PLANT POPULATION EFFECTS ON THE EFFICIENT USE OF WATER:

WATER UPTAKE CHARACTERISTICS

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General Premise and Personnel

Exploratory studies* with peanuts (Arachis hypogaea L.) early in the 1960 decade suggested that row spacing had an effect on water use (evapotranspiration) of the crop. Such a characteristic could be of enormous importance from the standpoints of both crop production and conservation of the water resource. If an effect exists which causes plants to tend to evapotranspire less water, it is conceivable that the water thus saved might be directed toward a storage system where it could be held for further use by man. The implication on crop production is that it may be possible to produce crops using less water than is now required. Such a condition would permit growing plants where it is not now feasible and could lead to greatly reduced requirements of irrigation. The principal objectives of this study were to: 1) confirm the reduced evapotranspiration (ET) effect, 2) measure the water budget and energy budget of the treatment causing reduced water loss, and identify the mechanisms involved, and 3) look for the reduced ET characteristic in other crop plants. The study confirmed the existence of the reduced ET effect in peanuts. It appears that peanuts grown in narrow (12 inch) rows, with a north-south orientation lose less water during the summer peak than any orientation of wide rows (36 inches) and with east-west orientation of narrow rows.

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*Author's unpublished data.

Determination of energy budget and water budget carries the implication of adaptation of instrumentation to the system under study. A system of instrumentation was developed to permit measurements in a replicated study. Simultaneous measurements are desirable for many micrometeorological measurements, and instrumentation to permit near simultaneity was developed. Many aspects of this instrumentation were unique and will be reported supplementarily. The results of evapotranspiration reduction and crop yield are reported herein.

Owing to malfunctioning of the data acquisition system at the critical times of the growing season, no detailed energy budget measurements were accomplished. Back-up measurements were scanty, owing to the nature of the data acquisition system failure. The data acquisition system recorded information on magnetic tape, and it was not until this tape was fed into the computer that the malfunctions were noted. This occurred both seasons these measurements were attempted, and the peak water use period had passed.

A study was made on grain sorghum at Goodwell, Oklahoma, to search for the reduced ET effect. If the effect exists with grain sorghum it is not nearly so pronounced as with peanuts. The variation in soil moisture between plots was greater than any differences noted in differential water uptake.

Exploratory studies referred to in this work were conducted by Dr. R. S. Matlock, Dr. J. E. Garton, and Dr. J. F. Stone, and come from unpublished data. Dr. J. M. Davidson supervised the measurements of hydraulic conductivity in the field. Application to this study required that hydraulic conductivity be characterized as a function of water content of the soil. Dr. E. W. Chin Choy, Jr. was a graduate student and performed most of the manipulations and field measurements described in

this study. We acknowledge with gratitude the invaluable assistance provided by Arthur G. Hornsby, Garry N. McCauley, Harold R. Myers, Walter Opitz, Jr., L. Bryant Reeves and L. O. Schmitt, all affiliated with the Oklahoma Agricultural Experiment Station, and to Floyd King of King's Irrigation, Eakly, Oklahoma and Jimmie L. Stewart of Data Engineering Corporation, Tulsa, Oklahoma.

ABSTRACT

Effects of crop geometry on the evapotranspiration (ET) of water were studied over two growing seasons at the Caddo Research Station, Ft. Cobb, Oklahoma. Peanuts were grown in 12-inch rows and 36-inch rows. Plots were oriented with rows north-south and east-west. The four combinations of these treatments were replicated three times each year. A water budget on accrued water was computed each year. Difference of water content between dates was sensed with a neutron probe. These differences were corrected for either drainage or accretion from below by the deduction of a computed integrated water flux. This flux was determined from tensiometric measurement of total hydraulic head and pressure head across the fifth foot of the profile.

In actual practice, the tensiometer measurements did not permit useful estimates of the flux, being too erratic. However, they did indicate the periods of the season where there was zero or negligible flux through the fifth foot. During such periods, the neutron probe indication of water loss was a direct estimate of ET.

The results indicated that during peak water use the 12-inch rows with north-south orientation lost water at nearly half the rate of the highest user: the 36-inch north-south rows. East-west rows were intermediate, but the higher population (12-inch rows) tended to lose the lesser.

Plants grown in the 12-inch rows consistently yielded higher than the 36-inch rows' plants. Quality was about the same over the entire study.

Implications for water resource enhancement are that if the effect causing the reduced evapotranspiration on the 12-inch, north-south rows can be applied to other systems of growing plants, a significant portion of the input water, be it natural precipitation or irrigation, can be saved. Of course the saved water would have to be diverted to an acquifer or to surface impoundment. Furthermore, there would also be implication that this effect may lead to means of producing crops where precipitation or irrigation water supply is considered limiting, thereby being less wasteful of the resource.

Keywords: *water utilization, *water conservation, *planting management, evapotranspiration, soil-water-plant relationships, energy budget.

PLANT POPULATION EFFECTS ON THE EFFICIENT USE OF WATER: WATER UPTAKE CHARACTERISTICS

Introduction

Water Uptake

No prior research on the water requirements of a peanut crop as affected by plant population and row spacing was found in the literature. The exploratory experiments of the authors are the only known lead to any effects relating water uptake to peanut crop geometry.

Yield Considerations

In Oklahoma (Matlock, Garton and Stone, 1961) comparisons were made between 1956 and 1959 on various irrigation frequencies on 36- and 40-inch rows at two locations. The criteria for irrigation were: water tensions of a) 6 bars in the top 6 to 12 inches of the soil profile, b) 2 bars in the same zone, and c) 1 bar in the same zone. There was also a treatment without supplemental water. The amount of water applied at each irrigation was slightly more than two inches. The water treatment "c" gave the highest yield in the three years of study, and if monetary return is taken as the criteria of overall quality and yield, then this was the ideal treatment. This treatment required 6 irrigations one year, 5 irrigations two years, and 3 irrigations one year.

In Israel, irrigation frequencies were studied and a 14-day period gave the highest yield of 6 irrigation frequencies (Mantel and Goldin, 1964). However, statistically, the yield of this treatment was not significantly different from the yield obtained from the 30-day period.

Of interest in this study was that less than 20 percent of the water lost by evapotranspiration (ET) in frequencies of 21 days and less was extracted from the four to five foot depth of the soil profile. These workers also showed that in Israel about 26 inches of water would be needed to produce an optimum yield of peanuts under prevailing conditions.

In the two experiments cited, as with most studies of soil-water utilization, no account of the soil-drainage component of irrigated water was made. Thus, in the first study (Matlock et al., 1961) treatment "c" would probably have a higher drainage component than treatment "b". This would imply that treatment "b" could have been the more efficient of the two treatments. Similarly, in the Israeli experiment (Mantel and Goldin, 1964) the amount of water lost by percolation, as indicated by the root extraction pattern at the 4th and 5th foot depth, could contribute significantly to the water use rate.

One purpose of this experiment was to study the effect of row orientation and spacing on water utilization of peanuts (Arachis hypogaea, L.). The row orientations were north-south and east-west, i.e. parallel and normal to the prevailing summer wind. The row spacings were 12 and 36 inches with the plant density within row spacings held constant. Irrigation water was supplied to the crop by a sprinkler system, with changes of soil moisture being monitored with a Nuclear Chicago P-19 neutron probe and soil-water flow direction with tensiometers located at the 4th and 5th foot depths.

Preliminary Studies

In 1961 at the Perkins Agronomy Research Station, Perkins, Oklahoma, the soil-water content of the top 48 inches of the soil profile of a peanut population-irrigation study was regularly monitored using a Nuclear Chicago P-19 soil moisture probe. The plots monitored were 10- and 40-inch row spacings of 4.8 planted seeds per foot, for irrigated and non-irrigated treatments. The study was replicated four times. There was one neutron access tube per plot. It was located near the center of the plot and in an area which was selected to be representative of the plot. The plots were 4 rows wide by 19 feet long. For the irrigation treatment, water was applied on July 31, August 4, 16 and 28.

In 1968 at the Caddo Peanut Research Station, Ft. Cobb, Oklahoma, the water content of the top 48 inches of the soil profile for all plots was monitored by the neutron method, using a Nuclear-Chicago P-19 probe, immediately before and after each irrigation. The monitored plots were 12-inch and 36-inch row spacings. Since these plots were larger (60 ft. X 90 ft.) than the 1961 study, the neutron access tubes were located at about 10 feet from the north edges of the plots, in areas selected to be representative of the plant population. The selection of the north edge of the plot for the location of the neutron access tube, gave the maximum fetch since the predominant winds were due south. Plots were irrigated August 7, 21 and 27.

As can be seen in Figure 1, the averaged water content of the plots in the 1961 season for the treatments at the commencement of the neutron determination had a maximum spread of about 0.5 inches of water. At the end of the monitoring period the spread of water contents which occurred suggested that the use and accumulation of soil moisture by the various treatments was dependent on row spacing. The 1968 data did not show this wide spread at the end of the growing season (Figure 2).

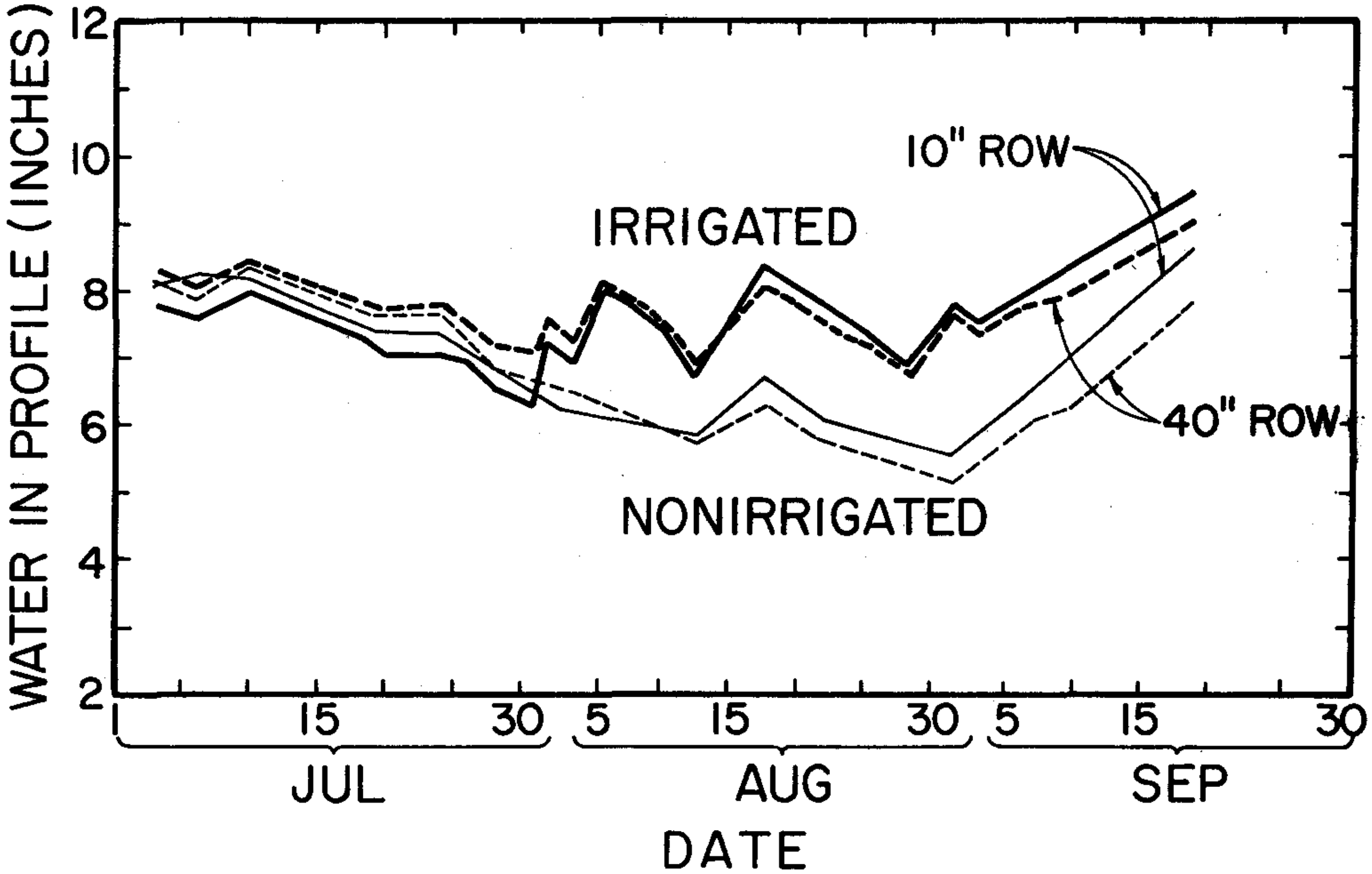


Figure 1. 1961 Neutron Determined Soil Moisture Content for the Growing Season

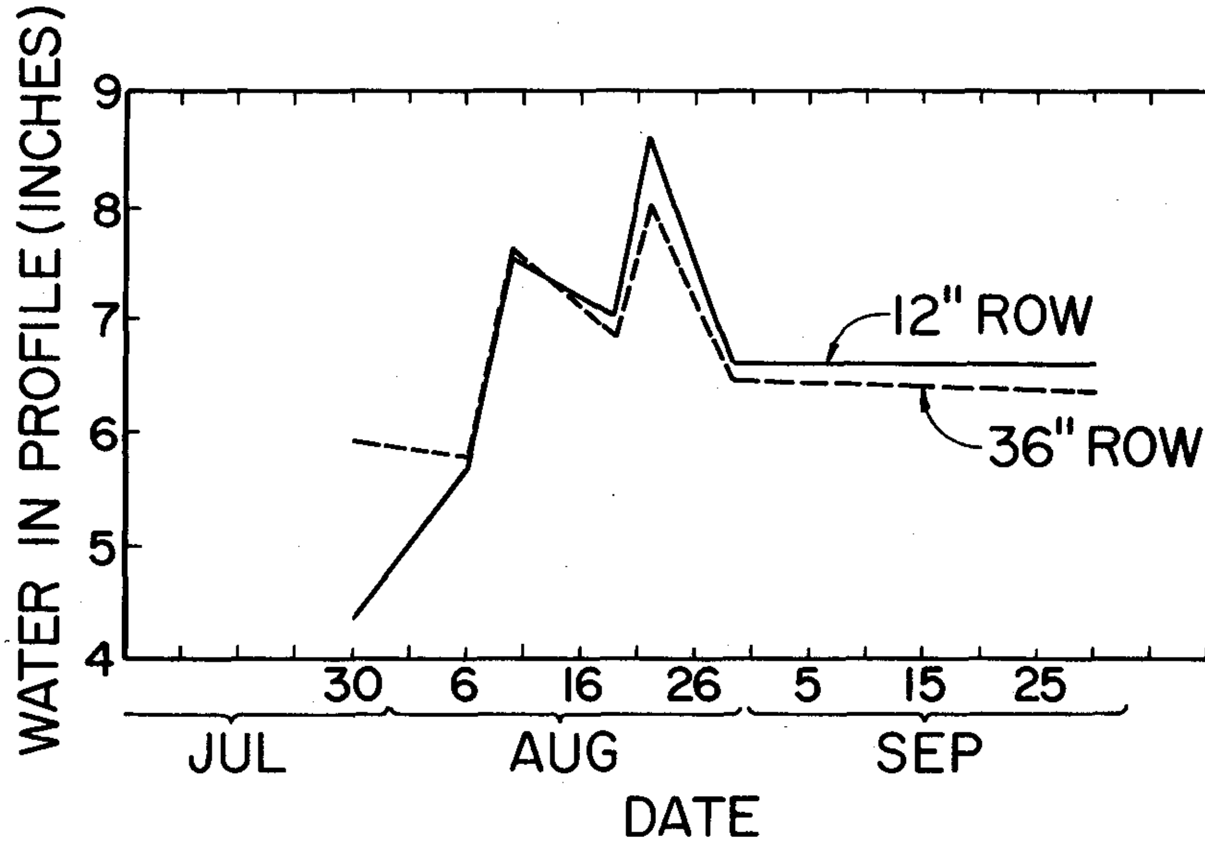


Figure 2. 1968 Neutron Determined Soil Moisture Content for the Growing Season

A difference in this layout of the 1961 and 1968 experiments was the directional orientation of the rows. In the 1961 study, the rows were north-south oriented, or parallel to the prevailing wind and angle of the noon sun, while the rows of 1968 were east-west and hence perpendicular to the prevailing wind and noon sun. Thus in 1969 and 1971, studies under this project were undertaken to investigate whether a difference in ET existed between north-south and east-west oriented rows and between wide (36-inch) and narrow (12-inch) rows.

Materials and Methods

As pointed out earlier, most studies on the water requirement of field crops combined soil-water drainage component with the evapotranspired component for a total water usage term. Separation of these two components is essential in an accurate evapotranspiration study. Hence, a water budget analysis was employed, using tensiometers and neutron probe water content determination. Tensiometers indicated the soil-water potential gradient across the 4th foot in the soil profile. Such data can be utilized in the Darcy Law with conductivity data to calculate downward water flux. Neutron probes were used to determine water content of the soil profile to 4 feet. Difference in content over time minus downward flux would be ET.

The tensiometers were constructed in the laboratory and were similar to the plastic type of Perrier and Evans (1961) and as modified by Henderson and Rogers (1963). The soil-water matric suction was measured with a mercury manometer. The direction of flow below the 4-foot depth could be determined by locating tensiometers at the 4- and 5-foot depth of the soil profile to measure the difference of the matric suction. Since the flow of water is in the direction of the higher matric suction, the direction and magnitude of the flow of water in this zone can be ascertained. By using the values of the hydraulic conductivity determined by the method of Davidson, Stone, Nielsen, and Larue (1969) in the Darcy equation, the flux of water can be calculated. Integrating the flux of water over days yields the magnitude of water drainage out of the root zone, i.e., the top 48 inches of the soil profile. A negative flux would mean water was moving into the root zone from below.

Hydraulic conductivity determination was made from data of soil-water pressure obtained from 3-inch (7.6 cm) cores obtained from the area at each depth increment. The tensiometers located at 6-inch (15.2 cm) increments in a 32- x 32-foot (10 x 10 meters) area. There were three tensiometers per increment. Since the hydraulic gradients were determined by these tensiometers, the average soil-water flux passing through any known increment where the tensiometers were located could be calculated from the water desorption data. Hydraulic conductivity for each depth increment was then determined by using the Darcy equation:

$$-K = \frac{v}{(\frac{d\phi}{dx} - 1)}$$

where v is the average soil-water flux (cm/day), $\frac{d\phi}{dx}$ the soil-water pressure head (cm water) gradient per depth increment (measured positively downward, cm). Regression analysis using the least squares technique was then used to determine the best fit line for the relationship between water content and hydraulic conductivity. The model which was used was $K = a\, e^{b\theta}$, where a and b are constants and θ is the volumetric water content.

The relationships between water content of the soil and the unsaturated hydraulic conductivity for locations A and B were:

$$\text{Location A -- } K = 9.63 \times 10^{-5} \exp(43.98\ \theta)$$

$$\text{Location B -- } K = 3.267 \times 10^{-5} \exp(37.62\ \theta).$$

The relationships between pressure head and water content are shown in table 2. The equation for calculating the flux was the familiar form of the Darcy equation:

$$v\ (\text{cm/day}) = K\ (\text{cm/day}) \frac{\text{total head (150 cm depth) - total head (120 cm depth)}}{(150-120)\ \text{cm}}\ .$$

Neutron measurements were with a Nuclear Chicago P-19 probe and readings were made immediately after and before each irrigation. The change of soil-water content of the plot between this period could be determined by difference in readings on successive dates. The direction and magnitude of water flow through the 4th foot of the soil profile was ascertained by the tensiometers and then by selecting periods of time between neutron measurements which were free from heavy rainfall or irrigation, evapotranspiration calculations were obtained by correcting the difference in neutron determination by the deep water flux.

The study was made on Cobb fine sandy loam soil and Meno fine sandy loam soil. The Cobb fine sandy loam was in 2 phases: 1-3 percent slope and 3-5 percent slope, severely eroded. The replications were oriented so that 2 replications were on Cobb fine sandy loam, and the remaining one on Meno fine sandy loam.

In 1969 and 1971, there were 4 treatments with 3 replications per treatment in both years. The treatments were 12- and 36-inch row spacings of north-south and east-west orientation. In both years the treatments within replications were randomly assigned; Figure 3 shows the layouts. The size of the plots was 100 by 100 feet.

In both 1969 and 1971, the neutron access tubes and tensiometers were located 10 to 15 feet from the north edge of the plots. The tensiometers were located at the 4- and 5-foot depth and were 5 to 10 feet from each other. The mercury manometers for the tensiometers were located at the edge of the plot and were connected to the tensiometers by 4 mm O.D. nylon tubing which was buried in the soil. There was one neutron access tube per plot. The depth of measurement was to 4 feet. Both neutron access tube and tensiometers were located in areas of the plot which seemed to be representative of that plot. In the field, the tensiometers were read daily and purged of air when needed.

Cultural Practices

In 1969, Treflan herbicide and 250 pounds of 8-32-16 fertilizer per acre were incorporated into the soil before planting. Starr variety of peanuts, "regular" size, was planted on June 5 with a 6-row Planet Jr. seed planter. The planter shoes were 1 foot apart and planting was such that all rows in the 12-inch plot were 12 inches (no border space between planter sweeps). For 36-inch rows, only the second and fifth shoes were used making all rows exactly 36 inches for the wide-row plots. The plots were hand harvested on October 30. The harvested area was 16 by 6 feet located near the center of each plot and from an area which appeared representative of the stand of that plot. The plant population and the pounds of cleaned, dried pod peanuts were determined as before. A sample from each plot was sent to the Oklahoma Federal-State Inspection Service at Durant, Oklahoma, to be graded.

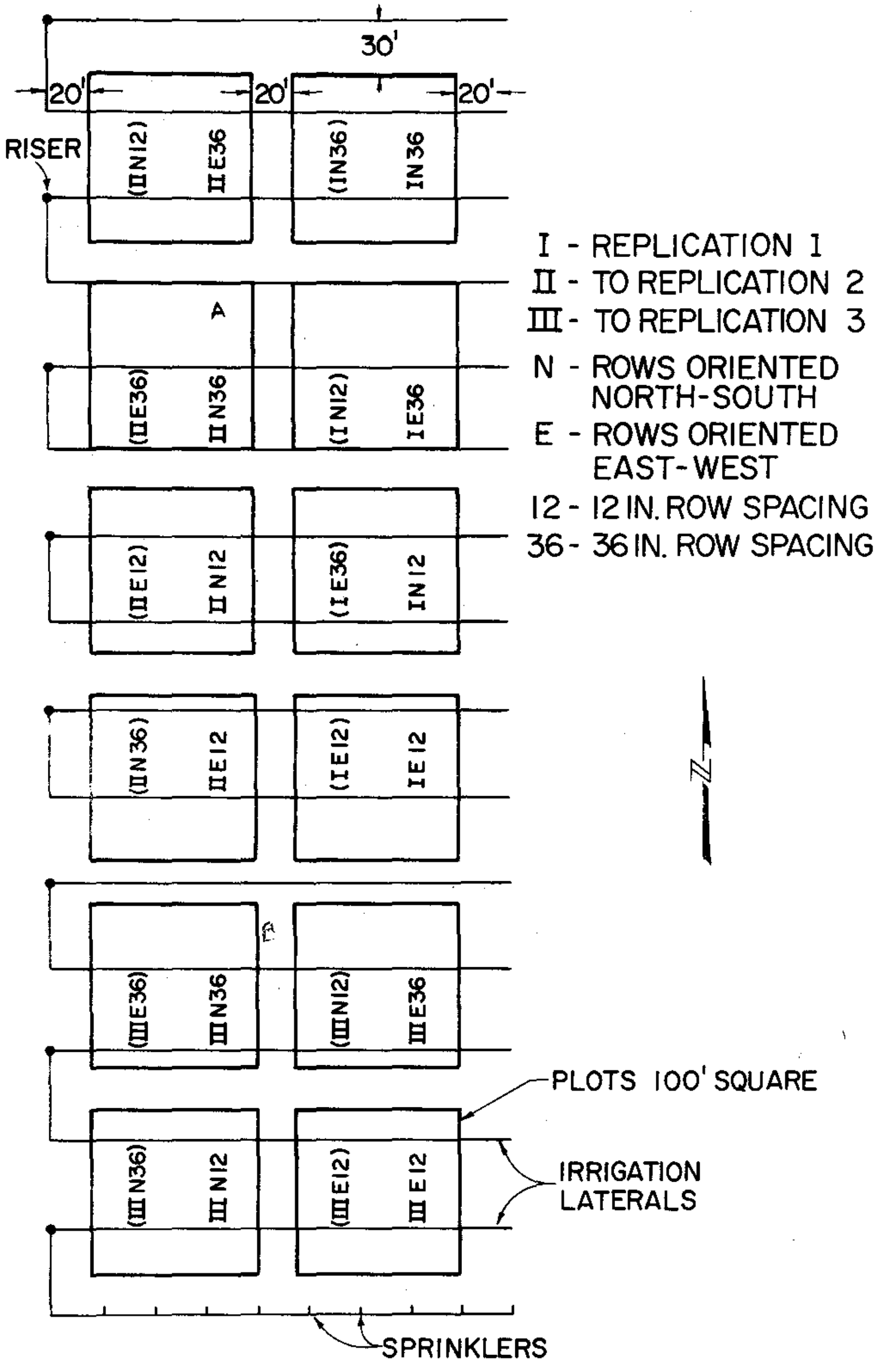


Figure 3. Field Layout of 1969 and 1971 Study. Numbers in Parenthesis Refer to 1969 Study

In 1971, no herbicide was deemed necessary. A preplant fertilizer of 250 pounds of 8-32-16 per acre was applied. Comet variety of peanut was planted on June 4 with a six row seed planted as in 1969. The plots were hand harvested on November 2. As before, the harvested area was a 16- by 6-foot section in the center of the plots which appeared representative of the plot. The harvested plants were counted and the weight of the cleaned, dried pod peanuts was determined. The samples were than graded.

The capacity of the irrigation system was about 200 gpm and allowed only four laterals (Figure 3) to be operative at a time, thus the area was irrigated in 4 sets. Two inches of water was applied per irrigation set, this taking 4 hours per set. The distribution of applied water was checked at random points in the plots with a rain guage and this confirmed the amount of water and uniformity of distribution by the system.

In 1969, the dates of irrigation were: July 31, August 10, 21 and September 1. In 1971, the dates of irrigation were: July 16, August 2, 12, 22 and September 1.

Results and Discussion

Water was applied uniformly over the entire area, but runoff was not measured so no attempt was made to determine the water budget on accretion. Thus, the total amount of water applied was not used in the estimation of ET. The depreciation of soil moisture following water input, whether irrigation or natural precipitation, was used to gauge evapotranspired water.

Selection of periods between neutron determinations of soil water which were free from rainfall excluded large parts of the growing seasons.

Figures 4 and 5 show the precipitation patterns. Accordingly, the criterion for analysis was modified to the selection of periods when the soil moisture content of any 6-inch increment of the top 36 inches of the soil profile did not exceed the value of the preceding determination made after irrigation.

1961 Study

Figure 1 shows the soil-moisture content for the growing season of 1961. As pointed out earlier, the difference of water content for all treatments at the beginning of the monitoring period was about 0.5 inches and at the end of this period, the spread was about 2 inches. Individual soil profiles of the treatments showed that the increase of water content of the narrow rows was mainly in the top 36 inches. Thus, the higher water contents of the narrow-row spacings, for both irrigated and non-irrigated treatments, in the latter part of the growing season was an actual accumulation of moisture in the root zone.

Table 1 shows that the rate of water loss by the narrow rows between July 24 and 31 and between August 21 and 28 was greater than that of the wide rows. Since there was no knowledge as to the amount of water lost by drainage from the profile, the estimate of the ET rate is probably too large. In this year there was 14.23 inches of rain (Figure 4) and 7.7 inches of water by irrigation.

1968 Study

Figure 2 shows the water content of the soil profile as determined by the neutron probe. A high initial soil-water content, plus timely precipitation (Figure 4) necessitated only 2 irrigations this year. The graphed value of July 30 for the narrow rows can be disregarded as this point represented only one plot (the neutron access tube in the other plots

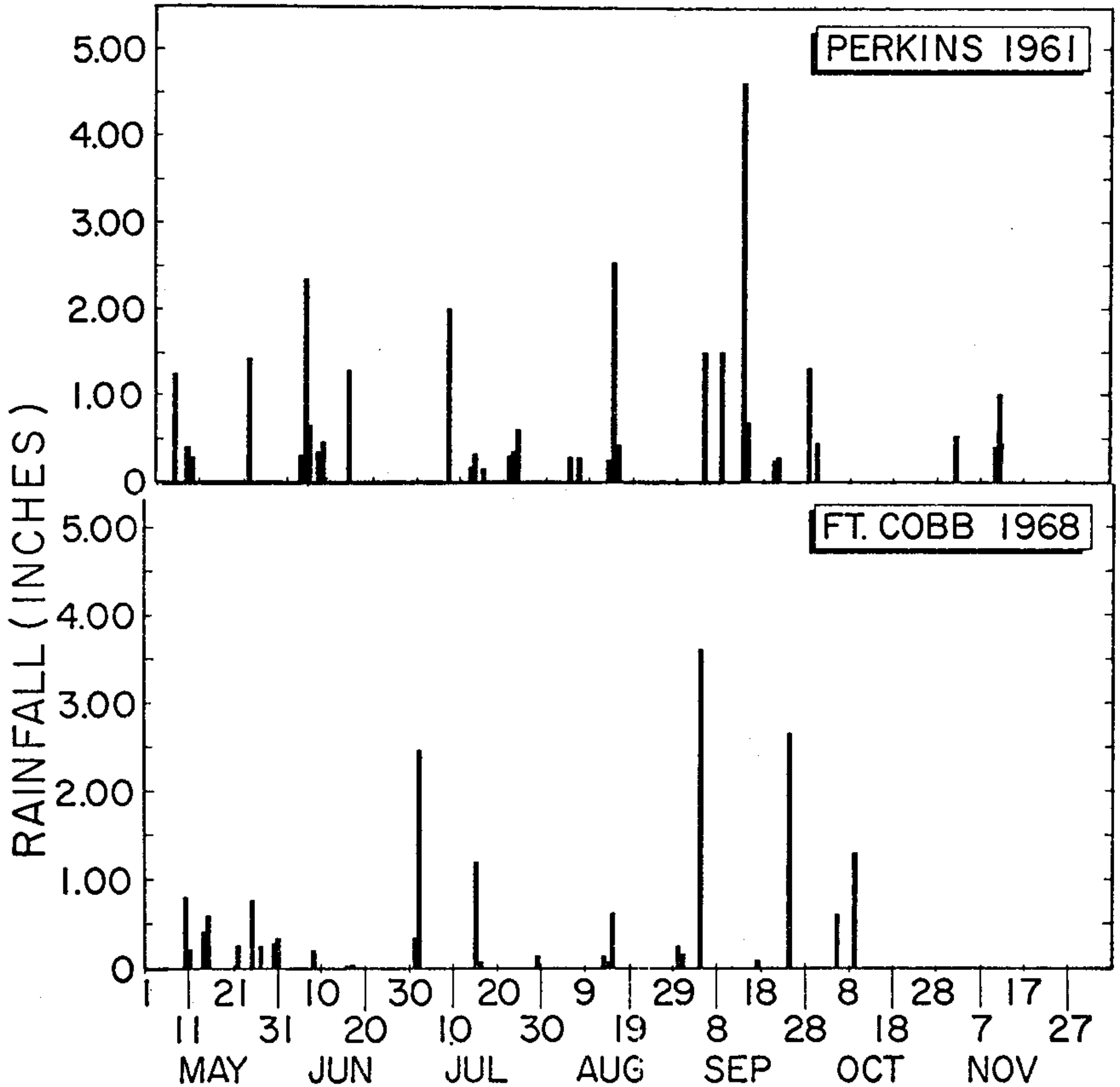


Figure 4. Precipitation Pattern, Ft. Cobb: 1961, 1968

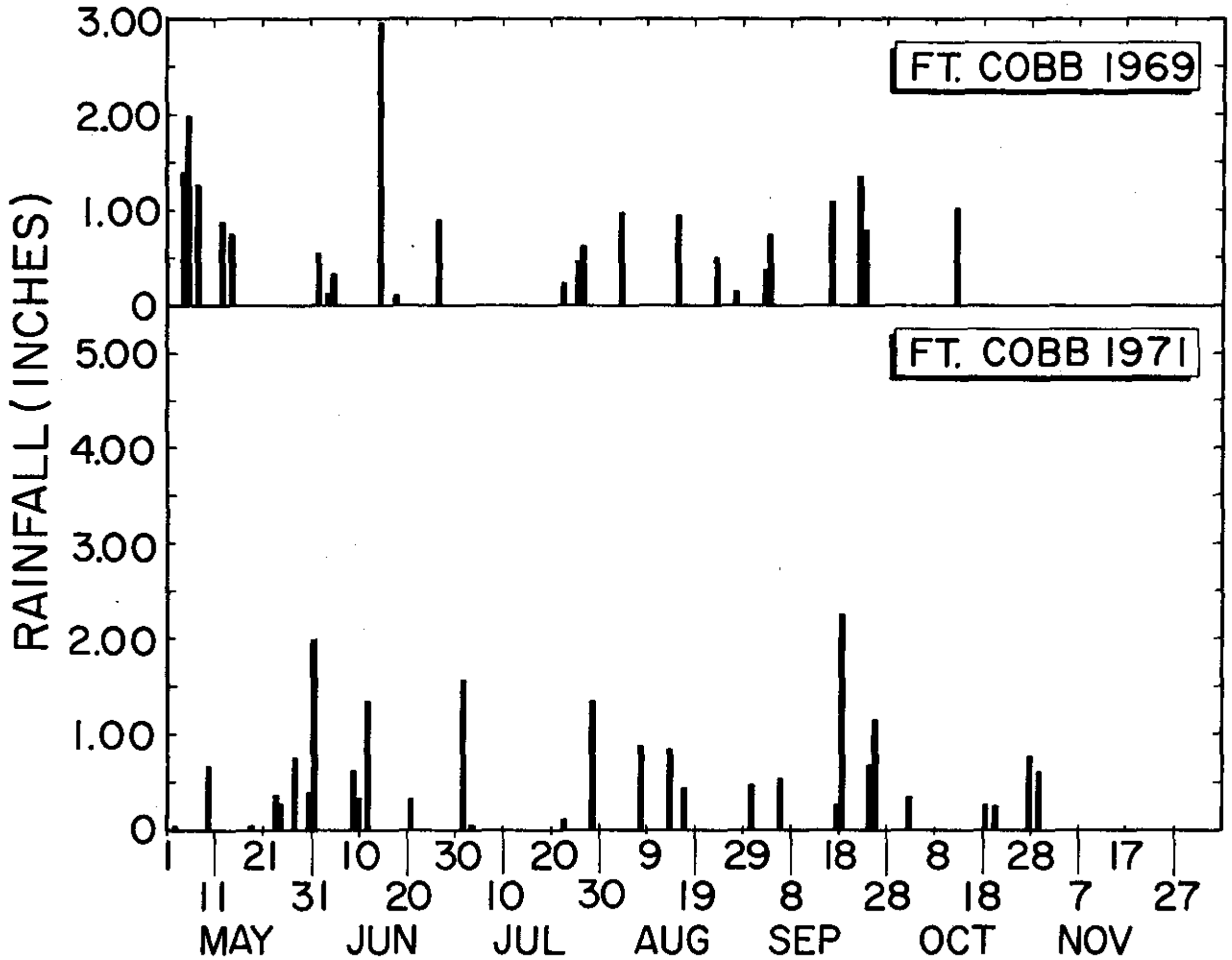


Figure 5. Precipitation Patterns, Ft. Cobb: 1969, 1971

were filled with water when the tubes were installed and had not completely drained). Note that the narrow row spacings apparently had a lower rate of water loss between August 9 and 19 than the wide rows, but the inch of precipitation which occurred between August 15 and 16 negates any meaningful estimate of ET.

1969 and 1971 Studies

The 1969 growing season was characterized by a very wet June and August (Figure 5). Between June and October, the precipitation totalled 13.5 inches and with 10 inches of irrigation water, a total of 23.5 inches of water reached the plots during the growing season.

Figure 6 shows the soil-moisture content by neutron probe determination for the growing season. As can be seen in this figure, the phenomenon of the water content of the close row spacing surpassing that of the wide row spacing was less pronounced than 1961. Nevertheless, the 12-inch, north-south oriented rows ultimately did have the greatest water remaining in the soil profile. Curves of these plots intersected the curve of the 36-inch, north-south plots on several occasions but did not surpass it until September 10. The close row spacing curve for the east-west orientation did not exceed, or even intersect, that of the wide row spacings.

Table 3 shows the tensiometric readings for the plots at the 4- and 5-foot depth. As can be seen, the potential gradients indicate that the movement of water in the close row spacings, regardless of orientation, generally was upward in this zone of the soil profile after August 7. Hence, these rows did not lose any water by drainage after August 7. On the other hand, some of the wide row spacings, i.e. 36 inches, had water draining through this portion of the soil profile as late as September.

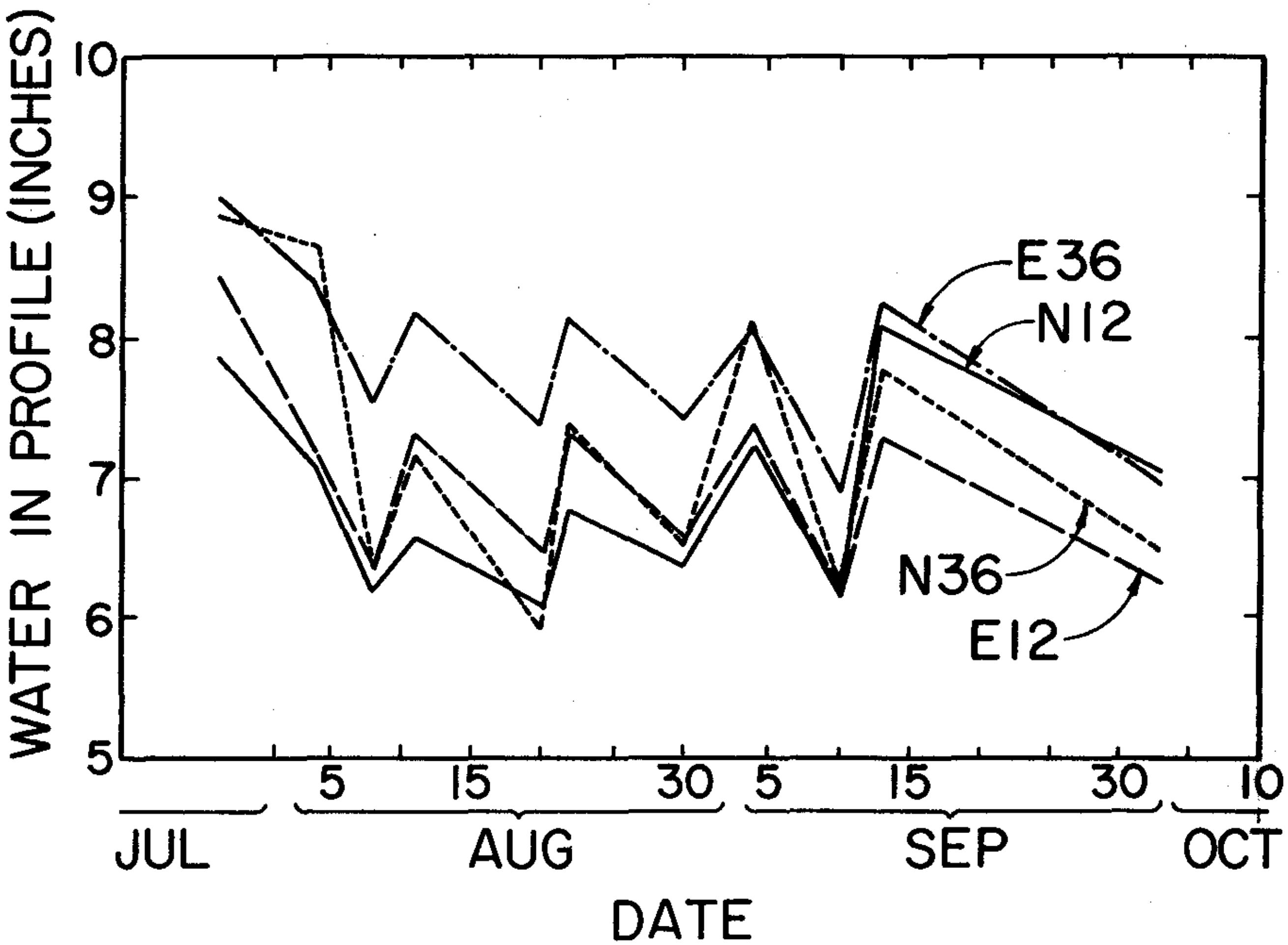


Figure 6: 1969 Neutron Determined Soil Moisture Content of the Growing Season

In the water flux determination the unsaturated hydraulic conductivity is computed from the water content of the soil. The tensiometers were calibrated to give both water content and matric suction. The water content as determined from the tensiometers should be in agreement with the neutron determination of water content, and thus one can be used to check the other. Table 4 lists such a comparison. Matric suctions listed in Table 4 can be converted to water content using Table 2. Examples of wide discrepancy are in evidence, e.g., plot 2E36 has a consistent difference of 100%. On the other hand, plot 3E36, 4 feet compare favorably. One could suspect the tensiometer as being too high, as could be caused by poor soil-cup contact. The neutron meter could read low if a cavity had developed outside the access tube near the 4th foot, a distinct possibility in such a sandy soil. In almost all plots the tensiometers did not respond to increases of water content which were detected by the neutron method.

Table 5 shows the calculation of soil-water flux for August 4 and 12, using the tensiometric data for total head gradients and with the water release data of Table 2. Many of the fluxes are negligibly small but some are unacceptably large, exceeding the total loss as recorded by the neutron measurements. Except for plots 1N12, 1N36 and 2E36, the magnitude of the flux values were generally less than 0.1 cm per day, in both the upward and downward directions. In plot 1N12, the magnitude of the upward flux was deemed too large to be credible. Similarly, the magnitude of the downward fluxes for plots 1N36 and 2E36 were too large to be valid. If one uses the neutron-probe determined water contents in the case of some of the extremes, smaller fluxes result. For example, 1N36, August 4 and 2E36, August 4 give K values of 0.03 and 0.01, respectively. Both these

TABLE 1

EVAPOTRANSPIRATION FOR 1961
BASED ON NEUTRON PROBE DETERMINATION

Date	No. of Days	Treatment	Total ET for Period (In. Water) Row Spacing 10"	40"
July 24-31	7	Irrigated	0.84	0.70
July 24-28	4	Nonirrigated	1.00	0.76
August 21-28	7	Irrigated	1.00	0.70
August 21-31	10	Nonirrigated	0.56	0.63

TABLE 2

VALUES OF SOIL-WATER CONTENT VERSUS SOIL-WATER PRESSURE AND VALUES OF SOIL BULK DENSITY

Location A, Cobb Loamy Sandy

Depth (cm)	0	15.0	30.5	45.5	61.0	76.0	91.5	106.5	122	137	152
Soil Water Pressure Head (cm)	Soil-Water Content (cm^3/cm^3)										
- 4	0.298	0.323	0.318	0.335	0.325	0.318	0.323	0.328	0.333	0.323	0.311
- 20	0.294	0.318	0.315	0.327	0.318	0.314	0.319	0.325	0.329	0.320	0.306
- 40	0.285	0.299	0.309	0.313	0.306	0.304	0.304	0.308	0.314	0.309	0.300
- 50	0.248	0.265	0.301	0.300	0.293	0.291	0.288	0.287	0.291	0.291	0.290
- 60	0.203	0.223	0.294	0.300	0.292	0.285	0.270	0.262	0.260	0.264	0.271
- 80	0.153	0.180	0.276	0.290	0.280	0.264	0.235	0.217	0.209	0.210	0.255
-100	0.133	0.159	0.257	0.283	0.270	0.247	0.209	0.186	0.173	0.172	0.188
-130	0.119	0.144	0.238	0.275	0.261	0.231	0.186	0.160	0.143	0.140	0.156
-160	0.110	0.136	0.223	0.269	0.254	0.222	0.173	0.147	0.128	0.126	0.139
-190	0.105	0.130	0.213	0.265	0.249	0.216	0.166	0.139	0.119	0.117	0.127
	Soil Bulk Density (gm/cm^3)										
	1.55	1.54	1.61	1.53	1.55	1.57	1.55	1.53	1.52	1.55	1.58

Location B, Meno Sandy Loam

Depth (cm)	0	15	30	45	60	75	90	105	120	135	150
Soil-Water Pressure Head (cm)	Soil-Water Content (cm^3/cm^3)										
- 4	0.304	0.300	0.297	0.353	0.347	0.349	0.325	0.339	0.324	0.324	0.313
- 20	0.299	0.297	0.294	0.340	0.336	0.345	0.320	0.329	0.318	0.318	0.308
- 40	0.287	0.287	0.287	0.311	0.312	0.316	0.308	0.309	0.311	0.309	0.299
- 50	0.274	0.276	0.281	0.300	0.305	0.309					
- 60	0.260	0.261	0.275	0.291	0.299	0.301	0.289	0.280	0.294	0.294	0.283
- 80	0.228	0.226	0.257	0.274	0.288	0.287	0.269	0.251	0.276	0.275	0.261
-100	0.209	0.203	0.244	0.260	0.279	0.277	0.252	0.228	0.258	0.258	0.241
-130	0.189	0.190	0.230	0.247	0.271	0.267	0.234	0.204	0.237	0.240	0.218
-160	0.180	0.184	0.222	0.238	0.265	0.259	0.223	0.190	0.223	0.223	0.199
-190	0.173	0.179	0.215	0.231	0.260	0.254	0.214	0.180	0.213	0.212	0.192
	Soil Bulk Density (gm/cm^3)										
	1.56	1.61	1.66	1.52	1.57	1.55	1.57	1.54	1.63	1.64	1.62

TABLE 2 (CONTINUED)

PARTICLE SIZE DISTRIBUTION
Location B

Depth (cm)	% Clay	% Silt*	% Sand	Textural Class
0	14.0	11.3	74.7	Sandy Loam
15	14.5	11.1	74.4	Sandy Loam
30	15.5	18.5	66.0	Sandy Loam
45	18.8	28.4	52.8	Sandy Loam
60	21.6	39.2	39.2	Loam
75	22.4	29.5	48.1	Loam
90	17.8	25.2	57.0	Sandy Loam
105	14.7	20.4	64.9	Sandy Loam
120	16.5	18.5	65.0	Sandy Loam
135	14.0	21.5	64.5	Sandy Loam
150	9.9	19.8	70.3	Sandy Loam

*Silt reading at 0.05

Saturated infiltration rate = 0.25 to 0.3 cm/hr

TABLE 3

TENSIOMETRIC DATA AT THE 4TH AND 5TH FT. DEPTH (TOTAL HEAD, CM WATER SUCTION), 1969

	1N12		1E12		1N36		1E36		2N12		2E12		2N36		2E36		3N12		3E12		3N36		3E36	
	4 ft	5 ft	4 ft	5 ft	4 ft	5 ft	4 ft	5 ft	4 ft	5 ft	4 ft	5 ft	4 ft	5 ft	4 ft	5 ft	4 ft	5 ft	4 ft	5 ft	4 ft	5 ft	4 ft	5 ft
July 24	205	207	227	243	186	210	213	221	197	202	238	238	218	273	174	201	204	247	-	-	-	-	247	277
25	219	217	235	246	283	234	220	226	203	203	244	243	227	280	177	207	226	256	-	-	-	-	261	279
26	211	210	222	243	179	229	218	223	199	197	242	241	223	276	173	201	219	255	-	-	-	-	257	277
30	230	223	244	251	184	234	224	227	203	203	262	256	228	281	176	207	241	261	247	346	258	259	258	282
August 1	221	214	242	250	187	234	223	226	202	202	253	251	232	280	176	202	241	257	326	294	260	259	260	282
4	227	213	247	251	187	234	224	226	205	205	257	252	247	281	176	204	253	259	341	297	262	262	262	272
5	231	223	251	254	189	236	224	228	205	205	262	250	229	283	178	205	263	262	347	303	262	261	260	286
7	241	222	257	254	190	236	228	228	184	209	265	257	236	285	179	206	275	266	385	309	268	264	272	291
8	251	224	261	256	190	236	229	230	213	213	269	260	238	288	179	205	286	272	433	311	272	267	276	293
9	250	224	246	259	190	236	233	233	212	210	274	261	246	285	181	206	291	269	411	312	270	264	271	291
10	254	224	270	260	193	232	230	230	212	210	277	265	247	288	182	207	309	270	430	316	273	266	275	294
12	213	212	272	260	194	237	232	232	213	212	280	267	247	288	181	205	328	279	483	331	280	267	277	296
13	265	223	275	340	195	234	233	232	214	212	285	267	247	290	186	206	363	277	605	333	283	271	281	300
14	279	228	284	603	197	239	237	235	217	214	294	273	252	291	188	211	458	297	750	339	286	272	291	303
15	264	232	292	248	199	239	240	236	223	219	304	273	267	297	191	210	518	412	612	-	296	274	295	299
18	302	-	291	271	203	230	237	233	227	220	305	263	272	298	192	211	420	289	693	-	296	275	298	302
20	314	-	304	280	203	240	245	237	238	224	330	320	283	305	196	212	560	560	682	-	327	276	308	307
21	289	-	302	276	204	241	247	238	237	227	355	283	288	301	198	211	615	294	813	-	313	277	308	307
22	-	-	307	284	215	242	248	236	240	223	357	286	294	308	203	216	584	300	812	-	313	277	316	311
25	347	-	304	289	217	245	255	240	290	232	350	292	307	315	209	217	590	300	440	376	323	281	328	-
27	329	-	306	291	218	247	257	242	247	233	335	292	308	313	207	217	454	437	508	366	320	284	326	316
29	362	-	310	293	222	250	259	240	247	235	350	291	314	315	211	217	558	319	686	366	326	254	333	316
30	372	-	314	296	225	251	260	241	288	238	367	293	319	440	212	220	688	312	687	376	331	286	340	316
September 2	425	-	325	306	232	252	269	243	299	240	378	296	326	306	219	221	749	320	843	384	347	289	356	321
4	434	-	325	308	234	254	272	242	298	238	369	297	341	321	223	222	683	310	826	378	341	290	361	322
8	501	-	350	306	245	259	280	247	303	245	350	306	357	326	228	216	808	336	836	447	376	291	390	320
10	710	-	482	345	247	256	292	247	305	260	-	315	376	333	467	249	806	351	852	481	411	294	431	332
13	800	-	361	356	254	262	297	247	300	245	-	-	394	341	-	214	798	352	845	459	465	316	428	333
15	725	-	360	354	262	266	299	262	307	250	-	-	404	337	-	226	779	376	827	447	452	295	422	336
17	517	-	360	359	264	266	310	253	378	252	-	-	400	328	-	227	790	340	741	434	426	299	421	336
19	575	-	361	350	269	259	310	253	287	254	-	-	400	335	-	230	618	337	738	446	451	324	415	322
22	817	-	361	360	279	270	318	253	283	253	-	-	357	340	-	231	640	341	872	443	482	301	425	338
24	737	-	357	360	279	295	320	255	288	259	-	-	432	340	-	230	746	340	961	436	490	301	428	338
October 3	812	-	382	338	297	275	354	260	308	273	-	-	473	370	-	235	795	350	835	484	701	307	500	353

TABLE 4

COMPARISON OF TENSIOMETRIC VALUES (PRESSURE HEAD, CM. WATER SUCTION) AND WATER CONTENT DETERMINATION BY THE NEUTRON METHOD FOR THE 1969 DATA AT THE 3RD AND 4TH FT. DEPTH OF THE SOIL PROFILE*

Plot Number	Depth (ft)	Moisture Deter- mined by	July	August						September			October
			28	4	8	11	20	22	30	4	10	13	3
1N12	3	Neutron	13.0	10.4	10.2	9.8	10.0	9.0	9.5	9.3	9.4	9.5	-
		Tensiometer	171	429	590	703	685	689	538	685	726	716	-
	4	Neutron	13.2	12.0	12.5	11.1	11.9	10.5	11.2	10.5	10.6	10.4	10.1
		Tensiometer	97	107	131	113	194	-	252	314	590	680	692
1E12	3	Neutron	14.0	13.1	12.3	11.7	11.4	10.8	10.8	10.5	10.6	10.7	-
		Tensiometer	150	228	323	419	654	670	699	720	723	717	-
	4	Neutron	19.0	13.9	13.6	12.9	12.8	13.1	12.2	12.5	11.6	11.3	11.0
		Tensiometer	119	127	141	151	184	187	194	205	362	241	262
1N36	3	Neutron	-	-	15.0	13.2	12.8	12.1	12.3	11.7	11.6	11.8	-
		Tensiometer	80	88	97	111	165	181	233	256	243	-	-
	4	Neutron	-	-	19.1	19.9	19.6	17.6	16.7	16.7	16.3	15.9	15.3
		Tensiometer	67	67	70	74	83	95	105	114	127	134	177
1E36	3	Neutron	15.1	13.0	15.6	14.2	13.1	13.0	13.4	12.4	13.4	12.6	-
		Tensiometer	139	150	165	176	313	444	481	564	713	724	-
	4	Neutron	17.8	15.9	17.2	16.7	16.4	16.9	17.0	16.5	13.6	15.7	14.4
		Tensiometer	107	104	109	111	125	128	140	152	172	177	234
2N12	3	Neutron	11.8	11.5	10.0	10.1	8.8	8.1	7.9	7.8	7.6	7.5	-
		Tensiometer	147	227	310	471	-	-	-	-	-	-	-
	4	Neutron	21.1	20.3	19.6	18.9	18.2	17.0	16.6	12.6	15.3	14.9	15.3
		Tensiometer	83	85	93	92	118	120	168	178	185	180	188
2E12	3	Neutron	-	13.9	12.7	11.8	10.6	10.5	10.4	10.6	10.3	10.1	-
		Tensiometer	222	436	702	739	715	715	702	726	724	726	-
	4	Neutron	-	15.6	15.0	14.4	12.8	12.6	12.6	12.9	12.6	11.7	11.3
		Tensiometer	134	137	149	158	235	237	247	249	-	-	-
2N36	3	Neutron	22.5	21.6	17.3	19.4	15.3	15.4	15.6	14.6	15.6	15.4	-
		Tensiometer	141	164	193	209	472	537	637	693	718	732	-
	4	Neutron	18.3	18.8	15.9	17.9	14.5	16.4	15.6	15.6	15.6	15.4	15.6
		Tensiometer	108	127	118	127	163	174	199	221	256	274	353
2E36	3	Neutron	11.8	11.3	11.0	10.9	10.0	9.5	9.4	9.2	8.9	8.7	-
		Tensiometer	70	78	84	95	154	178	230	282	380	384	-
	4	Neutron	15.4	16.1	13.6	13.7	15.6	12.4	12.3	11.8	11.5	11.6	10.7
		Tensiometer	54	56	59	61	76	89	92	103	347	-	-
3N12	3	Neutron	23.4	22.3	20.9	19.8	17.6	17.7	17.3	18.9	18.5	18.8	-
		Tensiometer	189	511	499	594	686	693	739	730	725	706	-
	4	Neutron	23.7	23.5	23.1	21.5	18.8	17.9	17.9	17.8	15.9	16.1	16.8
		Tensiometer	111	133	166	199	440	464	568	563	686	678	675
3N12	3	Neutron	20.4	17.6	16.5	16.0	15.5	15.1	14.7	15.7	15.1	14.7	-
		Tensiometer	-	476	496	-	456	502	679	734	751	745	-
	4	Neutron	27.6	22.7	22.3	21.1	18.6	17.9	18.0	18.9	16.9	16.8	16.5
		Tensiometer	-	221	313	336	562	692	567	706	732	725	715
3N36	3	Neutron	-	-	10.7	10.0	8.8	9.2	8.9	8.5	8.1	8.0	-
		Tensiometer	175	199	217	225	309	305	319	339	365	371	-
	4	Neutron	11.9	-	10.1	10.0	9.4	9.3	8.9	8.6	8.3	8.0	7.5
		Tensiometer	132	142	152	156	207	193	.211	231	291	345	581
3E36	3	Neutron	19.3	16.8	18.1	16.5	15.2	14.6	14.4	19.3	14.0	13.3	-
		Tensiometer	177	242	322	429	701	709	762	745	745	732	-
	4	Neutron	20.6	20.8	19.0	18.2	17.9	18.7	17.7	16.2	17.6	17.9	17.7
		Tensiometer	136	143	156	156	188	196	220	241	311	308	380

*Water content is % water, vol. basis

TABLE 5

CALCULATION OF WATER FLUX AT THE 4TH AND 5TH FT. DEPTH USING TENSIOMETRIC DATA OF AUGUST 4TH AND 12TH, 1969

Plot No.	Date	K From Location A			K From Location B		
		θ	K	v	θ	K	v
1N12	4	0.217	1.352	-0.631	0.266	0.727	-0.339
	12	0.227	2.098	-0.070	0.271	0.878	-0.029
1E12	4	0.166	0.143	0.019	0.240	0.273	-0.036
	12	0.154	0.084	-0.034	0.230	0.187	-0.075
1N36	4	0.242	4.095	6.359	0.272	0.912	1.429
	12	0.225	1.911	2.739	0.267	0.756	1.083
1E36	4	0.214	1.182	0.079	0.260	0.578	0.038
	12	0.214	0.761	0.0	0.254	0.463	0.0
2N12	4	0.240	3.695	0.0	0.279	1.185	0.0
	12	0.227	2.099	-0.070	0.272	0.912	-0.030
2E12	4	0.162	0.120	-0.020	0.237	0.244	-0.040
	12	0.149	0.068	-0.029	0.225	0.155	-0.067
2N36	4	0.150	0.071	0.080	0.228	0.174	0.197
	12	0.148	0.065	0.088	0.226	0.161	0.220
2E36	4	0.266	11.642	10.865	0.292	2.315	2.161
	12	0.268	12.734	10.187	0.290	1.788	1.430
3N12	4	0.174	0.203	0.041	0.247	0.356	-0.071
	12	0.136	0.038	-0.038	0.213	0.099	-0.162
3E12	4	0.127	0.131	-0.192	0.206	0.076	-0.111
	12	+	-	-	+	-	-
3N36	4	0.156	0.092	0.0	0.234	0.195	0.0
	12	0.149	0.068	-0.029	0.225	0.155	-0.067
3E36	4	0.150	0.071	0.023	0.227	0.167	0.055
	12	0.138	0.042	-0.026	0.216	0.111	-0.070

+Matric suctions too large for water-content estimation plots were near site A, Figure 3. The resulting fluxes are 0.04 and 0.009 cm per day. However, lacking proof as to whether tensiometers or neutron determinations were at fault, no corrections of this type were attempted. Table 6 shows the result of computing these fluxes for the period of August 11 through August 20. The same faults are in evidence. Here fluxes were computed by the conductivity values obtained geographically near the respective plots.

An assumption was made which did permit limited, valid calculations of ET. Water flux was assumed negligible after the first week in August. This seems reasonable since the neutron readings over the entire field indicated dry conditions in the 4th foot. The flux at 10% water would be less than 0.01 cm per day. Also the tensiometer data tended to show total potential gradient near zero after the first week in August. Hence, differences in water content over time as indicated by the neutron method were recorded as measures of ET.

Table 7 shows the calculation of ET from changes of neutron determined water content. As the table shows, in the early part of August, the 12-inch row spacing of north-south orientation had the lowest daily loss of moisture. This value was about half of that of the east-west oriented rows of similar spacings. In the latter part of August, the 12-inch north-south oriented rows continued to be the lowest in ET, but the ET rate for the east-west oriented 36- and 12-inch rows were about the same. In early September, the ET rate for all but the 36-inch north-south oriented rows were about the same.

1971 Study

At the start of the growing season, the soil profile was exceedingly dry due to the deficiency of precipitation on the preceding winter.

TABLE 6

CUMULATIVE FLUX (CM. WATER) FOR AUGUST 11-20, 1969, USING THE HYDRAULIC CONDUCTIVITIES DETERMINED AT THE NORTH AND SOUTH PORTIONS OF THE EXPERIMENTAL AREA

	1N12	1E12	1N36	1E36	2N12	2E12	2N36	2E36	3N12	3E12	3N36	3E36
North	*		33.0	-0.87	-2.6	-0.45		52.5				
South		-4.07					1.65		*	*	-1.67	0.33

*No value assigned due to a) missing data within period or b) the values of the matric suction obtained within this period for these plots exceeded the lower limit of the water desorbtion versus matric suction relationship found in the lab.

NOTE: Negative sign denotes upward flux

TABLE 7

EVAPOTRANSPIRATION FOR 1969, BASED ON NEUTRON PROBE DETERMINATION

	Total ET For Period (In. Water)			
	North-South Oriented Rows		East-West Oriented Rows	
Date	12"	36"	12"	36"
August 11-20	0.48	1.22	0.81	1.36
August 22-30	0.38	0.85	0.75	0.72
September 4-10	1.04	1.86	1.25	1.18

This is evidenced by the low water contents of the plots, by neutron determination, and by the high matric suction shown by the tensiometers, Figure 7 and Table 8, respectively.

Figure 7 shows the water content of the plots during the growing season. Accumulation of moisture by the narrow rows was evident only for a small part of the growing season by the north-south oriented rows, and only for a few days for the east-west oriented rows. The 36-inch, east-west oriented rows showed a high accumulation of moisture on August 16, but this point of the graph represented only one neutron determination as there was water ponding on the surface of the soil in the vicinity of the other neutron access tubes. Because of the occurrence of precipitation between several neutron readings, i.e., increase of moisture in the top 18 inches of the soil, only two periods were valid for the calculation of ET, as shown in Table 9. Table 8 shows there was a large amount of missing data in the tensiometer readings. Problems were encountered in the field this year by rodents gnawing at the nylon tubing which connected the tensiometers to the mercury manometers. Also, several tensiometers malfunctioned at the end of the growing season. Nevertheless, where data were available only two plots did not show zero total head gradient in the 4th foot before July 26. The matric suction in the plots was higher than those of 1969. Hence, the same technique for estimation of ET was employed as in 1969: assume difference of water content between neutron readings represent ET after August 1. These are the data in Table 9. In the early part of August, the 12-inch, north-south oriented rows had the lowest ET in agreement with what had been found the previous year of study. In the other period of calculation, the ET rate was higher than that of the previous year of the same date.

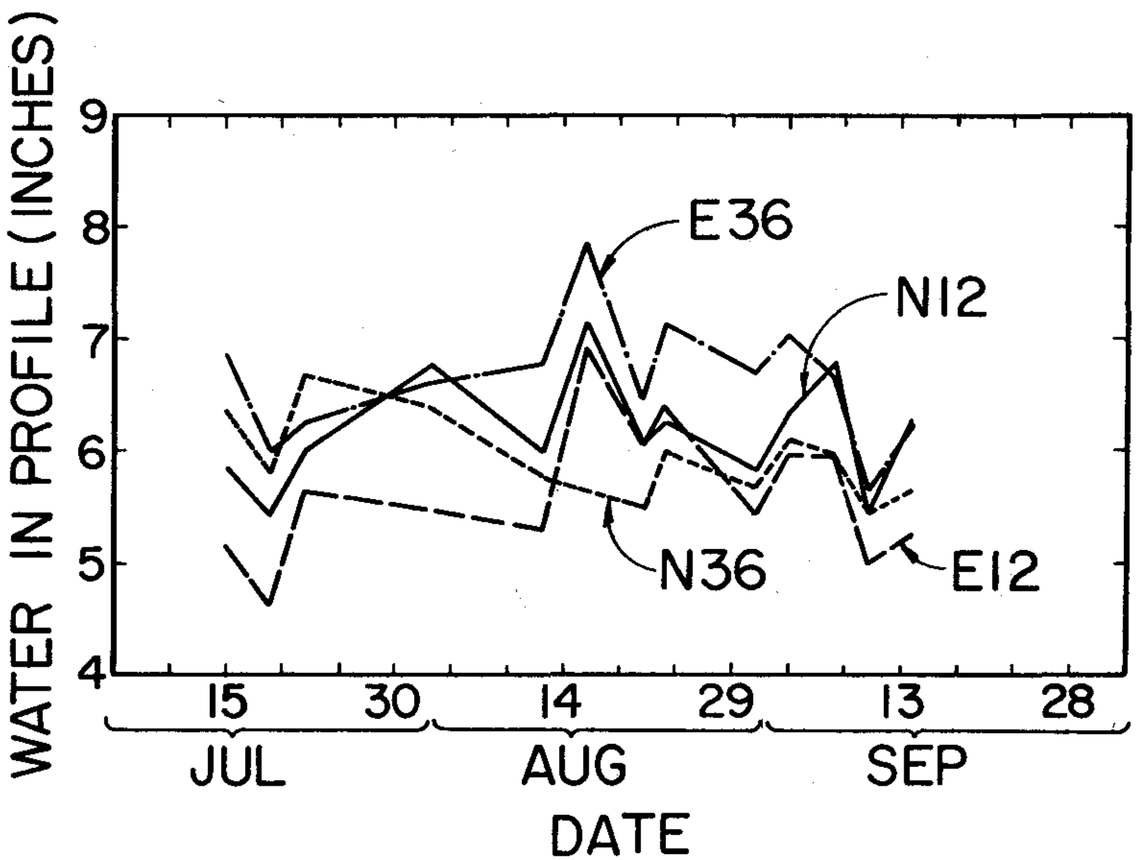


Figure 7. 1971 Neutron Determined Soil Moisture Content of the Growing Season

TABLE 8

1971 TENSIOMETRIC DATA AT THE 4TH AND 5TH FT. DEPTH (TOTAL HEAD, CM WATER SUCTION)

Plot:	1N12		1E12		1N36		1E36		2N12		2E12		2N36		2E36		3N12		3E12		3N36		3E36	
Depth:	4 ft	5 ft	4 ft	5 ft	4 ft	5ft	4 ft	5 ft	4 ft	5 ft	4 ft	5 ft	4 ft	5 ft	4 ft	5 ft	4 ft	5 ft	4 ft	5 ft	4 ft	5 ft	4 ft	5 ft
July 14	-	448	244	444	488	362	319	352	599	501	565	421	323	363	196	105	363	335	-	550	381	458	-	-
15	-	-	-	-	534	380	370	373	659	558	629	327	345	336	-	-	374	295	-	557	480	477	174	201
16	-	-	-	-	539	388	409	383	720	657	292	327	-	-	-	-	-	-	-	552	525	476	204	238
19	-	-	-	-	-	385	490	387	779	638	351	435	324	383	-	-	-	-	-	602	696	486	-	-
21	182	513	313	455	667	342	477	-	-	-	380	421	-	-	-	-	-	-	-	539	632	442	-	-
22	-	573	369	405	-	-	535	367	789	495	441	423	328	355	-	-	-	-	-	589	677	467	-	-
23	-	586	397	425	-	-	554	368	805	466	464	382	339	356	-	-	-	-	-	586	673	477	-	435
26	-	-	452	353	-	-	578	358	-	-	534	342	340	351	-	-	-	-	-	586	663	470	-	-
27	170	473	414	-	-	-	-	-	-	-	524	422	-	-	312	338	-	-	-	550	384	463	-	410
28	254	565	483	530	-	-	587	-	-	-	597	435	345	370	-	-	-	-	-	590	491	476	-	420
29	263	445	-	-	282	347	-	-	-	-	579	431	321	331	-	-	383	274	-	561	495	453	-	401
August 2	303	562	318	503	367	360	-	-	-	-	676	442	357	354	-	-	395	310	-	593	681	463	-	406
4	342	487	365	507	-	-	-	-	-	-	638	425	364	432	-	-	-	312	-	568	582	444	-	404
5	378	479	-	-	-	-	-	-	-	-	644	431	375	355	-	-	414	-	-	574	644	458	-	-
10	339	430	369	504	-	-	-	-	-	-	-	433	457	-	-	-	349	327	-	590	-	-	-	-
11	-	456	359	-	-	-	-	-	-	-	-	436	475	-	-	-	358	330	-	592	-	-	-	-
16	-	516	495	510	-	-	-	-	-	-	727	-	498	-	-	-	378	335	-	-	-	-	-	-
17	-	535	510	516	-	-	-	-	-	-	-	-	433	-	-	-	360	331	-	-	-	-	-	-
18	320	533	524	516	-	-	-	-	-	-	480	442	485	-	-	-	366	336	-	-	-	-	-	-
19	-	538	-	-	-	-	-	-	-	-	523	446	504	-	-	-	372	336	-	-	-	-	-	-
24	-	546	-	-	-	-	-	-	-	-	630	455	582	-	-	-	388	335	-	-	-	-	-	-

TABLE 9

EVAPOTRANSPIRATION FOR 1971, BASED ON NEUTRON PROBE DETERMINATION

	Total ET For Period (In. Water)			
	North-South Oriented Rows		East-West Oriented Rows	
Date	12"	36"	12"	36"
August 2-12	0.56[1]	0.67*	0.82	-
August 16-21	0.85	1.47*	1.04	1.39

*Value from 1 tube

Yield

Table 10 shows the yields of the 1969 and 1971 studies. The results of the crop yield was statistically significantly different at the 8% level of uncertainty. Row orientation did not affect the yields of the crop, or the quality of the crop, as measured by the percentage of SMK. Nevertheless, the percentage of SMK was high for the two years, in excess of 70%.

In 1971, the plant spacings in the rows was about a third that of the 1969 season, but the plant yield which resulted was less than a third of the yield of the plants of 1969. The more effective irrigation in the 1969 season would account for much of this.

Discussion

In considering the relationship between the water content of the soil, as determined by the neutron method, versus the matric suction, as indicated by tensiometric response, the sampling volume characteristic of the respective instruments, along with water conductivity of the non-homogeneous soil is important. For example, the entire area was irrigated on August 10, 1969. The time lag for the tensiometers to reflect this pulse of water at the 4-foot depth varied from August 12 (plots 1N12, 1N36, 2N36 and 3E36) to August 18 (plots 1N12, 1E36, 2N12 and 2E12). Using the neutron method, however, an increase of water content was detected at the 4-foot depth two days after irrigation in all plots. It would have been desirable to compare conductivities in the above plots between the 1969 and 1971 data. In 1971, insufficient tensiometric data prohibited this comparison. This is unfortunate in

TABLE 10

1969 AND 1971 CROP CHARACTERISTICS

	1969 Row Spacings				1971 Row Spacings			
	12-in Rows Orientation		36-in Rows Orientation		12-in Rows Orientation		36-in Rows Orientation	
	North-South	East-West	North-South	East-West	North-South	East-West	North-South	East-West
Yield: Pounds Per Acre	3448	3811	3130	3085	3270	3220	2590	2680
Grams Per Plant	29.21	30.46	69.82	70.84	9.46	11.32	19.05	18.89
Plant Spacing (Plants/Ft)	1.26	1.32	1.40	1.37	3.59	3.80	4.23	4.90
Percent Sound Mature Kernels	75.3	72.6	72.3	73.0	71.0	73.0	71.0	71.0

Analysis of Variance (Yield/Harvested Area)

1969				1971			
Source	D.F.	S.S.	M.S.	Source	D.F.	S.S.	M.S.
Total	11	17.067		Total	11	13.989	
Reps	2	5.527	2.763	Reps	2	0.671	0.335
Treatments	3	4.667	1.556	Treatments	3	5.790	1.930
Spacing	1	3.853	3.853	Spacing	1	5.740	5.740
Orientation	1	0.334	0.334	Orientation	1	0.007	0.007
Spac x Orien	1	0.480	0.480	Spac x Orien	1	0.043	0.043
Error	6	6.873	1.146	Error	6	7.530	1.255

that such comparisons could have established whether further sampling for water content versus matric suction relationship need be established for the non-conforming portions of the field.

Table 11 shows the calculated ET values, expressed as a percentage of the maximum ET obtained for each period. Two definite trends can be seen in this table. The first is that the north-south oriented rows had the extremes in ET. The 12-inch row spacings had the lowest ET for all treatments, while (except for the August 11-20 period) the 36-inch row spacings had the highest.

Narrow east-west rows seem to have an advantage over wide east-west rows. It seems clear that peanuts grown in narrow rows of north-south orientation evapotranspire less water than those in wide rows of any orientation and narrow rows in east-west orientation. Higher populations seem to lose less water than sparse. However, row orientation seems to be the big factor.

The reason for this effect is not obvious. It is most regrettable that the malfunction of the data acquisition system prevented the planned detailed energy budget determination and aerodynamic studies.

In considering the row orientation effect, Yao and Shaw (1964 a,b) found that in 42-inch rows, the net radiation of east-west oriented corn crop was higher than the north-south oriented rows. The authors concluded that this higher net radiation contributed to a more "efficient water usage" by the north-south oriented rows. The efficient water usage value was based on the ratio of yield to neutron determined soil-water content. No effort was made by the authors to determine the component of water lost by drainage through the soil profile. Furthermore, differences between canopy coverage of corn and peanut would cast some doubt on the applicability of the above information to this study.

TABLE 11

EVAPOTRANSPIRATION OF 1969 AND 1971 ON A PERCENTAGE BASIS*

Year	Date	North-South Oriented Rows 12"	North-South Oriented Rows 36"	East-West Oriented Rows 12"	East-West Oriented Rows 36"
1969	August 11-20	35	90	60	100
	August 22-30	45	100	86	91
	September 4-10	55	100	66	62
1971	August 2-12	29	100	73	-
	August 16-21	58	100	70	95

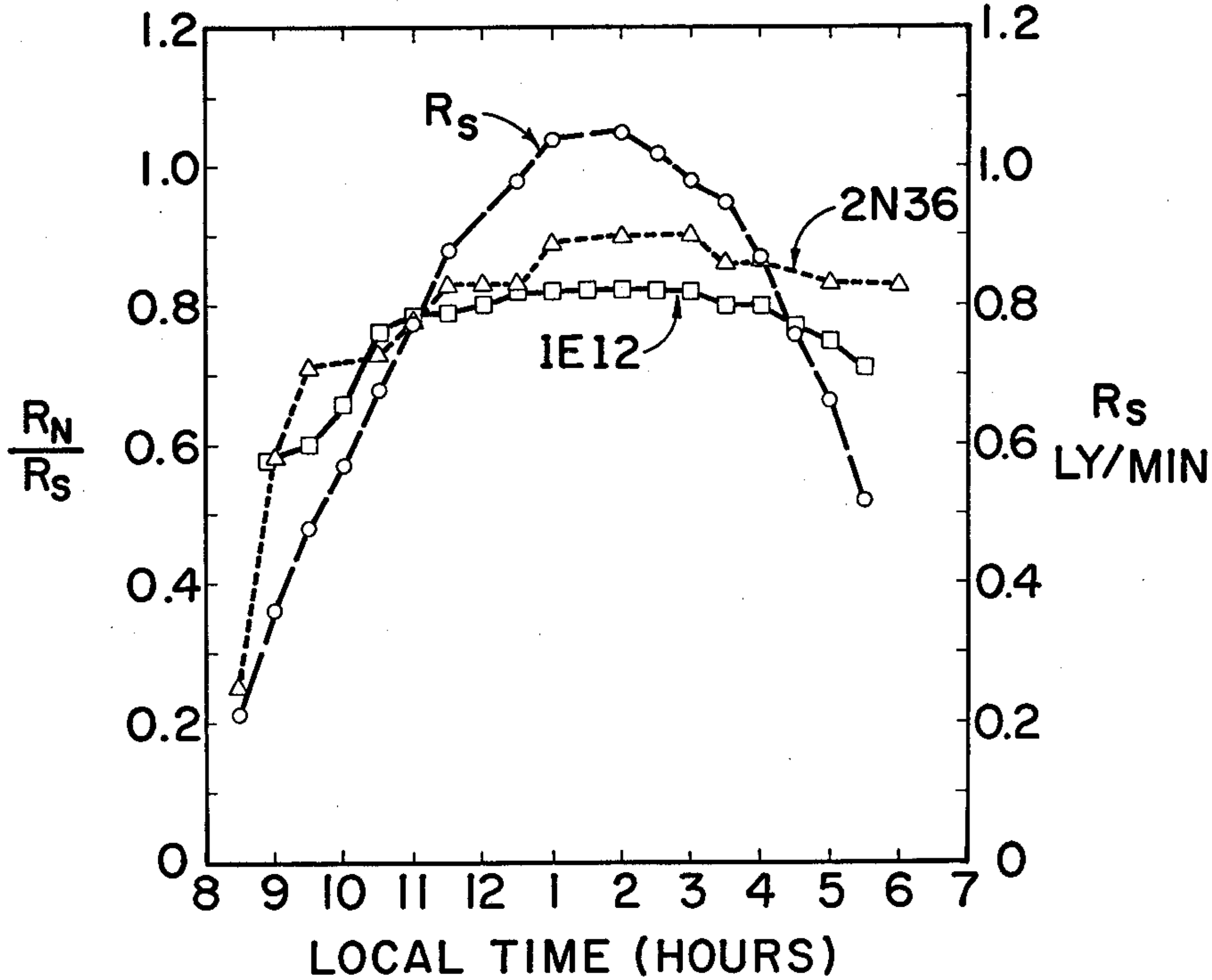
*100 Percent Being Assigned to the Highest Value Within a Given Period

Tanner, Peterson and Love (1960) postulated that high plant populations of corn would have a higher ET than low plant populations. The basis of this postulation was based on the magnitude of the transpiration. On both dry and moist soils, the greater transpiration rate of the high plant populations would make the ET higher in both instances. Also, low plant populations would have a higher sensible heat loss. No orientation effect was mentioned by the authors.

Again, morphological differences between corn and peanut makes it difficult to compare the effects of various row orientations and plant populations on ET. Differences which should be considered are: a) the structure of the crop canopy, and b) leaf area index.

In considering the structure of the crop, Figure 8 shows a comparison of the ratio of net radiation to solar radiation for two plots on September 6, 1969. Solar radiation was determined in the center of the east border of the experimental area with a Kipp and Zonen solarimeter, while net radiation was determined over the indicated plots by two Thornthwaite miniature net radiometers, Model 601. Visual observations indicated that the soil surface of the wide row spacings was drier than the narrow row spacings, and the plant cover of the latter plant spacing was more extensive over the soil surface than the former row spacings. This observation was for a single date, and does not represent the R_N/R_S ratio for the period of September 4-10. Nevertheless, this information is indicative of the type of coverage which was achieved. This response was different from those of Tanner, et al. (1960). This figure implied that the net radiant energy for the wide row spacings was higher than the narrow row spacings, hence, more solar energy was being absorbed by the wide spacing.

FIGURE 8. SOLAR RADIATION AND NET RADIATION FOR TWO PLOTS. SEPT. 6, 1969



Conclusions

Peanuts grown in 12-inch, north-south rows lose less water to ET than t ose grown in 36-inch, north-south rows, or east-west rows of either orientation. Higher population seems to favor this effect, but directional orientation is the big factor. The phenomenon is not explained.

The reason for this effect needs to be elucidated in future research since the implications are that: a) certain plants can be made to use less water, reducing irrigation requirements or permitting growth in droughty areas and b) there may be ways to reduce the average ET over a region, thereby permitting the diversion of water through the soil overburden to aquifers for storage.

Future studies need not only establish the energy budget to explain this phenomenon but need to monitor plant factors to determine the components of soil evaporation and plant transpiration. These need to be related to radiant energy extinction under the canopy and transpiration effects in the canopy, which may be related to aerodynamic effects both within and above the canopy. Recent studies have shown leaf area index can be important in the determination of the portion of transpiration in ET. (Brun, et al. 1972, Ritchie and Burnett, 1971, and Ritchie and Jordan, 1972).

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