/11	5	1	30	163.62	193.62
665	10/11	8	1	120	183.24	303.24
666	10/11	8	2	150	86.72	236.72
667	10/11	8	3	120	126.76	246.76
668	10/11	8	4	150	85.11	235.11

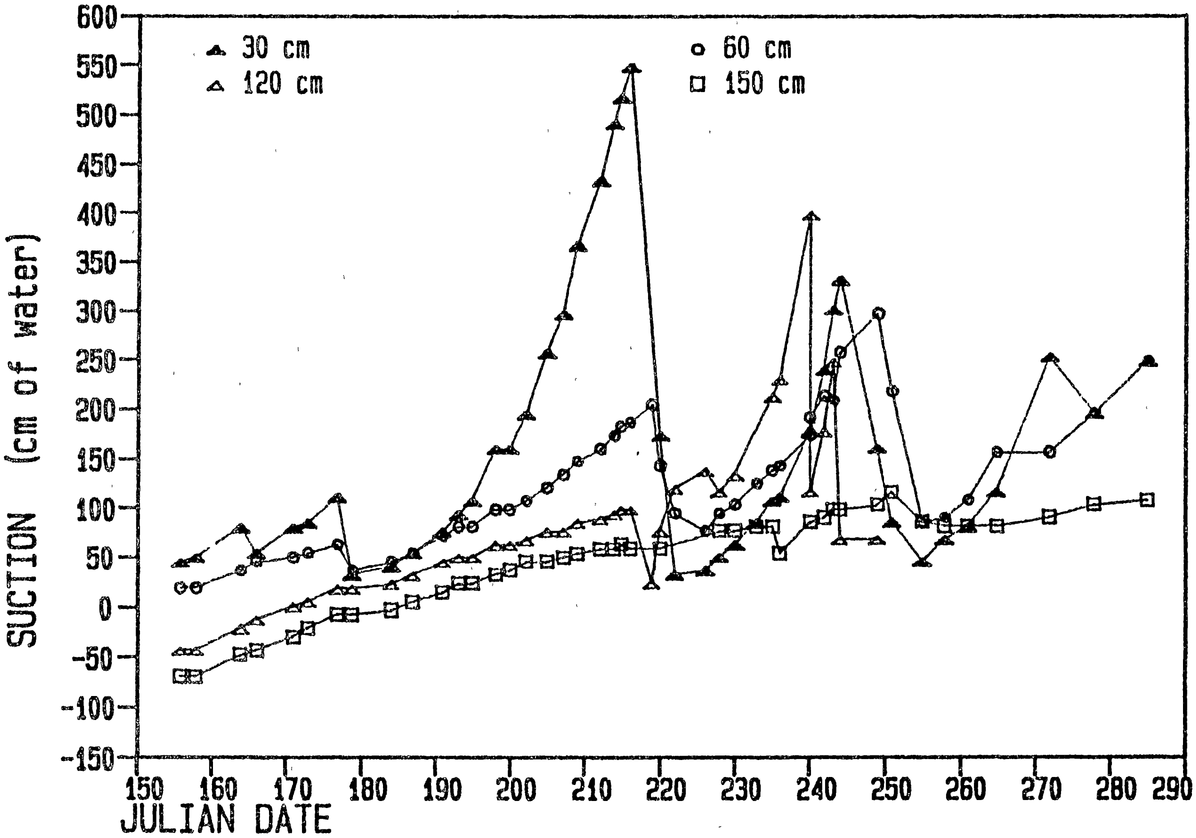

Figure 10. Soil Moisture Suction During the Irrigation Period for Plot No. 2 (Treatment T1)

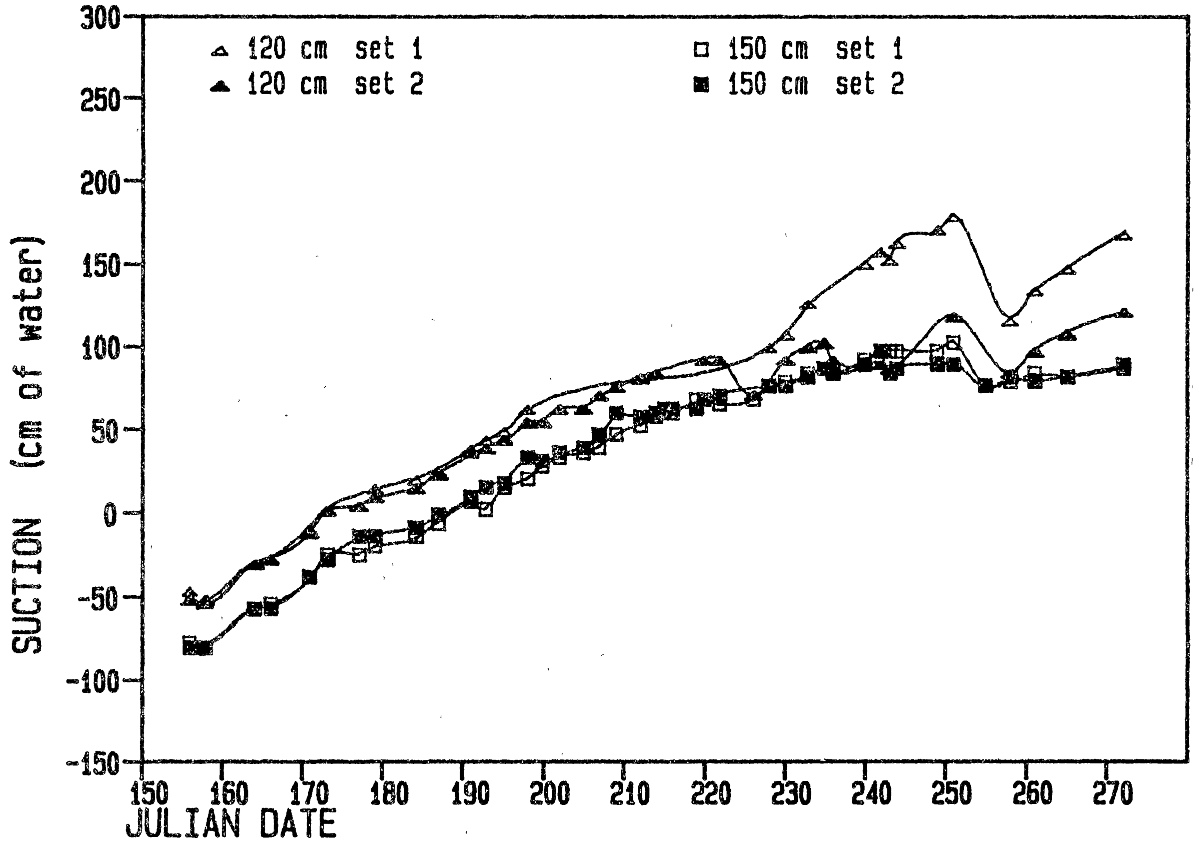

Figure 11. Soil Moisture Suction During the Irrigation Period for Plot No. 4 (Treatment T2)

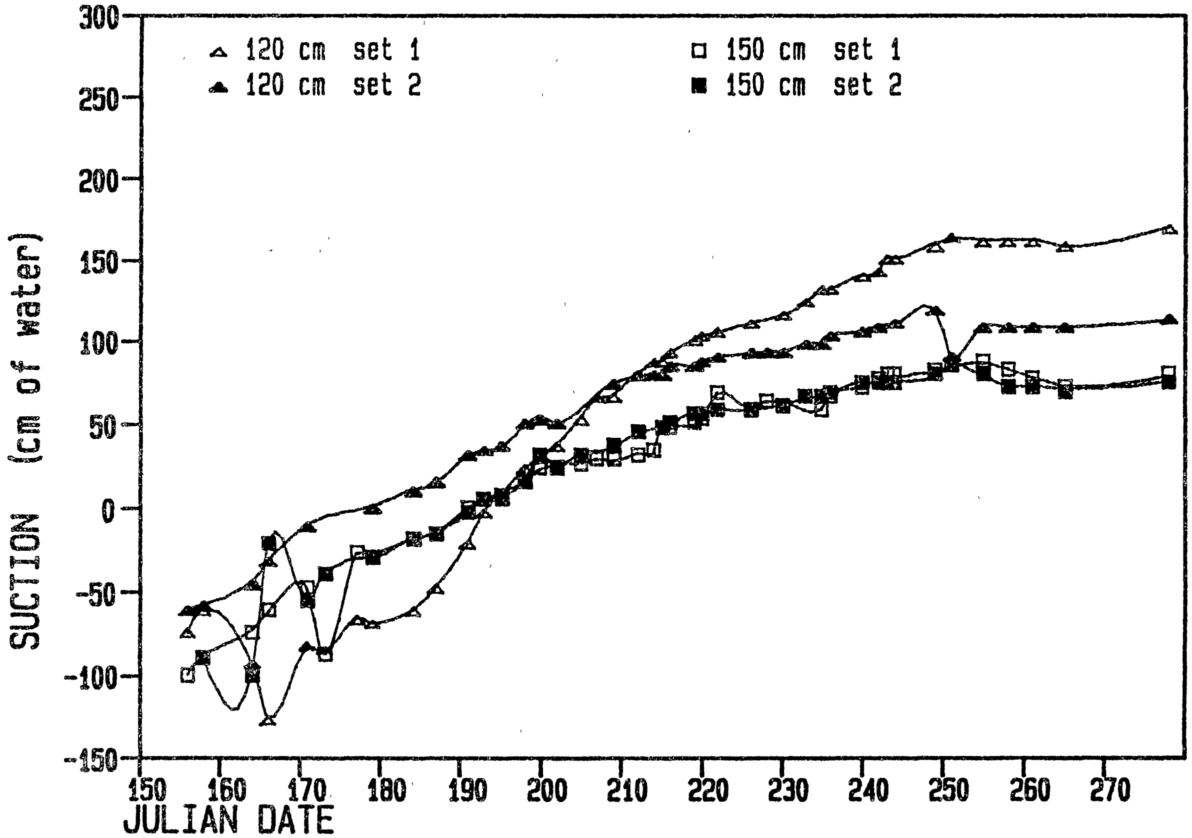

Figure 12. Soil Moisture Suction During the Irrigation Period for Plot No. 8 (Treatment T3)

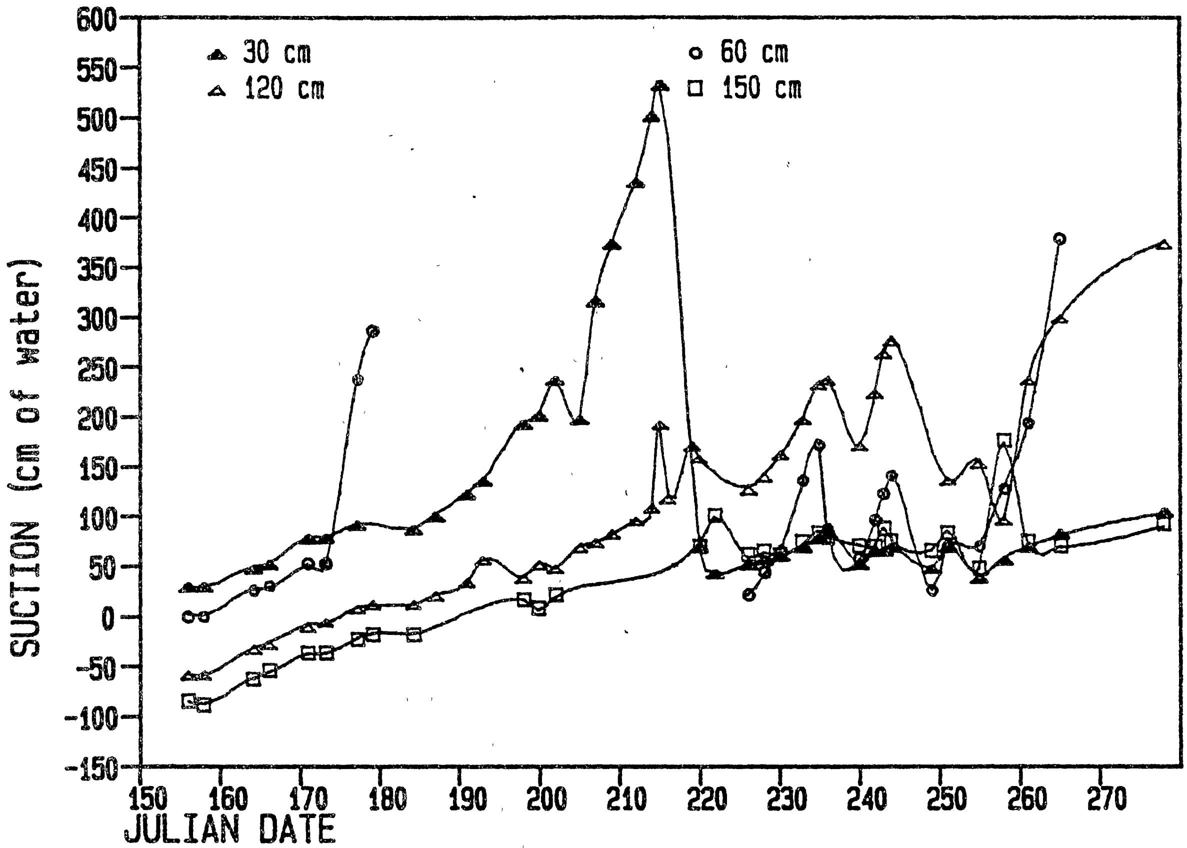

Figure 13. Soil Moisture Suction During the Irrigation Period for Plot No. 5 (Treatment T4)

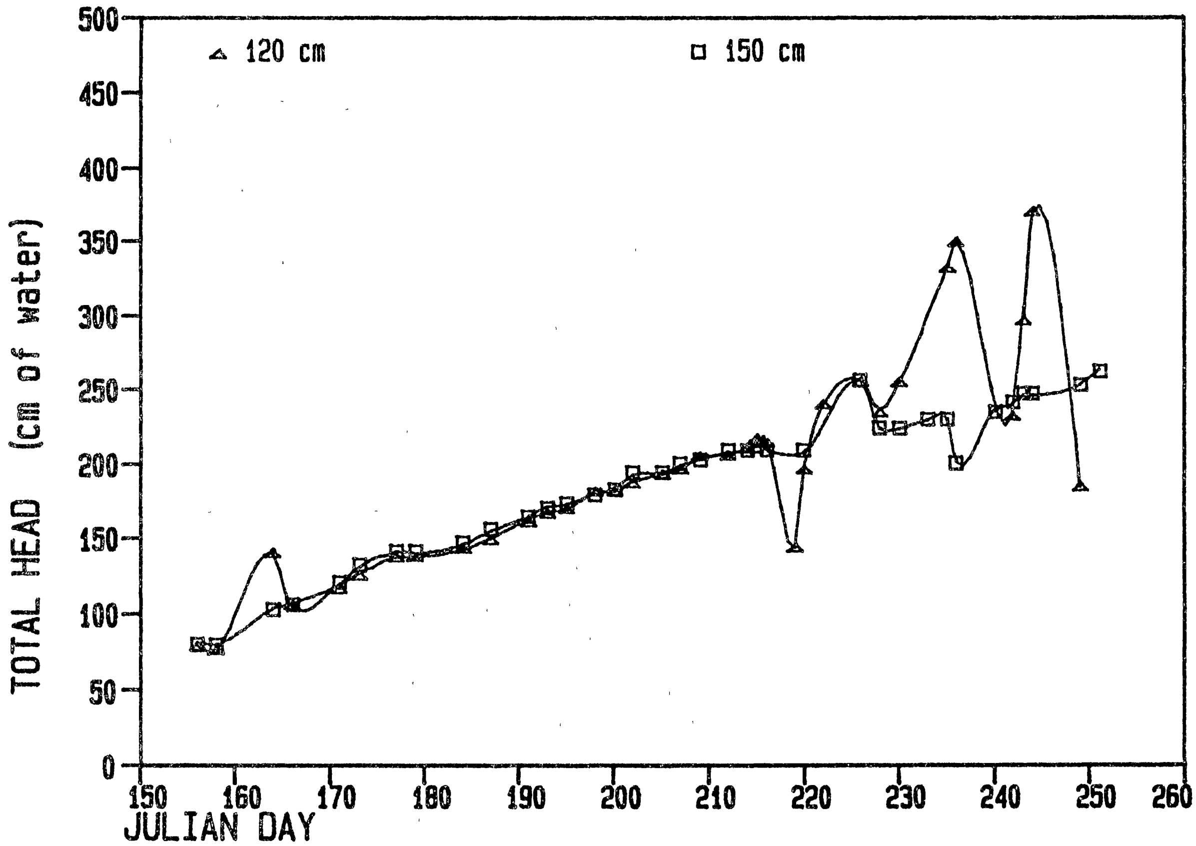

Figure 14. Total Head in Lower Root Zone During the Irrigation Period for Plot No. 2 (Treatment T1)

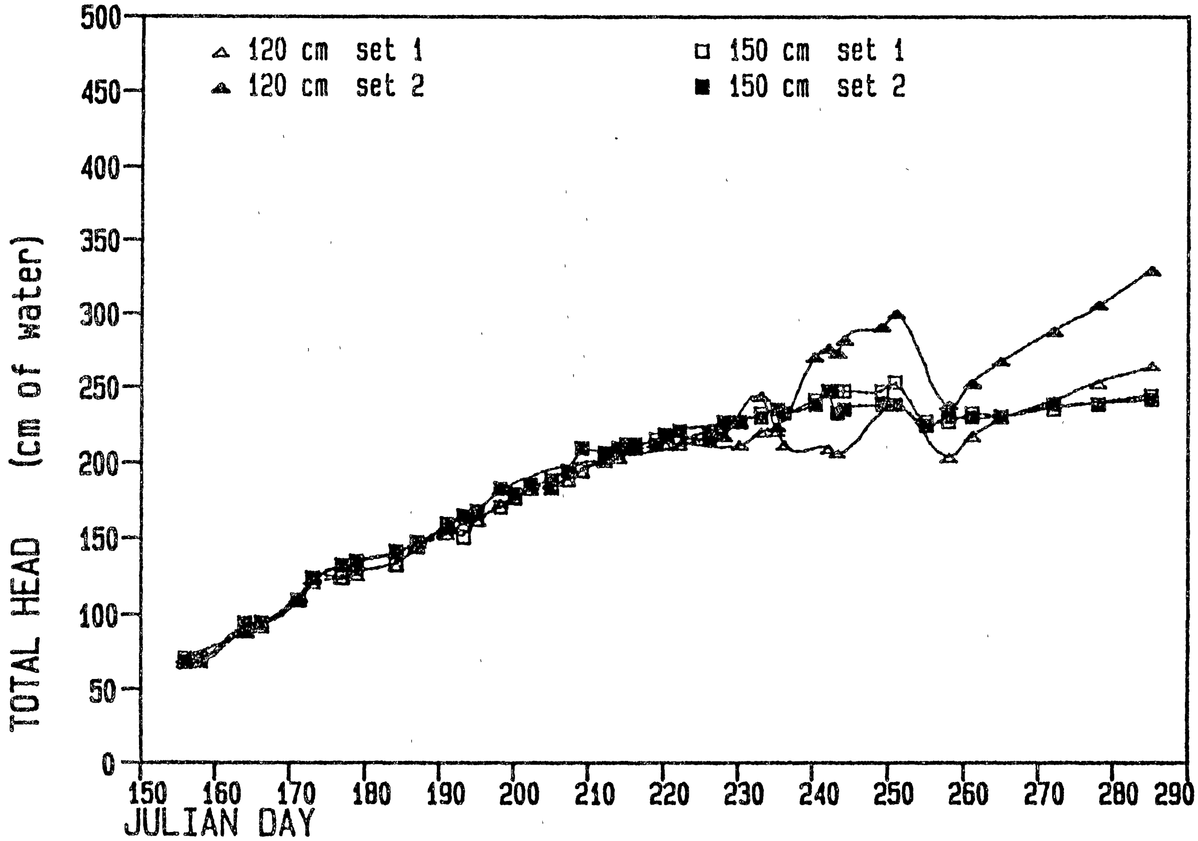

Figure 15. Total Head in Lower Root Zone During the Irrigation Period for Plot No. 4 (Treatment T2)

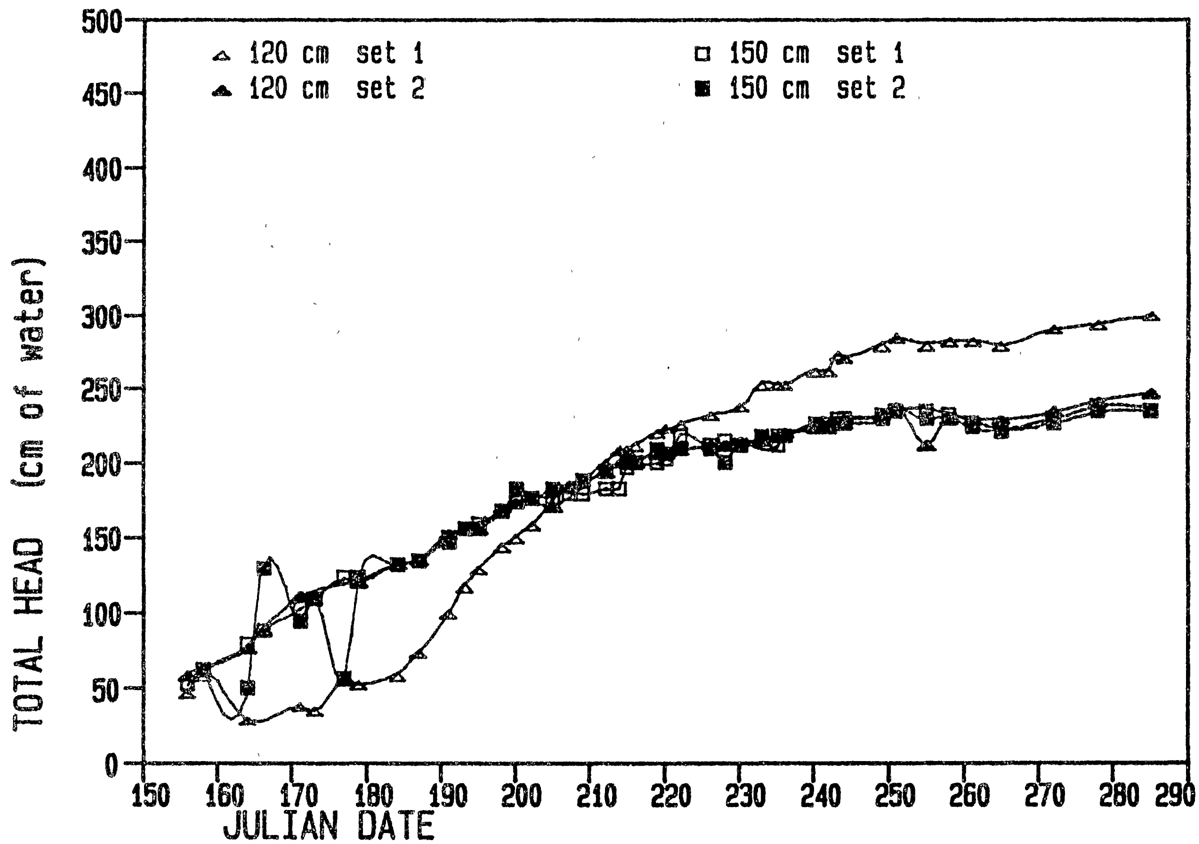

Figure 16. Total Head in Lower Root Zone During the Irrigation Period for Plot No. 8 (Treatment T3)

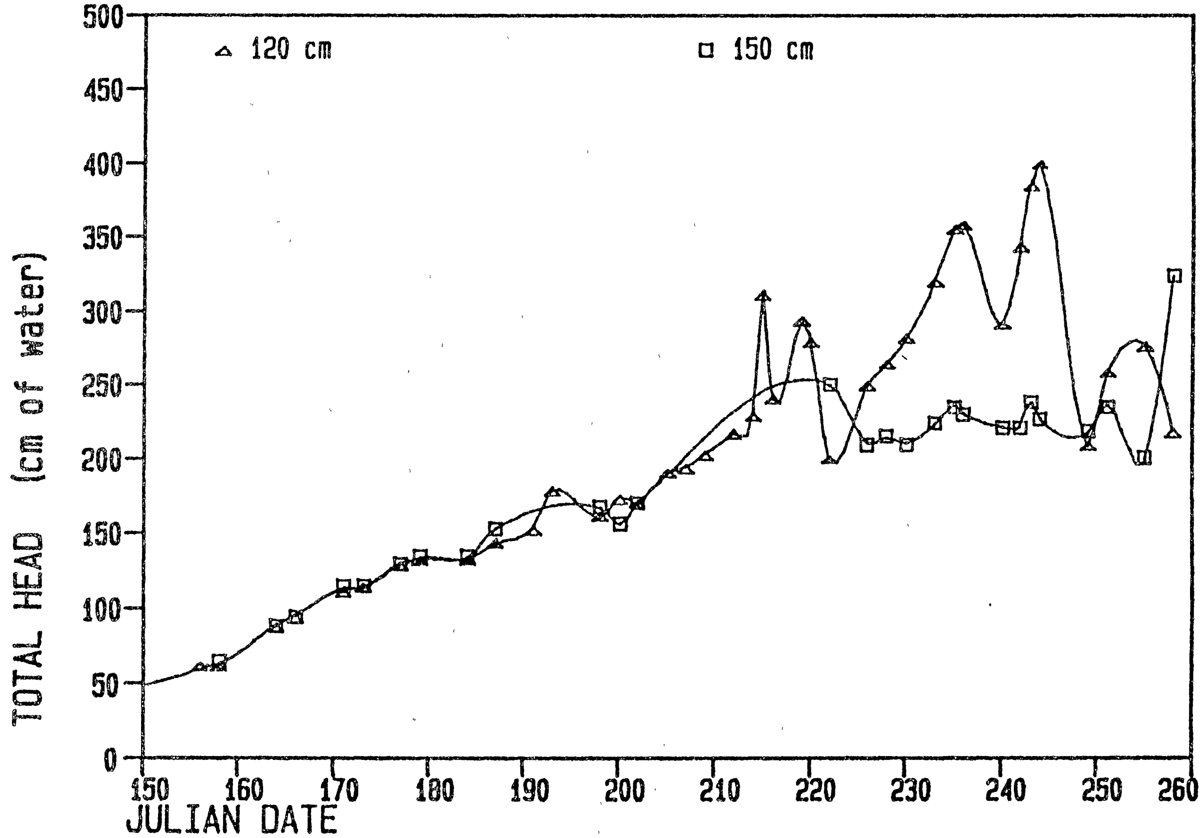

Figure 17. Total Head in Lower Root Zone During the Irrigation Period for Plot No. 5 (Treatment T4)

APPENDIX D

STATISTICAL ANALYSIS OF NUT YIELD

YIELD IN KG

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: YIELD

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	6	333.78376294	55.63062716	1.81	0.2040	0.546353	24.4722
ERROR	9	277.14686782	30.79409642		ROOT MSE		YIELD MEAN
CORRECTED TOTAL	15	610.93063076			5.54924287		22.67573696

SOURCE	DF	ANOVA SS	F VALUE	PR > F
TRT	3	14.49807436	0.16	0.9226
BLOCK	3	319.28568858	3.46	0.0646

YIELD IN GRAMS/CUBIC METER OF TREE VOLUME

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: YIELD

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	6	604.23433750	100.70572292	1.68	0.2311	0.529037	22.9222
ERROR	9	537.90500625	59.76722292		ROOT MSE		YIELD MEAN
CORRECTED TOTAL	15	1142.13934375			7.73092639		33.72687500

SOURCE	DF	ANOVA SS	F VALUE	PR > F
TRT	3	16.01016875	0.09	0.9641
BLOCK	3	588.22416875	3.28	0.0725

```
DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: YIELD
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE,
      NOT THE EXPERIMENTWISE ERROR RATE.

ALPHA=0.05  DF=9  MSE=30.7941

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

DUNCAN   GROUPING              MEAN       N  TRT

                A             23.821      4  2
                A
                A             23.367      4  4
                A
                A             22.029      4  3
                A
                A             21.485      4  1
```

```
DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: YIELD
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE,
      NOT THE EXPERIMENTWISE ERROR RATE.

ALPHA=0.05  DF=9  MSE=30.7941

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

DUNCAN   GROUPING              MEAN       N  BLOCK

                A             27.630      4  4
                A
                A             26.054      4  2
                A
        B       A             20.646      4  3
        B
        B                     16.372      4  1
```

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: YIELD
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE.

ALPHA=0.05 DF=9 MSE=76.8173

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

DUNCAN GROUPING	MEAN	N	TRT
A	43.379	4	2
A			
A	38.435	4	3
A			
A	38.345	4	1
A			
A	35.431	4	4

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: YIELD
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE.

ALPHA=0.05 DF=9 MSE=76.8173

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

DUNCAN GROUPING		MEAN	N	BLOCK
	A	45.329	4	3
	A			
B	A	41.270	4	2
B	A			
B	A	40.159	4	4
B				
B		28.832	4	1

DIFFERENCES IN YIELD (KG) BETWEEN YEARS

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: KG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	19	1109.83036250	58.41212434	1.08	0.4572	0.631297	37.7540
ERROR	12	648.18492500	54.01541042		ROOT MSE		KG MEAN
CORRECTED TOTAL	31	1758.01528750			7.34951770		19.46687500

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
BLOCK	3	301.26811250	1.86	0.1903	3	301.26811250	1.86	0.1903
TRT	3	65.67366250	0.41	0.7520	3	65.67366250	0.41	0.7520
TRT*YEAR	4	397.29427500	1.84	0.1863	4	397.29427500	1.84	0.1863
BLOCK*TRT	9	345.59431250	0.71	0.6910	9	345.59431250	0.71	0.6910

TESTS OF HYPOTHESES USING THE TYPE I MS FOR BLOCK*TRT AS AN ERROR TERM

SOURCE	DF	TYPE I SS	F VALUE	PR > F
TRT	3	65.67366250	0.57	0.6486

DIFFERENCES IN YIELD (GRAMS/CUBIC METER) BETWEEN YEARS

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: KG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	19	2222.99090937	116.99952155	0.85	0.6337	0.574522	40.7772
ERROR	12	1646.29946250	137.19162188		ROOT MSE		KG MEAN
CORRECTED TOTAL	31	3869.29037188			11.71288273		28.72406250

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
BLOCK	3	310.37365937	0.75	0.5409	3	310.37365937	0.75	0.5409
TRT	3	121.34665938	0.29	0.8284	3	121.34665938	0.29	0.8284
TRT*YEAR	4	992.76098750	1.81	0.1919	4	992.76098750	1.81	0.1919
BLOCK*TRT	9	798.50960313	0.65	0.7399	9	798.50960313	0.65	0.7399

TESTS OF HYPOTHESES USING THE TYPE I MS FOR BLOCK*TRT AS AN ERROR TERM

SOURCE	DF	TYPE I SS	F VALUE	PR > F
TRT	3	121.34665938	0.46	0.7196

APPENDIX E

STATISTICAL ANALYSIS OF NUT CHARACTERISTICS

NUT CHARACTERISTICS

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: NUTWT

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	6	4174.96595000	695.82765833	4.81	0.0181	0.762255	5.5548
ERROR	9	1302.15695000	144.68410556		ROOT MSE		NUTWT MEAN
CORRECTED TOTAL	15	5477.12290000			12.02847062		216.54250000

SOURCE	DF	ANOVA SS	F VALUE	PR > F
TRT	3	693.30700000	1.60	0.2574
BLOCK	3	3481.65895000	8.02	0.0065

NUT CHARACTERISTICS

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: WTNUT

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	6	10.42913750	1.73818958	4.80	0.0183	0.761724	5.5589
ERROR	9	3.26235625	0.36248403		ROOT MSE		WTNUT MEAN
CORRECTED TOTAL	15	13.69149375			0.60206646		10.83062500

SOURCE	DF	ANOVA SS	F VALUE	PR > F
TRT	3	1.73266875	1.59	0.2582
BLOCK	3	8.69646875	8.00	0.0066

NUT CHARACTERISTICS

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: KERWT

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	6	2115.76828750	352.62804792	4.88	0.0173	0.764786	6.7066
ERROR	9	650.71710625	72.30190069		ROOT MSE		KERWT MEAN
CORRECTED TOTAL	15	2766.48539375			8.50305243		126.78562500

SOURCE	DF	ANOVA SS	F VALUE	PR > F
TRT	3	384.21916875	1.77	0.2224
BLOCK	3	1731.54911875	7.98	0.0066

NUT CHARACTERISTICS

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: PERKER

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	6	6.22405000	1.03734167	0.31	0.9145	0.172673	3.0958
ERROR	9	29.82132500	3.31348056		ROOT MSE		PERKER MEAN
CORRECTED TOTAL	15	36.04537500			1.82029683		58.79875000

SOURCE	DF	ANOVA SS	F VALUE	PR > F
TRT	3	2.57862500	0.26	0.8529
BLOCK	3	3.64542500	0.37	0.7789

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: NUTWT
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE.

ALPHA=0.05 DF=9 MSE=144.684

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

DUNCAN GROUPING	MEAN	N	BLOCK
A	227.78	4	2
A			
A	227.37	4	3
A			
A	219.36	4	1
B	191.66	4	4

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KERWT
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE.

ALPHA=0.05 DF=9 MSE=72.3019

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

DUNCAN GROUPING	MEAN	N	BLOCK
A	135.30	4	2
A			
A	133.10	4	3
A			
A	129.62	4	1
B	109.11	4	4

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: WTNUT
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE.

ALPHA=0.05 DF=9 MSE=0.362484

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

DUNCAN GROUPING	MEAN	N	BLOCK
A	11.392	4	2
A			
A	11.372	4	3
A			
A	10.970	4	1
B	9.587	4	4

APPENDIX F

STATISTICAL ANALYSIS OF THE LEAF ELEMENTAL CONCENTRATIONS

LEAF ELEMENTAL CONCENTRATIONS

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: N

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	6	0.14080000	0.02346667	4.72	0.0192	0.758723	3.1055
ERROR	9	0.04477500	0.00497500		ROOT MSE		N MEAN
CORRECTED TOTAL	15	0.18557500			0.07053368		2.27125000

SOURCE	DF	ANOVA SS	F VALUE	PR > F
TRT	3	0.06492500	4.35	0.0374
BLOCK	3	0.07587500	5.08	0.0249

LEAF ELEMENTAL CONCENTRATIONS

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: P

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	6	0.00021100	0.00003517	1.53	0.2719	0.504785	4.4821
ERROR	9	0.00020700	0.00002300		ROOT MSE		P MEAN
CORRECTED TOTAL	15	0.00041800			0.00479583		0.10700000

SOURCE	DF	ANOVA SS	F VALUE	PR > F
TRT	3	0.00010450	1.51	0.2762
BLOCK	3	0.00010650	1.54	0.2694

LEAF ELEMENTAL CONCENTRATIONS

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: K

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	6	0.11075000	0.01845833	1.57	0.2597	0.511843	19.1317
ERROR	9	0.10562500	0.01173611		ROOT MSE		K MEAN
CORRECTED TOTAL	15	0.21637500			0.10833333		0.56625000

SOURCE	DF	ANOVA SS	F VALUE	PR > F
TRT	3	0.06012500	1.71	0.2345
BLOCK	3	0.05062500	1.44	0.2951

LEAF ELEMENTAL CONCENTRATIONS

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: CA

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	6	0.30965000	0.05160833	0.46	0.8197	0.235803	18.1602
ERROR	9	1.00352500	0.11150278		ROOT MSE		CA MEAN
CORRECTED TOTAL	15	1.31317500			0.33392032		1.83875000

SOURCE	DF	ANOVA SS	F VALUE	PR > F
TRT	3	0.16452500	0.49	0.6967
BLOCK	3	0.14512500	0.43	0.7340

LEAF ELEMENTAL CONCENTRATIONS

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: MN

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	6	684497.37500000	114082.89583333	1.05	0.4530	0.412525	32.7896
ERROR	9	974790.06250000	108310.00694444		ROOT MSE		MN MEAN
CORRECTED TOTAL	15	1659287.43750000			329.10485707		1003.68750000

SOURCE	DF	ANOVA SS	F VALUE	PR > F
TRT	3	23955.18750000	0.07	0.9726
BLOCK	3	660542.18750000	2.03	0.1798

LEAF ELEMENTAL CONCENTRATIONS

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: FE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	6	96.37500000	16.06250000	1.05	0.4561	0.411090	7.5050
ERROR	9	138.06250000	15.34027778		ROOT MSE		FE MEAN
CORRECTED TOTAL	15	234.43750000			3.91666667		52.18750000

SOURCE	DF	ANOVA SS	F VALUE	PR > F
TRT	3	73.18750000	1.59	0.2589
BLOCK	3	23.18750000	0.50	0.6891

LEAF ELEMENTAL CONCENTRATIONS

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: MG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	6	0.00150000	0.00025000	0.20	0.9666	0.120000	12.3753
ERROR	9	0.01100000	0.00122222		ROOT MSE		MG MEAN
CORRECTED TOTAL	15	0.01250000			0.03496029		0.28250000

SOURCE	DF	ANOVA SS	F VALUE	PR > F
TRT	3	0.00085000	0.23	0.8720
BLOCK	3	0.00065000	0.18	0.9091

LEAF ELEMENTAL CONCENTRATIONS

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: ZN

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	6	26.00000000	4.33333333	0.71	0.6515	0.320988	18.6571
ERROR	9	55.00000000	6.11111111		ROOT MSE		ZN MEAN
CORRECTED TOTAL	15	81.00000000			2.47206616		13.25000000

SOURCE	DF	ANOVA SS	F VALUE	PR > F
TRT	3	10.50000000	0.57	0.6470
BLOCK	3	15.50000000	0.85	0.5029

```
DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: N
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE,
      NOT THE EXPERIMENTWISE ERROR RATE.

ALPHA=0.05   DF=9   MSE=0.004975

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

DUNCAN    GROUPING              MEAN       N   TRT

                A              2.3500      4   3
                A
        B       A              2.2875      4   1
        B       A
        B       A              2.2750      4   2
        B
        B                      2.1725      4   4
```

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DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: N
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE,
      NOT THE EXPERIMENTWISE ERROR RATE.

ALPHA=0.05   DF=9   MSE=0.004975

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

DUNCAN    GROUPING              MEAN       N   BLOCK

                A              2.3250      4   2
                A
                A              2.3200      4   3
                A
                A              2.2850      4   1

                B              2.1550      4   4
```

VITA 2

David Reid Epperly

Candidate for the Degree of

Master of Science

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Biographical:

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Education: Graduate from Hydro Public High School, Hydro, Oklahoma, in May, 1979; recieved Bachelor of Science Degree in Agricultural Engineering from Oklahoma State University in May, 1983; completed requirements for the Master of Science degree at Oklahoma State University in May, 1985.

Professional Experience: Teaching Assistant, Department of Agricultural Engineering, Oklahoma State University, August, 1982 to May, 1983 and January, 1985 to May, 1985; Research Assistant, Department of Agricultural Engineering, Oklahoma State University, August, 1983 to May, 1985.