MEASURING ROOTING DEPTH AND DISTRIBUTION OF GRAIN SORGHUM FOR PREDICTING SOIL MOISTURE DEPLETION AND IRRIGATION SCHEDULING

by

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B.Sc. (Agriculture), Ahmadu Bello University, 1973

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Agronomy

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1976

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ACKNOWLEDGMENTS

I wish to express my gratitude to Drs. I. D. Teare, L. R. Stone, and L. V. Withee for planning this study and for a most helpful critique of the entire manuscript.

I also wish to thank the United States Government and Ahmadu Bello University, Zaria, Nigeria, for financing my studies.

My appreciation is extended to Vance Hadorn, Deanna Bayer, Mike Sauber and all the other Kansas State University students who helped with both field and laboratory work.

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INTRODUCTION

The root systems of plants have received less attention than the above ground parts because the latter are conspicuous, have definite economic value and form an easily available source of material for study, while it is quite difficult to make periodic examinations of roots growing in the soil. As a result, knowledge of root systems is relatively scarce.

Knowledge of rooting depth and distribution is important in designing irrigation systems and in determining proper time and amount of water application.

Wise use of irrigation water can save money and labor, minimize leaching of soluble plant nutrients, lessen crop protection problems, and facilitate other cultural practices. Insufficient water in the root zone creates plant water stress and reduces dry matter accumulation and yield. Knowledge of the relationship between plant top growth and rooting depth and distribution can be used in conjunction with evapotranspiration data to estimate time and amount of irrigation water needs.

The objectives of this study were to measure the rate of grain sorghum root extension and development in relation to identifiable stages of physiological development under irrigated and nonirrigated conditions, to correlate the development of the roots with the tops, and to measure soil water depletion and root development of five grain sorghum varieties in investigating the interaction between root development, grain sorghum varieties, and water use.

Chapter I

TOP AND ROOT GROWTH OF IRRIGATED AND NONIRRIGATED GRAIN SORGHUM

TOP AND ROOT GROWTH OF IRRIGATED AND NONIRRIGATED GRAIN SORGHUM[1/]

ABSTRACT

Field research relating grain sorghum [Sorghum bicolor (L.) Moench] root development to top development at more than one stage of growth is limited. This study was conducted to investigate the relationship between depth and distribution of grain sorghum roots in the field and above ground morphological development (plant height, leaf area index, dry matter) during the growing season under irrigated and nonirrigated conditions. Soil cores were taken with a soil coring machine throughout the season and roots washed free using 35 mesh screen. Soil water was determined in the 15 to 150 cm soil profile by neutron moderation and in the 0 to 15 cm layer by gravimetric sampling throughout the season.

Root development was characterized by rapid root penetration early in the season in both irrigated and nonirrigated sorghum. Roots reached maximum depths of 150 cm in the irrigated and 140 cm in the nonirrigated sorghum 7 weeks after planting. Maximum root dry matter of 17.1 g and 12.3 g was reached at 10 and 11 weeks after planting in the irrigated and nonirrigated sorghum, respectively. Maximum lateral root proliferation occurred between 9 and 10 weeks after planting in the irrigated sorghum and between 8 and 9

[1/] Contribution no. 177, Kansas Water Resources Research Institute, Manhattan. The U.S. Department of Interior, Office of Water Research and Technology provided partial support. Contribution no. 1548-J, Department of Agronomy, Evapotranspiration Laboratory, Kansas Agricultural Experiment Station, Manhattan, Kansas 66506.

weeks after planting in the nonirrigated sorghum. A greater proportion of total root dry matter was accumulated at the lower depths in the nonirrigated than in the irrigated sorghum. There was little increase in leaf dry matter after the 8th week but stem dry matter continued to increase and reached a maximum 9 weeks after planting in both treatments. Stem dry matter declined in both treatments during panicle development. Rate of dry matter accumulation in both roots and tops was higher in the irrigated treatment.

Quadratic regression and correlation analyses of effective root depth and top height gave R values of 0.978 and 0.975 for irrigated and nonirrigated sorghum, respectively, and with root dry matter and top dry matter gave R values of 0.973 for irrigated and 0.941 for nonirrigated sorghum.

Additional index words: Leaf area index, physiological stage, neutron moderation, dry matter, panicle development.

INTRODUCTION

In general, research on higher plants has concerned itself more with the foliage than with the root systems. This is partially due to the greater difficulty in making periodic examinations of roots growing in the soil. Most research work on roots has been done in the greenhouse, growth chamber, rhizotron, or with one observation in the field at or near maturity.

Weaver (1924) excavated roots of Black Amber [Sorghum bicolor (L.) Moench] near maturity and reported that they reached a working depth of 122 cm and had a maximum penetration of 137 cm to 143 cm. Miller (1916) reported that the root systems of Blackhull Kafir and Dwarf milo sorghums planted in rows 113 cm apart reached maximum depths of 183 cm and had a maximum lateral spread of 113 cm. Others (Bloodworth et al., 1960; Nakayama and van Bavel, 1963; Stone et al., 1973) have reported that the major concentration of sorghum roots occurred within the surface 30 cm. Field studies relating root development to top development of grain sorghum during the growing season are few. Lavy and Eastin (1969) related ^{32}P uptake by spaced (324 cm) sorghum plants to root depth at 23, 39, and 59 days after emergence and Nakayama and van Bavel (1963) related ^{32}P uptake to sorghum root distribution patterns at 11 times throughout the season. Lavy and Eastin (1969) and Nakayama and van Bavel (1963) observed ^{32}P uptake at 152 cm root depth.

Crops where root and top growths have been studied throughout the season are corn (Zea mays) (Foth, 1962); oats (Avena sativa) (Thurman and

Grissom, 1954); cotton (Gossypium hirsutum) (Pearson and Lund, 1968); and soybeans [Glycine max (L.) Merr.] (Mayaki et al., 1976).

This field research was conducted to examine grain sorghum rooting depth and distribution during the season under irrigated and nonirrigated conditions. Selected above ground morphological parameters (plant height, leaf area index, dry matter) were monitored during the growing season to see if meaningful relationships between root depth and distribution in a barrier free soil and morphological parameters at various physiological stages could be established.

MATERIALS AND METHODS

The study was conducted on the Ashland Agronomy Research Farm 14 km south of Manhattan, Kansas. The soil is Muir silt loam (fine silty, mixed, mesic, Pachic Haplustoll) which has developed from alluvial deposits. The surface silt loam extends to the 14 cm depth; silty clay loam from 14 cm through 50 cm; silty clay from 50 cm through 81 cm; and silt loam below 81 cm. The soil profile has slight plowpan features in the 14 cm to 22 cm layer, but is relatively free from root restricting features.

Grain sorghum (cv. Pioneer 846) was planted on May 21 in rows 75 cm apart and 12.2 m long, and thinned to a population of 10 plants per meter. Four plots 12 rows wide and 12.2 m long, two irrigated and two nonirrigated, were used. Physiological stages (Table 1) were recorded as described by Vanderlip (1972). No differences in physiological stages were noted between irrigated and nonirrigated sorghum until stage 8 (hard dough). The nonirrigated sorghum reached hard dough two days before the irrigated sorghum [nonirrigated (August 21), irrigated (August 23)].

Table 1. Grain sorghum physiological stages of development during the 1975 season.

Stage No.	Description	1975	
		Month	Day
	Planting	May	21
0	Emergence	May	27
1	3-leaf stage	June	11
2	5-leaf stage	June	18
3	Growing point differentiation	July	2
4	Flag leaf visible in whorl	July	10
5	Boot stage	July	18
5.6	Panicles fully emerged	July	24
6	Half bloom	July	28
7	Soft dough	August	8
8	Hard dough	August	22
9	Physiological maturity	August	30

The irrigated plots received a total of 31 cm of water, 10 cm applied at stage 4 (flag leaf just visible in whorl, July 9), 10 cm applied at stage 5.4 (panicles beginning to emerge from boot, July 22) and 11 cm applied at stage 7 (soft dough, August 8). Water was metered into basins using gated pipe. Soil water content was determined in the 15 to 150 cm soil profile at 15 cm intervals using neutron moderation and in the 0 to 15 cm layer by gravimetric sampling. One access tube was placed in the center of each of the four plots. Available water in the root zone was estimated as the soil water held between -0.2 and -15 bars soil water potential.

Soil cores used for root determination were collected using a tractor mounted coring machine.[2] The coring tube had an internal diameter of 8.3 cm. Three samples were taken from each plot giving six samples each for the irrigated and nonirrigated treatments. Each sample consisted of a composite of two cores, one centered on one sorghum plant in the row and another 25 cm perpendicular from the crop row (1/3 row width). The soil cores were partitioned with depth into 15 cm increments. The top 15 cm increment was further partitioned into two 7.5 cm sections. Samples were taken once a week from stage 2.1 (5-leaf stage) to stage 6.8 (nearing soft dough) and once every two weeks after stage 6.8. Roots were washed free from soil using 35 mesh screen. Maximum rooting depth was taken to be the maximum depth at which roots were observed at the time of sampling. Effective rooting depth was taken as the 15 cm depth increment containing more than 0.01 g of oven dry roots in the soil core taken in the crop row.

2/ The Giddings Model G. S. Soil Sampling Machine by the Giddings Machine Company, Ft. Collins, Colorado.

Plant tops were sampled for dry weight, leaf area, node count, and height from stage 2.1 (5-leaf stage) to maturity. The tops were partitioned into leaves, stems, and panicles. All dry weights were determined by oven drying at 100C. Leaf area was measured with a leaf area meter.[3/] Plant height was measured from ground surface to the uppermost leaf whorl before panicle emergence and from ground surface to the tip of the inflorescence after panicle emergence. Grain yield was obtained from a 4-m strip length sample from the two center rows of each plot.

RESULTS AND DISCUSSION

Water received during the season (rainfall and irrigation) is plotted against physiological stage and date in Fig. 1. Total soil water and available soil water in the 150 cm soil profile under irrigated and nonirrigated conditions are plotted against physiological stage and date in Fig. 2. Available soil water in the irrigated soil profile never reached 50% depletion throughout the growing season. In the nonirrigated soil profile, available soil water was more than 50% depleted from about mid July to the end of the growing season. The increase in soil water in both irrigated and nonirrigated profiles after mid-August was due to rainfall (Figs. 1 and 2).

Description of Root Growth

Effective rooting depth in relation to physiological stage and date is plotted in Fig. 3. By stage 3.8 traces of roots were observed in the crop row samples at depths of 150 cm in the irrigated sorghum and 140 cm in the nonirrigated sorghum. However, the roots did not proliferate at these

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[3/] Automatic leaf area meter, Model AAM-5 by Hayashi Co., Ltd., Tokyo, Japan.

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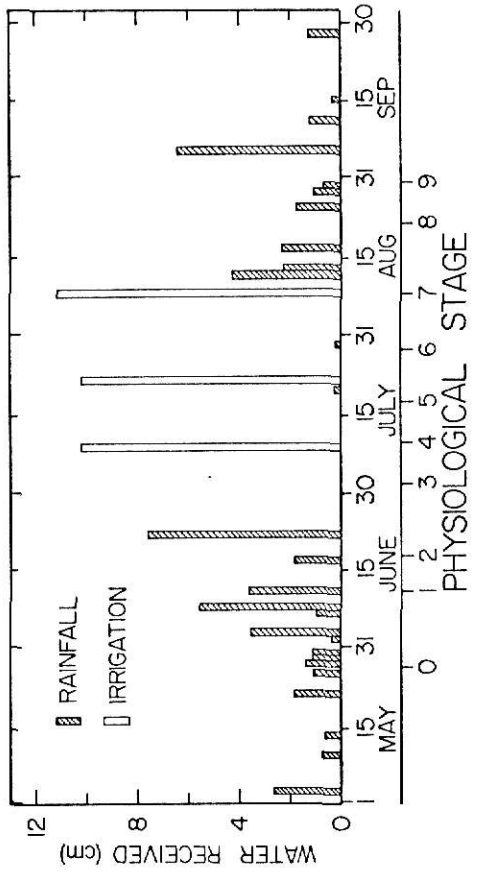


Fig. 1. Water received (irrigation and rainfall) in relation to physiological stage and date.

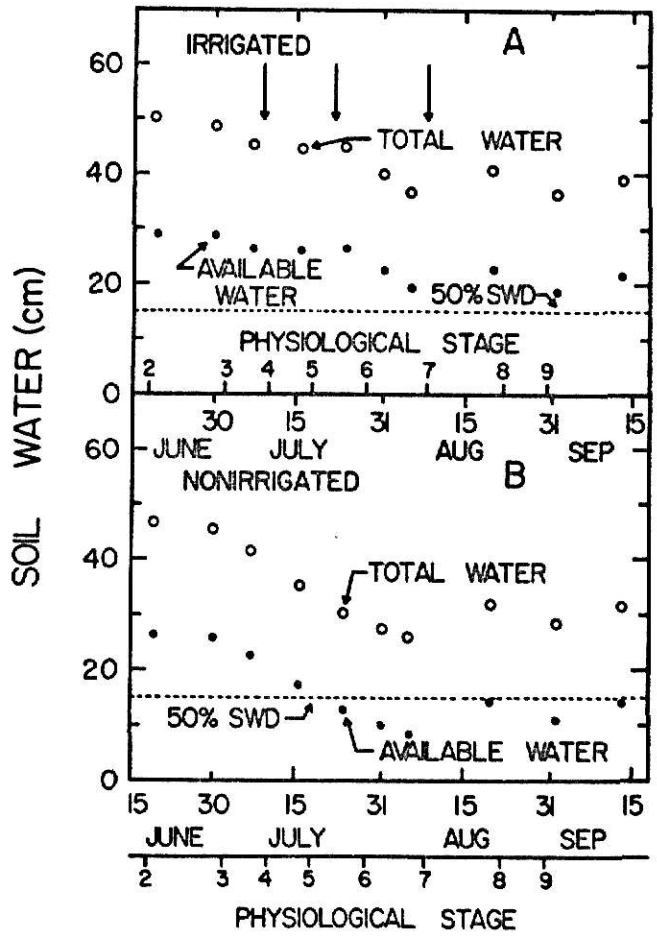


Fig. 2. Total water and available water in the 150 cm soil profile in relation to physiological stage and date under (A) irrigated and (B) nonirrigated conditions. 50% available soil water depletion (SWD) is illustrated by dotted lines. Vertical arrows indicate irrigation dates.

depths until stage 6.4 (August 1). The root depth in the crop row was deeper than the depth in the 1/3 row from stage 2.1 to stage 6.4 in both treatments. The 1/3 row depth caught up with the row depth at stage 6.4 and the two remained fairly equal throughout the rest of the season in both irrigated and nonirrigated sorghum (data not shown).

Total average root weight is plotted against physiological stage and date in Fig. 4. Initial increase in root dry matter was slow in both irrigated and nonirrigated sorghum. There was a slight increase in the rate of root dry matter accumulation between stages 2.9 and 3.8 (June 30 and July 8) and a sharp increase between stages 3.8 and 4.8 (July 8 and 16) in both treatments. The latter was the period of maximum root dry matter accumulation (0.61 g/1.08 dm^2 soil surface/day) in the nonirrigated treatment. The rate for the irrigated treatment during the same period was 0.68 g/1.08 dm^2 soil surface/day, but the maximum rate of 0.90 g/1.08 dm^2 soil surface/day occurred between stages 5.7 and 6.4 (July 25 and August 1) after the second irrigation on July 22. Increase in crown root weight and not lateral root proliferation accounted for the increase in root dry matter between stages 3.8 and 4.8. An examination of total root weight below the 7.5 cm depth showed that maximum lateral root proliferation occurred between stages 5.7 and 6.4 (July 25 and August 1) in the irrigated sorghum and between stages 4.8 and 5.7 (July 16 and 25) in the nonirrigated sorghum (data not shown).

A comparison of Figs. 2 and 4 will show that the available soil water declined as root dry matter increased in both irrigated and nonirrigated sorghum. The decrease in the irrigated treatment indicated that evapotranspiration exceeded water applied. Root dry matter in the irrigated sorghum reached a maximum at stage 6.4 (August 1). The available soil

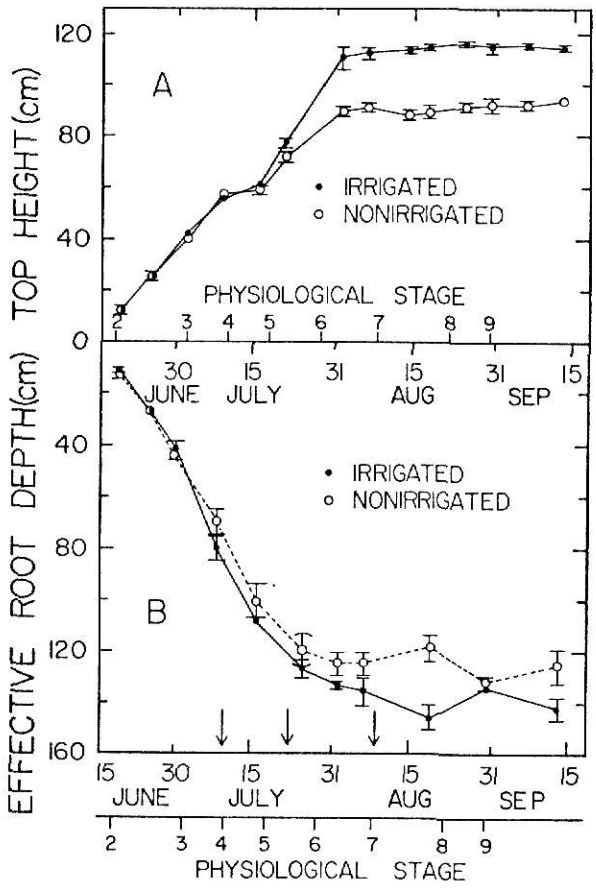


Fig. 3. Grain sorghum (A) top height and (B) root depth in relation to physiological stage and date under irrigated and nonirrigated conditions. Arrows indicate irrigation dates. Φ indicates standard error of the treatment mean.

water in the irrigated soil profile dropped to 19.3 cm on August 5. This was the second lowest recorded during the season (the lowest being 19.1 cm recorded on September 1). The available soil water in the nonirrigated soil profile dropped to 8.9 cm (the lowest of the season) on August 5 and maximum root dry matter in the nonirrigated sorghum was recorded on August 6. These are in line with the findings of Conrad and Veihmeyer (1929) who reported a correlation between the amount of sorghum roots and the extent to which the soil has been dried by root activity.

The major difference in root dry matter between irrigated and nonirrigated sorghum was in the top 15 cm of soil (Table 2). A maximum difference of 5.92 g/1.08 dm^2 soil surface occurred at stage 6.4 (August 1). From July 9 to maturity, slightly greater proportion of total root dry matter was accumulated in the 30-90 cm depth in the nonirrigated sorghum than in the irrigated sorghum. The major difference in root dry matter between the row and 1/3 row in both treatments was in the 0-30 cm depth. This suggests a uniform proliferation of roots below the 30 cm depth at the later stages of growth.

Description of Top Growth

Plant height for irrigated and nonirrigated sorghum is plotted according to physiological stage in Fig. 3. The data show that there was a rapid increase in top height (2.2 cm per day) between stages 2.1 and 3.8 (June 19 and July 9). The rate of increase in height decreased between stages 3.8 and 4.8 (July 9 and 16) the period after emergence of the flag leaf and prior to panicle emergence from the boot. Another rapid increase in height was observed between stages 4.8 and 6.4 (July 16 and August 1, associated with peduncle elongation) in both irrigated and nonirrigated sorghum. The

Table 2. Grain sorghum total root dry matter, mean combined values of samples in row and 1/3 row, as a function of depth and time under irrigated and nonirrigated conditions (g/1.08 dm^2 soil surface).

Sampling date	Depth (cm) 0-7.5	7.5-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	120-135	135-150	150-165	165-180	Total
Irrigated														
June 19		.113(0-15)*												.113
June 25		.503(0-15)*	T**											.503
June 30	.936	.025	.019	.003	.003									.985
July 8	3.991	.060	.065	.057	.038	.024	.010	.010	.003	.001	T			4.256
July 16	9.122	.242	.122	.078	.053	.032	.014	.006	.009	.008	.011	.004		9.701
July 25	9.098	.684	.333	.169	.122	.175	.080	.033	.016	.009	.004	.002		10.725
Aug. 1	14.266	1.180	.629	.280	.231	.189	.126	.068	.051	.025	.002			17.047
Aug. 6	13.086	.491	.266	.178	.127	.113	.149	.071	.038	.031	.015			14.565
Aug. 19	10.479	1.666	.367	.147	.117	.129	.142	.085	.040	.043	.015	.001		13.231
Aug. 30	10.401	.503	.360	.144	.099	.117	.103	.097	.061	.025	.004			11.914
Sep. 13	13.262	.960	.195	.103	.095	.094	.144	.120	.044	.046	.025	.001		15.089
Nonirrigated														
June 19		.103(0-15)*												.103
June 25		.665(0-15)*	.018											.683
June 30	1.540	.052	.019	T	.002									1.612
July 8	3.409	.045	.066	.029	.023	.007	.005	.005	.001	T	T			3.590
July 16	7.869	.242	.076	.078	.055	.057	.039	.010	.010	.001	T			8.437
July 25	8.065	.458	.274	.275	.198	.086	.079	.024	.003	.002				9.729
Aug. 1	9.951	.288	.110	.121	.153	.125	.109	.051	.045	.012	.008	.004		11.131
Aug. 6	11.115	.218	.166	.105	.166	.133	.103	.141	.084	.014	.003			12.248
Aug. 19	8.971	.580	.268	.098	.118	.116	.097	.142	.064	.026	.002			10.482
Aug. 30	5.381	.447	.137	.223	.142	.142	.114	.140	.078	.031	.004	T		6.839
Sep. 13	10.693	.533	.221	.082	.125	.134	.078	.109	.047	.016	.007			12.045

*The top 15 cm was not partitioned into 7.5 cm sections on the first 2 sampling dates.

**T = Trace.

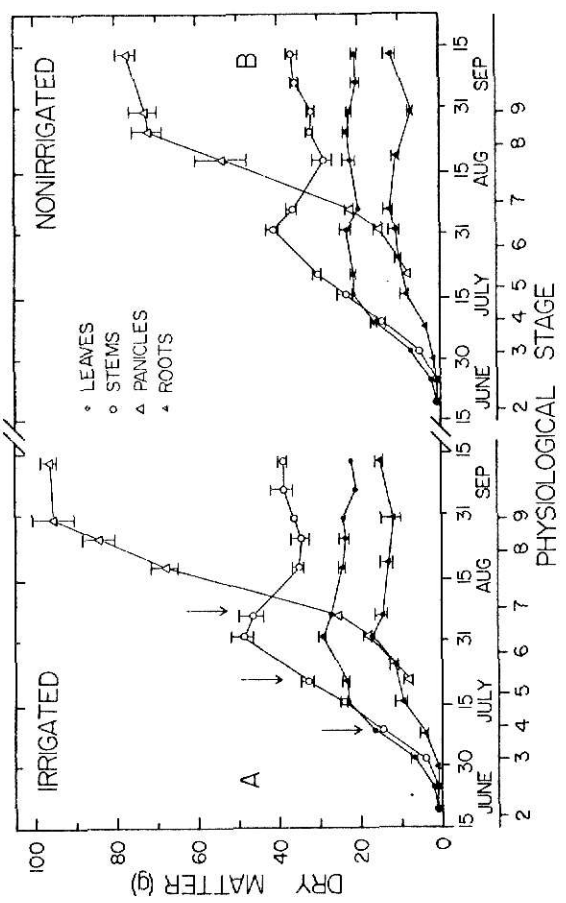


Fig. 4. Grain sorghum leaves, stems, and panicles (g/plant), and roots (g/1.08 dm^2 soil surface) dry matter in relation to physiological stage and date under (A) irrigated and (B) nonirrigated conditions. Arrows indicate irrigation dates. Φ indicates standard error of the treatment mean.

average increase in height between stages 4.8 and 6.4 was 3.1 cm per day in the irrigated sorghum and 1.9 cm per day in the nonirrigated sorghum. There was little increase in height in either treatment after stage 6.8 (August 6). The irrigated sorghum reached a maximum height of 116 cm and the non-irrigated sorghum reached a height of 94 cm.

Dry matter of leaves, stems, and panicles of irrigated and nonirrigated sorghum is plotted against physiological stage in Fig. 4. Initial increase in total top dry matter was slow in both treatments. There was a rapid increase in total top dry matter between stages 3 and 6.4 (July 2 and August 1) for both irrigated and nonirrigated sorghum. The average rate of increase in total dry matter during this period was 2.83 grams per plant per day for irrigated and 2.24 grams per plant per day for nonirrigated sorghum. Between stages 6.4 and 6.8 (August 1 and 6) the rate of increase in total dry matter decreased slightly in both irrigated and nonirrigated treatments. This was reflected as a decrease in stem weight in both treatments (Fig. 4), probably caused by the development of the inflorescence. Another sharp increase in total dry matter was observed in both treatments between stages 6.8 and 8.4 (August 6 and 25). This was due to accelerated dry matter accumulation in the panicle (Fig. 4). Physiological maturity was reached on August 30 in both irrigated and nonirrigated sorghum. A slight increase in total dry matter after physiological maturity may reflect the perennial nature of sorghum for we also observed that branches developed at the upper nodes during this period.

Leaf area index is plotted against physiological stage in Fig. 5. There was a sharp increase in leaf area index between stages 2.1 and 4.8 (June 19 and July 16) in both treatments. A maximum leaf area index of 5.0 in the irrigated and 4.9 in the nonirrigated sorghum was reached at

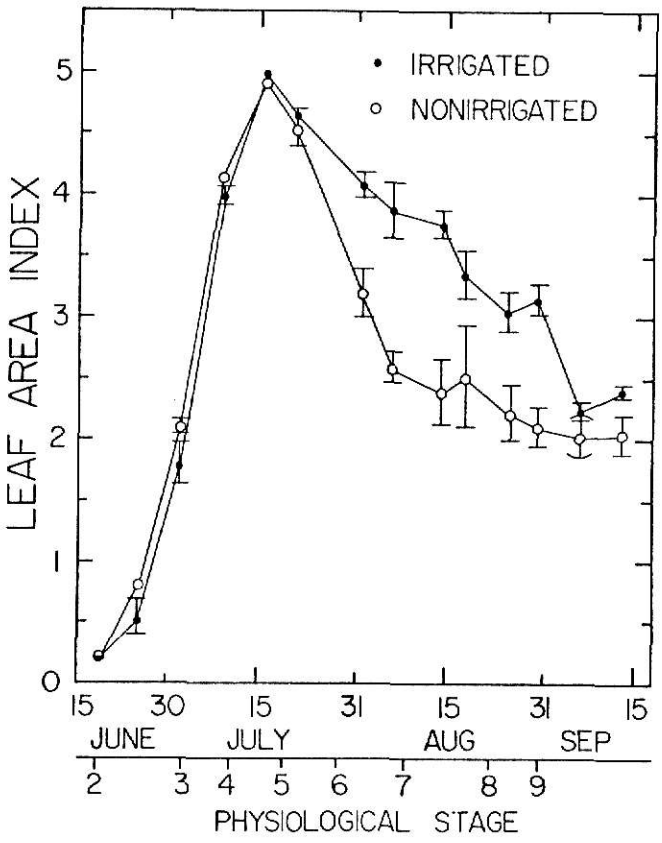


Fig. 5. Grain sorghum leaf area index in relation to physiological stage and date under irrigated and nonirrigated conditions. Φ indicates standard error of the treatment mean.

stage 4.8 (July 16). There was a sharp decrease in leaf area index in the nonirrigated treatment between stages 4.8 and 6.4 (July 16 and August 1) associated with lower leaf senescence during the dry period between June 23 and August 11. There was also a decrease in leaf area index in the irrigated treatment, but the decrease was smaller because of less lower leaf senescence and expansion of upper leaves. The greatest difference in leaf area between the two treatments occurred during the grain filling period (August 1 to 30, stages 6.4 to 9). Complete leaf cover was obtained in the irrigated sorghum at stage 5 (July 18) but canopy closure was so fleeting in the nonirrigated sorghum that we classified it as not closed. Dry leaves still attached to the plant at the time of sampling were taken and weighed as part of the plant so that the weight of leaves in both treatments remained fairly constant while leaf area index was declining (Figs. 4 and 5).

Average grain yield was 8073 kg/ha in the irrigated sorghum and 6165 kg/ha in the nonirrigated sorghum, at 12.5% moisture content by weight.

Relationship Between Root and Top Growth

Effective root depth and top height for irrigated and nonirrigated sorghum are plotted against physiological stage in Fig. 3.

Increase in root depth in the early stages of growth was faster than increase in top height in both treatments (Fig. 3). The average rate of root extension to the maximum depth between stages 2.1 and 3.8 (June 19 and July 8) was 7.0 cm per day (initial irrigation was on July 9). The average rate of root extension to the effective depth between stages 2.1 and 3.8 was 3.3 cm per day. The average rate of top height increase during this period was 2.2 cm per day. Top height reached 112 cm in the irrigated and 91 cm in the nonirrigated sorghum at stage 6.8 (August 6) and there was little increase

in height in either treatment thereafter. The average rate of increase in height between stages 2.1 and 6.8 (June 19 and August 6) was 2.1 cm per day in the irrigated and 1.64 cm per day in the nonirrigated sorghum. At stage 6.8 the effective root depth in the irrigated sorghum was 136 cm and 125 cm in the nonirrigated sorghum. The rate of root extension between stages 2.1 and 6.8 was 2.58 cm per day for irrigated and 2.33 cm per day for nonirrigated sorghum. Ratio of effective root depth to top height was greater in the nonirrigated treatment during most of the season. Effective root depth-top height ratio reached a maximum of 1.78 in the irrigated and 1.71 in the nonirrigated sorghum at stage 4.8 (July 16). The ratio dropped to 1.2 in the irrigated and 1.4 in the nonirrigated sorghum at stage 6.4 (August 1) and remained fairly constant throughout the rest of the season.

Initial increase in dry matter of both roots and tops was slow in both treatments (Fig. 4). The seasonal average increase in top dry matter was 1.82 g/plant/day in the irrigated and 1.55 g/plant/day in the nonirrigated sorghum. The average increase in root dry matter from the first sampling (June 19) to August 1 (stage 6.4) when a maximum was reached in the irrigated sorghum was 0.39 g/1.08 dm^2 soil surface/day. The average increase in root dry matter in the nonirrigated sorghum from June 19 to August 6 (stage 6.8) was 0.25 g/1.08 dm^2 soil surface/day. The root dry matter reached a maximum at stage 6.4 (August 1, 10 weeks after planting) in the irrigated and at stage 6.8 (August 6, 11 weeks after planting) in the nonirrigated sorghum then started to decline. Unlike the continuous decline observed in soybeans (Borst and Thatcher, 1931; Mayaki et al., 1976), we observed an increase in root matter after August 30 particularly in the crown which may be related to the perennial nature of sorghum. Stem dry matter also

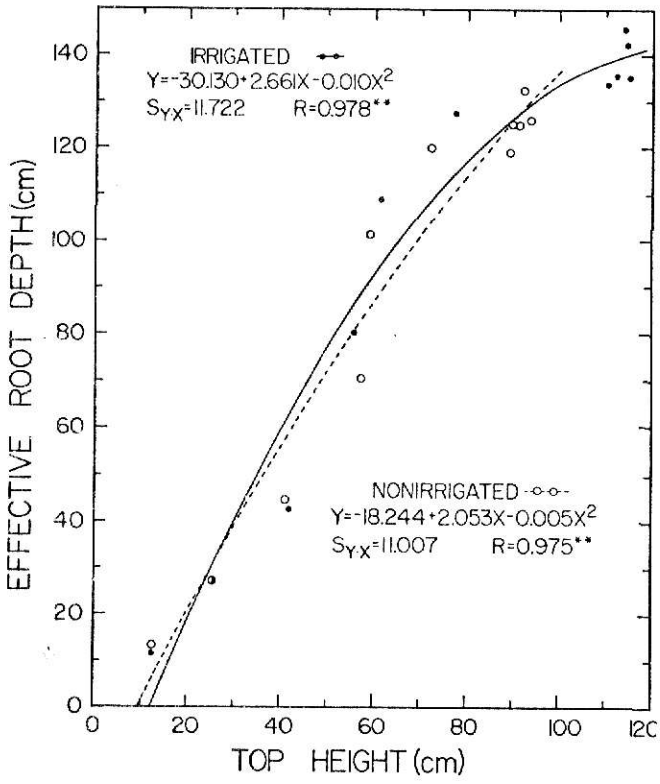


Fig. 6. Correlations between grain sorghum effective root depth and top height under irrigated and nonirrigated conditions.

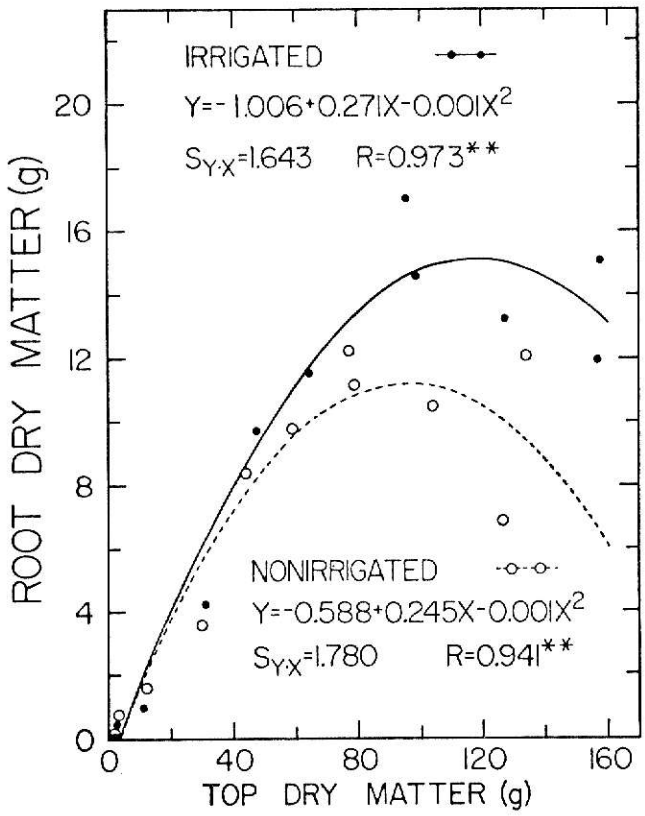


Fig. 7. Correlations between grain sorghum root dry matter (g/1.08 dm^2 soil surface) and top dry matter (g/plant) under irrigated and non-irrigated conditions.

increased at the end of the growing season in both treatments after a decline from maximum.

When maximum leaf area was attained between stages 4 and 5 there was large dry matter accumulation in both roots and tops in irrigated and non-irrigated sorghum.

Results of quadratic regression and correlation analysis with effective rooting depth and top height data are listed in Fig. 6. R values between root depth and top height were 0.978 with a standard error of 11.722 for irrigated sorghum and 0.975 with standard error of 11.007 for nonirrigated sorghum. Results of quadratic regression and correlation analysis with root dry matter and top dry matter data are reported in Fig. 7. R values between root and top dry matter were 0.973 and 0.941 with standard errors of 1.643 and 1.780 for irrigated and nonirrigated grain sorghum, respectively.

Even though there were high correlations between top growth parameters and root data, we do realize that plant growth characteristics may change with soil type, nutrient status of the soil, sorghum varieties, climatic factors, cultural practices, soil aeration, soil temperature, and water availability. However, we feel these field data will assist in understanding the development of the total grain sorghum plant.

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Chapter II

ROOT DEVELOPMENT AND WATER EXTRACTION OF FIVE GRAIN SORGHUM VARIETIES

ROOT DEVELOPMENT AND WATER EXTRACTION OF FIVE GRAIN SORGHUM VARIETIES[1/]

ABSTRACT

One method of scheduling irrigation is based on estimating soil moisture depletion from climate, soil, and crop data (Jensen et al., 1969). Root depth and ramification are important factors in determining the quantity of water which may be depleted before irrigation is required. This study was conducted to measure soil water depletion and root development of five grain sorghum varieties [Sorghum bicolor (L.) Moench cvs. RS610, NC42Y, Pioneer 846, F65A, and F61] and their interactions. Soil cores were collected for root determination with a tractor mounted coring machine on three dates during the growing season and roots washed free using 35 mesh screen. Soil water was determined in the 15 to 150 cm soil profile by neutron moderation and in the 0 to 15 cm layer by gravimetric sampling throughout the season. One Mercury manometer tensiometer was installed at 130 cm and one at 150 cm depth in each plot for determination of hydraulic potential.

At 41 days after planting between 95 and 98% of total root dry matter in all the varieties was in the top 15 cm. At 91 days after planting the proportion of total root dry matter in the top 15 cm varied from 88 to 91%. No significant differences in total root dry matter among varieties was observed on any of the sampling dates. There was no difference in rooting

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[1/] Contribution no._____, Kansas Water Resources Research Institute, Manhattan. The U.S. Department of Interior, Office of Water Research and Technology provided partial support. Contribution no._____, Department of Agronomy, Evapotranspiration Laboratory, Kansas Agricultural Experiment Station, Manhattan, Kansas 66506.

depth among varieties at 41 days after planting. Seventy days after planting, NC42Y was the deepest rooted, with roots at the 180 cm depth; F61 at 170 cm; F65A at 157 cm; and both RS610 and Pioneer 846 at 150 cm. NC42Y and F61 were significantly different from each other and from F65A, RS610 and Pioneer 846 at < 1% P. The shallow rooted varieties (RS610, Pioneer 846, and F65A) used more water in the 0 to 150 cm profile than the deeper rooted varieties (NC42Y and F61).

Additional index words: Soil water depletion, neutron moderation, hydraulic potential, tensiometer.

INTRODUCTION

Root depth and ramification are important factors in determining the quantity of water which may be depleted before irrigation is required. The amount of subsoil water used depends on several factors, four of which are (1) atmospheric demand; (2) the plant's ability to regulate the flow of water through the plant system; (3) exploitation of the subsoil reservoir by the root system; and (4) conductivity of the soil (Teare et al., 1973). Jamison (1956) also points out that available soil moisture supply depends on plant, climatic, and soil factors. The plant factors are drought resistance, root depth and ramification, plant vigor, and growth stage. Thus maximum use of soil moisture is possible only when plant roots proliferate in large volumes of soil. Without large root systems, plants are usually subjected to moisture stress, with resulting decrease in dry matter accumulation and yield. One method for scheduling irrigation is based on estimating soil moisture depletion from climate, soil, and crop data (Jensen et al., 1969).

The major concentration of sorghum roots occur within the surface 30 cm (Burton et al., 1954; Bloodworth et al., 1960; Nakayama and van Bavel, 1963; and Stone et al., 1973). Nakayama and van Bavel reported approximately 90% of the water and ^{32}P uptake by sorghum [Sorghum bicolor (L.) Moench cv. RS610] occurred from the upper 60% of the root zone in all of various irrigation treatments. Conrad and Veihmeyer (1929) reported a correlation between the amount of sorghum roots and the extent to which the soil had been dried by root activity.

The objective of this study was to measure soil water depletion and root development of five grain sorghum varieties and their interactions.

MATERIALS AND METHODS

Root systems of five grain sorghum varieties cvs. RS610 (smaller root), NC42Y (deeper roots), Pioneer 846, F65A (lesser roots) and F61 (good root system)[2/] were sampled on three dates during the growing season. The study was conducted on the Ashland Agronomy farm 14 km south of Manhattan, Kansas. The soil is Muir silt loam (fine-silty, mixed, mesic, Pachic Haplustoll).

All varieties were planted on May 21, 1975 in rows 75 cm apart and 12.2 M long, and thinned to a population of 10 plants per meter. A completely randomized block design was used, with three plots allotted to each variety. Each plot received 11 cm of irrigation water applied 61 days after planting (July 21). Water was metered into basins using gated pipe. Physiological stages were recorded as described by Vanderlip (1972).

Soil cores were collected for root determination using a tractor mounted coring machine.[3/] The coring tube had an internal diameter of 8.3 cm. Two samples were collected from each plot giving six samples for each variety. Each sample consisted of a composite of two cores, one centered on one sorghum plant in the row and another 25 cm perpendicular from the crop row (1/3 row width). The soil cores were partitioned with depth into 15 cm increments. The top 15 cm was further partitioned into two 7.5 cm sections. Roots were washed free from soil using 35 mesh screen. Plant tops were sampled for height, leaf area index, and dry weight, at 42, 62, 89, 103, and 118 days after planting. Leaf area was measured with a leaf area meter.[4/]

[2/] Maunder, A. B. Personal communication. March 1975.

[3/] The Giddings Model G. S. Soil Sampling Machine by the Giddings Machine Company, Ft. Collins, Colorado.

[4/] Automatic leaf area meter, Model AAM-5 by Hayashi Co., Ltd., Tokyo, Japan.

Plant height was measured from ground surface to the uppermost leaf whorl before panicle emergence and from ground surface to the tip of the inflorescence after panicle emergence. The tops were partitioned into leaves, stems, and panicles. Dry weights were determined by oven drying at 100 C.

Soil water content was determined in the 15 to 150 cm soil profile at 15 cm intervals by neutron moderation and in the 0 to 15 cm layer by gravimetric sampling. One access tube was placed in the center of each plot. Available water in the root zone was estimated as the soil water held between -0.2 and -15 bars soil water potential. One Mercury manometer tensiometer was installed in the crop row at the 130 cm and one at the 150 cm depth in each plot for determination of hydraulic potential. Hydraulic potential is listed with the ground surface as the reference level.

Grain yield was obtained from four meters of the two center rows of each plot.

RESULTS AND DISCUSSION

Root dry matter with depth and time is shown in table 1. On July 1 between 90 and 97% of the total root dry matter was in the top 7.5 cm and 95 to 98% was in the top 15 cm. On this date all varieties except RS610 were approaching stage 3 (growing point differentiation). RS610 reached stage 3 on June 27. Total root dry matter at this stage varied from 0.8 g/1.08 dm^2 soil surface for NC42Y to 1.6 g/1.08 dm^2 soil surface for RS610. By August 20, the proportion of total root dry matter in the top 15 cm varied from 88 to 91%. Total root dry matter at this time varied from 7.9 g/1.08 dm^2 soil surface for RS610 to 11.6 g/1.08 dm^2 soil surface for NC42Y. All varieties except NC42Y had a higher total root dry matter on July 30 than on

either July 1 or August 20. NC42Y had about the same total root dry matter on August 20 as on July 30. The higher total root dry matter for RS610 and Pioneer 846 on July 1 was due to crown roots. RS610 had the least total root dry matter during the two later sampling dates. The differences in total root dry matter among the varieties were not significant on any one sampling date (by the F test).

Rooting depth for the five varieties on the three sampling dates is given in table 2. There was no significant difference in rooting depth among varieties on July 1. By July 30 NC42Y was the deepest rooted, followed by F61, F65A, Pioneer 846 and RS610. There was no significant difference in rooting depth between F65A, Pioneer 846, and RS610 but NC42Y and F61 were significantly different from each other and from the other three varieties at < 1% P. On July 30 NC42Y had roots at the 180 cm depth, F61 at 170 cm, F65A at 157 cm and both Pioneer 846 and RS610 at 150 cm. Rooting depth for all the varieties on August 20 was about the same as on July 30. Though F61 was deeper-rooted than F65A the latter had slightly greater total root dry matter on all sampling dates. RS610 and Pioneer 846 had the shallowest roots but Pioneer 846 had slightly greater total root dry matter than RS610 on July 30 and August 20. Except for differences in rooting depths, root dry matter distribution with depth was similar for all the varieties [Tables 2 and 3].

Table 4 shows total heads measured at the 130 and 150 cm depth with the soil surface as a reference. The data show the soil was consistently drier under RS610 and F65A, relatively moist under F61 and NC42Y, and Pioneer 846 was in-between, at both the 130 and 150 cm depths. This may not entirely reflect the pattern of water extraction by the roots as water can move from one depth increment to another independently of plant root extraction (Stone

et al., 1976). However, moisture extraction by plant roots dominate over Darcian flow, with dominance increasing as moisture content decreased (Molz and Remson, 1971). NC42Y and F61 being deeper rooted may be getting some of their moisture requirements below the 150 cm depth.

Tables 5 and 6 show the total and available water in the 150 cm soil profile under the five varieties. Total soil water content in each depth increment under all varieties decreased from June 19 to August 1, and available water decreased or remained the same. Rainfall during the period June 19 to August 1 was very limited (Table 7). Total and available water in the top 60 cm increased under all varieties from August 1 to August 20 but decreased or remained the same below 60 cm. This increase was due to a total of 6.6 cm of rain on August 12 and 13 (Table 7). RS610 had the least total and available water in the 150 cm soil profile on all sampling dates, followed by F65A, Pioneer 846, F61 and NC42Y in increasing order. This does not show a direct relationship between the amount of roots and the extent to which the soil had been dried as we observed in an earlier study with irrigated and nonirrigated grain sorghum (cv. Pioneer 846). This may be due to differences in maturity of the varieties. RS610 being earlier maturing required more water relatively earlier in the season for grain filling. The shallow rooted varieties (RS610, Pioneer 846, and F65A) used more water in the 0 to 150 cm profile than the deeper rooted varieties (NC42Y and F61). This may be due to the latter varieties obtaining some of their moisture requirement below the 150 cm depth.

Table 1. Root dry matter, mean combined values of samples in row and 1/3 row, as a function of depth and time under five grain sorghum varieties (g/1.08 dm^2 soil surface).

	Variety														
	RS610			NC42Y			Pioneer 846			F65A			F61		
Depth (cm)	July 1	July 30	Aug. 20	July 1	July 30	Aug. 20	July 1	July 30	Aug. 20	July 1	July 30	Aug. 20	July 1	July 30	Aug. 20
0-7.5	1.581	8.249	6.418	0.707	9.876	9.676	1.328	10.520	7.872	1.169	11.114	8.135	0.794	10.005	7.653
7.5-15	.036	.539	.542	.037	.481	.822	.031	.512	.787	.088	.777	.739	.033	.746	.745
15-30	.017	.348	.147	.019	.186	.155	.027	.148	.182	.017	.294	.296	.021	.365	.199
30-45	T*	.144	.116	.012	.171	.122	.015	.111	.110	.007	.147	.133	.004	.164	.145
45-60	T	.211	.136	.004	.158	.152	.003	.168	.147	.001	.211	.164	.001	.187	.169
60-75	T	.310	.171	.001	.204	.176	T	.181	.115	T	.195	.164	T	.209	.235
75-90		.174	.137	T	.168	.152		.108	.158		.253	.163		.141	.124
90-105		.103	.094		.074	.131		.055	.071		.135	.156		.076	.115
105-120		.076	.068		.069	.104		.058	.060		.083	.103		.072	.103
120-135		.027	.052		.063	.048		.031	.025		.051	.042		.059	.061
135-150		.009	.008		.041	.035		.011	.006		.024	.023		.026	.042
150-165		.001	.001		.027	.010		.002	.001		.014	.003		.015	.015
165-180					.009	.002						T		.003	.000
180-195					.001	.000									
Total	1.634	10.191	7.890	0.780	11.528	11.585	1.404	11.905	9.534	1.282	13.298	10.121	0.853	12.068	9.606

*T = Trace

Table 2. In-row and 1/3 row maximum rooting depth as a function of time in five varieties of grain sorghum (cm).

RS610

	Plot														
	51				55				59						
Date	R1	R2	1/3R1	1/3R2	R1	R2	1/3R1	1/3R2	R1	R2	1/3R1	1/3R2	$\bar{X}$	S	$S/\sqrt{n}$
July 1	50	55	30	53	53	53	45	45	60	65	65	62	53.00	9.95	2.87
July 30	149	155	148	156	140	155	155	138	154	150	150	160	150.83	6.52	1.88
Aug. 20	151	150	140	155	143	170	156	160	140	150	165	135	151.25	10.63	3.07

NC42Y

	Plot														
	57				61				64						
Date	R1	R2	1/3R1	1/3R2	R1	R2	1/3R1	1/3R2	R1	R2	1/3R1	1/3R2	$\bar{X}$	S	$S/\sqrt{n}$
July 1	35	40	60	42	51	56	57	80	50	54	48	66	53.25	12.15	3.51
July 30	191	185	186	188	183	184	170	187	170	190	185	180	183.25	6.86	1.98
Aug. 20	195	170	190	180	180	187	165	187	180	194	190	180	183.17	9.16	2.64

Pioneer 846

	Plot														
	52				58				62						
Date	R1	R2	1/3R1	1/3R2	R1	R2	1/3R1	1/3R2	R1	R2	1/3R1	1/3R2	$\bar{X}$	S	$S/\sqrt{n}$
July 1	60	49	40	36	63	59	45	30	56	57	45	58	49.83	10.64	3.072
July 30	151	160	145	162	160	150	148	145	144	161	163	140	152.42	8.28	2.39
Aug. 20	154	145	140	160	150	154	144	155	155	150	148	165	151.67	7.00	2.02

Table 2. (continued)

F65A

Date	Plot 53 R1	53 R2	53 1/3R1	53 1/3R2	54 R1	54 R2	54 1/3R1	54 1/3R2	60 R1	60 R2	60 1/3R1	60 1/3R2	$\bar{X}$	S	$S/\sqrt{n}$
July 1	55	51	54	50	56	45	51	57	65	69	55	64	56.00	6.93	2.00
July 30	158	170	140	160	141	178	150	155	168	156	152	160	157.33	11.17	3.22
Aug. 20	168	160	165	165	158	150	154	165	150	170	141	174	160.00	9.71	2.80

F61

Date	Plot 56 R1	56 R2	56 1/3R1	56 1/3R2	63 R1	63 R2	63 1/3R1	63 1/3R2	65 R1	65 R2	65 1/3R1	65 1/3R2	$\bar{X}$	S	$S/\sqrt{n}$
July 1	36	42	42	40	59	57	62	63	56	45	49	49	50.00	9.20	2.66
July 30	170	169	184	156	171	169	185	160	170	177	181	169	171.75	8.81	2.54
Aug. 20	165	174	170	171	170	172	160	174	180	170	180	160	170.50	6.46	1.86

Table 3. Percentage of root dry matter as a function of depth and time in five varieties of grain sorghum.

	Variety														
	RS610			NC42Y			Pioneer 846			F65A			F61		
Depth (cm)	July 1	July 30	Aug. 20	July 1	July 30	Aug. 20	July 1	July 30	Aug. 20	July 1	July 30	Aug. 20	July 1	July 30	Aug. 20
0-7.5	96.8	80.9	81.3	90.6	85.7	83.5	94.6	88.4	82.6	91.2	83.6	80.4	93.1	82.9	79.7
7.5-15	2.2	5.3	6.7	4.7	4.2	7.1	2.2	4.3	8.2	6.9	5.8	7.3	3.9	6.2	7.8
15-30	1.0	3.4	1.9	2.4	1.6	1.3	1.9	1.2	1.9	1.3	2.2	2.9	2.5	3.0	2.1
30-45		1.4	1.5	1.5	1.5	1.1	1.1	0.9	1.2	0.5	1.1	1.3	0.5	1.4	1.5
45-60		2.1	1.7	0.5	1.4	1.3	0.2	1.4	1.5	0.1	1.6	1.6	0.1	1.5	1.8
60-75		3.0	2.2	0.1	1.8	1.5		1.5	1.2		1.5	1.6		1.7	2.4
75-90		1.7	1.7		1.5	1.3		0.9	1.7		1.9	1.6		1.2	1.3
90-105		1.0	1.2		0.6	1.1		0.5	0.7		1.0	1.5		0.6	1.2
105-120		0.8	0.9		0.6	0.9		0.5	0.6		0.6	1.0		0.6	1.1
120-135		0.3	0.7		0.5	0.4		0.3	0.3		0.4	0.4		0.5	0.6
135-150		0.1	0.1		0.3	0.3		0.1	0.1		0.2	0.2		0.2	0.4
150-165					0.2	0.1					0.1			0.1	0.1
165-180					0.1										
180-195															
Total	100.0	100.0	99.9	99.8	100.0	99.9	100.0	100.0	100.0	100.0	100.0	99.8	100.1	99.9	100.0

Table 4. Total head referenced to the soil surface measured with tensiometers placed at 130 and 150 cm depths under five varieties of grain sorghum (cm H_2O).

RS610

Date	130 cm Plot 51	55	59	$\bar{X}$	S	150 cm Plot 51	55	59	$\bar{X}$	S
July 1	262.8	273.8	271.5	269.4	5.8	264.0	276.3	286.5	275.6	11.3
2	265.3	276.3	275.3	272.3	6.1	269.0	282.5	295.3	282.3	13.2
7	275.3	283.8	280.3	279.8	4.3	281.5	292.5	307.8	293.9	13.2
8	276.5	283.8	281.5	280.6	3.7	282.8	310.0	296.5	296.4	13.6
9	272.8	281.3	274.0	276.0	4.6	279.0	282.5	277.8	279.8	2.4
10	272.8	282.5	275.3	276.9	5.0	280.3	283.8	276.5	280.2	3.7
11	277.8	285.0	277.8	280.2	4.2	282.8	286.3	277.8	282.3	4.3
14	287.8	290.0	285.3	287.7	2.4	291.5	292.5	281.5	288.5	6.1
15	297.8	293.8	287.8	293.1	5.0	300.3	295.0	284.0	293.1	8.3
16	297.8	297.5	292.8	296.0	2.8	299.0	297.5	286.5	294.3	6.8
17	304.0	300.0	297.8	300.6	3.1	304.0	301.3	287.8	297.7	8.7
18	310.3	305.0	302.8	306.0	3.9	307.8	305.0	291.5	301.4	8.7
21	331.5	316.3	317.8	321.9	8.4	324.0	318.8	302.8	315.2	11.0
23	325.3	323.8	320.3	323.1	2.6	315.3	325.0	306.5	315.6	9.3
24	331.5	326.3	320.3	326.0	5.6	320.3	330.0	307.8	319.4	11.1
25	332.8	326.3	320.3	326.5	6.3	325.3	330.0	306.5	320.6	12.4
28	342.8	331.3	325.3	331.1	8.9	336.5	338.8	312.8	329.4	14.4
29	345.3	302.5	326.5	324.8	21.5	344.0	341.3	314.0	333.1	16.6
30	352.8	336.3	330.3	339.8	11.7	350.3	346.3	319.0	338.5	17.0
31	351.5	338.8	330.3	340.2	10.7	355.3	346.3	317.8	339.8	19.6
Aug. 1	356.5	342.5	332.8	343.9	11.9	360.3	348.8	319.0	342.7	21.3
4	365.3	351.3	337.8	351.5	13.8	364.0	355.0	321.5	346.8	22.4
6	376.5	363.8	342.8	361.0	17.0	379.0	365.0	326.5	356.8	27.2
7	381.5	370.0	345.3	365.6	18.5	382.8	370.0	326.5	359.8	29.5
8	390.3	377.5	349.0	372.3	21.1	389.0	375.0	331.5	365.2	30.0
11	429.0	403.8	365.3	399.4	32.1	429.0	392.5	339.0	386.8	45.3
12	450.3	415.0	375.3	413.5	37.5	461.5	403.8	342.8	402.7	59.4
13	484.0	428.8	389.0	433.9	47.7	520.3	407.5	351.5	426.4	86.0
15	479.0	428.8	372.8	426.9	53.1	427.8	406.3	340.3	391.5	45.6
18	477.8	423.8	356.5	419.4	60.8	411.5	402.5	336.5	383.5	41.0
19	485.3	426.3	365.3	425.6	60.0	427.8	416.3	344.0	396.0	45.4
20	481.5	423.8	356.5	420.6	62.6	427.8	411.3	339.0	392.7	47.2
21	487.8	425.0	354.0	422.3	66.9	436.5	416.3	339.0	397.3	51.5
22	495.3	426.3	357.8	426.5	68.8	446.5	420.0	342.8	403.1	53.9
26	535.3	438.8	371.5	448.5	82.3	477.8	437.5	350.3	421.9	65.2
27	524.0	435.0	356.5	438.5	83.8	447.8	421.3	344.0	404.4	53.9
29	525.3	440.0	359.0	441.4	83.2	451.5	418.8	352.8	407.7	50.3
Sep. 2	549.0	438.8	362.8	450.2	93.6	475.3	430.0	355.3	420.2	60.6
3	562.8	447.5	376.5	462.3	94.0	486.5	438.8	357.8	427.7	65.1
6	566.5	441.3	360.3	456.0	103.9	480.3	385.0	352.8	406.0	66.3
8	451.5	447.5	369.0	422.7	46.5	---	428.8	356.5	392.7	51.1
9	445.3	446.3	361.5	417.7	48.7	---	422.5	351.5	387.0	50.2

Table 4. (continued)

		NC42Y									
		130 cm					150 cm				
		Plot			$\bar{X}$	S	Plot			$\bar{X}$	S
Date		57	61	64			57	61	64		
July	1	---	268.0	232.5	250.3	25.1	271.3	254.3	235.0	253.5	18.2
	2	---	276.8	226.3	251.6	35.7	272.5	255.5	233.8	253.9	19.4
	7	---	269.3	231.3	250.3	26.9	276.3	255.5	243.8	258.5	16.5
	8	273.8	269.3	238.8	260.6	19.0	271.3	260.5	242.5	258.1	14.5
	9	273.8	259.3	237.5	256.9	18.3	272.5	258.0	237.5	256.0	17.6
	10	275.0	259.3	242.5	258.9	16.3	272.5	258.0	238.8	256.4	16.9
	11	280.0	260.5	243.8	261.4	18.1	273.8	259.3	241.3	258.1	16.3
	14	292.5	263.0	246.3	267.3	23.4	276.3	261.8	242.5	260.2	17.0
	15	301.3	263.0	236.3	266.9	32.7	278.8	264.3	233.8	259.0	23.0
	16	311.3	266.8	252.5	276.9	30.7	280.0	265.5	247.5	264.3	16.3
	17	321.3	268.0	255.0	281.4	35.1	283.8	268.0	250.0	267.3	16.9
	18	330.0	270.5	258.8	286.4	38.2	287.5	269.3	252.5	269.8	17.5
	21	352.5	278.0	266.3	298.9	46.8	293.8	276.8	265.0	278.5	14.5
	23	345.0	278.0	268.8	297.3	41.6	298.8	279.3	268.8	282.3	15.2
	24	347.5	279.3	270.0	298.9	42.3	300.0	279.3	268.8	282.7	15.9
	25	343.8	281.8	271.3	299.0	39.2	301.3	280.5	270.0	283.9	15.9
	28	342.5	285.5	277.5	301.8	35.4	305.0	285.5	280.0	290.2	13.1
	29	345.0	288.0	280.0	304.3	35.4	306.3	286.8	282.5	291.9	12.7
	30	348.8	293.0	281.3	307.7	36.1	308.8	290.5	285.0	294.8	12.5
	31	347.5	293.0	283.8	308.1	34.4	333.8	290.5	281.3	301.9	28.0
Aug.	1	352.5	295.5	287.5	311.8	35.4	312.5	291.8	282.5	295.6	15.4
	4	356.3	298.0	291.3	315.2	35.8	315.0	296.8	290.0	300.6	12.9
	6	365.0	303.0	297.5	321.8	37.5	317.5	300.5	295.0	304.3	11.7
	7	367.5	305.5	298.8	323.9	37.9	320.0	303.0	296.3	306.4	12.2
	8	371.3	308.0	301.3	326.9	38.6	322.5	305.5	298.8	308.9	12.2
	11	382.5	319.3	311.3	337.7	39.0	332.5	314.3	302.5	316.4	15.1
	12	392.5	323.0	317.5	344.3	41.8	337.5	319.3	305.0	320.6	16.3
	13	405.0	330.5	323.8	353.1	45.1	342.5	324.3	315.0	327.3	14.0
	15	381.3	328.0	322.5	343.9	32.5	342.5	323.0	311.3	325.6	15.8
	18	372.5	325.5	323.8	340.6	27.6	338.8	321.8	312.5	324.4	13.3
	19	380.0	331.8	330.0	347.3	28.4	345.0	329.3	318.8	331.0	13.2
	20	373.8	330.5	330.0	344.8	25.1	338.8	326.8	317.5	327.7	10.7
	21	375.0	396.8	355.0	375.6	20.9	341.3	350.5	352.5	348.1	6.0
	22	375.0	331.8	341.3	349.4	22.7	342.5	328.0	322.5	331.0	10.3
	26	383.8	343.0	341.3	356.0	24.1	348.8	336.8	327.5	337.7	10.7
	27	376.3	336.8	332.5	348.5	24.1	343.8	331.8	316.3	330.6	13.8
	29	377.5	338.0	341.3	352.3	21.9	346.3	335.5	322.5	334.8	11.9
Sep.	2	378.8	343.0	346.3	356.0	19.8	346.3	338.0	328.8	337.7	8.8
	3	390.0	353.0	353.8	365.6	21.1	353.8	346.8	338.8	346.5	7.5
	6	380.0	339.3	346.3	355.2	21.8	347.5	336.8	331.3	338.5	8.2
	8	385.0	341.8	350.0	358.9	22.9	350.0	341.8	341.3	344.4	4.9
	9	382.5	340.5	350.0	357.7	22.0	348.8	341.8	335.0	341.9	6.9

Table 4. (continued)

Pioneer 846											
	130 cm					150 cm				
	Plot			$\bar{X}$	S	Plot			$\bar{X}$	S
Date	52	58	62			52	58	62		
July 1	270.3	266.3	235.0	257.2	19.3	276.5	268.8	238.8	261.4	19.9
2	267.8	268.8	246.3	261.0	12.7	277.8	267.5	248.8	264.7	14.7
7	291.5	275.0	257.5	274.7	17.0	296.5	277.5	258.8	277.6	18.9
8	297.8	277.5	257.5	277.6	20.2	301.5	278.8	257.5	279.3	22.0
9	284.0	276.3	253.8	271.4	15.7	285.3	273.8	255.0	271.4	15.3
10	282.8	277.5	253.8	271.4	15.4	285.3	276.3	255.0	272.2	15.6
11	285.3	277.5	255.0	272.6	15.7	289.0	276.3	256.3	273.9	16.5
14	294.0	281.3	260.0	278.4	17.2	296.5	281.3	258.8	278.9	19.0
15	299.0	287.5	261.3	282.6	19.3	297.8	285.0	261.3	281.4	18.5
16	304.0	291.3	263.8	286.4	20.5	304.0	287.5	262.5	284.7	20.9
17	309.0	293.8	266.3	289.7	21.6	307.8	290.0	266.3	288.0	20.8
18	314.0	296.3	270.0	293.4	22.1	310.3	295.0	268.8	291.4	21.0
21	332.8	300.0	280.0	304.3	26.7	324.0	301.3	276.0	300.4	24.0
23	345.3	302.5	282.5	310.1	32.1	337.8	306.3	278.8	307.6	29.5
24	347.8	303.8	286.3	312.6	31.7	347.8	307.5	281.3	312.2	33.5
25	345.3	305.0	285.0	311.8	30.7	342.8	307.5	281.3	310.5	30.9
28	354.0	311.3	290.0	318.4	32.6	352.8	313.8	288.8	318.5	32.3
29	354.0	308.8	292.5	318.4	31.9	356.5	316.3	290.0	320.9	33.5
30	362.8	310.0	296.3	323.0	35.1	366.5	318.8	295.0	326.8	36.4
31	367.8	312.5	297.5	325.9	37.0	364.0	318.8	296.3	326.4	34.5
Aug. 1	371.5	313.8	298.8	328.0	38.4	375.3	323.8	295.0	331.4	40.7
4	377.8	317.5	301.3	332.2	40.3	380.3	327.5	297.5	335.1	41.9
6	392.8	326.3	307.5	342.2	44.8	381.5	340.0	301.3	340.9	40.1
7	396.5	321.3	308.8	342.2	47.4	382.8	336.3	297.5	338.9	42.7
8	400.3	327.5	310.0	345.9	47.9	386.5	336.3	305.0	342.6	41.1
11	416.5	342.5	318.8	359.3	51.0	391.5	336.3	312.5	346.8	40.5
12	429.0	346.3	321.3	365.5	56.4	405.3	341.3	316.3	354.3	45.9
13	454.0	350.0	326.3	376.8	67.9	440.3	350.0	318.8	369.7	63.1
15	425.3	341.3	327.5	364.7	52.9	402.8	338.8	318.8	353.5	43.9
18	417.8	336.3	332.5	362.2	48.2	391.5	330.0	323.8	348.4	37.4
19	435.3	340.0	332.5	369.3	57.3	481.5	341.3	326.3	383.0	85.6
20	430.3	335.0	332.5	365.9	55.8	409.0	332.5	326.3	355.9	46.1
21	429.0	336.3	335.0	366.8	53.9	407.8	332.5	331.3	357.2	43.8
22	425.3	330.0	335.0	363.4	53.6	416.5	327.5	330.0	358.0	50.7
26	435.3	338.8	338.8	371.0	55.7	441.5	332.5	333.8	369.3	62.6
27	422.8	333.8	338.8	365.1	50.0	415.3	321.3	332.5	356.4	51.3
29	425.3	335.0	341.3	367.2	50.4	417.8	323.8	337.5	359.7	50.8
Sep. 2	444.0	336.3	346.3	375.5	59.5	434.0	325.0	338.8	365.9	59.3
3	462.8	350.0	356.3	389.7	63.4	442.8	341.3	343.8	376.0	57.9
6	432.8	---	341.3	387.1	64.7	432.8	327.5	332.5	364.3	59.4
8	447.8	---	347.5	397.7	70.9	440.3	338.8	---	389.6	71.8
9	445.3	---	348.8	397.1	68.2	437.8	335.0	---	386.4	72.7

Table 4. (continued)

		F65A									
		130 cm					150 cm				
		Plot			$\bar{X}$	S	Plot			$\bar{X}$	S
Date		53	54	60			53	54	60		
July	1	272.8	266.3	262.5	267.2	5.2	276.5	263.8	272.5	270.9	6.5
	2	270.3	270.0	263.8	268.0	3.7	272.8	267.5	272.5	270.9	3.0
	7	284.0	281.3	271.3	278.9	6.7	281.5	275.0	280.0	278.8	3.4
	8	284.0	277.5	271.3	277.6	6.4	280.3	273.8	280.0	278.0	3.7
	9	277.8	270.0	267.5	271.8	5.4	280.3	271.3	270.0	273.9	5.6
	10	279.0	270.0	268.8	272.6	5.6	279.0	270.0	270.0	273.0	5.2
	11	282.8	272.5	271.3	275.5	6.3	282.8	273.8	272.5	276.4	5.6
	14	291.5	300.0	281.3	290.9	9.4	285.3	278.8	277.5	280.5	4.2
	15	294.0	282.5	286.3	287.6	5.9	292.8	281.3	280.0	284.7	7.0
	16	299.0	286.3	291.3	292.2	6.4	295.3	283.8	283.8	287.6	6.6
	17	302.8	288.8	293.8	295.1	7.1	299.0	286.3	286.3	290.5	7.3
	18	306.5	295.0	307.5	303.0	6.9	302.8	290.0	290.0	294.3	7.4
	21	326.5	317.5	322.5	322.2	4.5	315.3	300.0	298.8	304.7	9.2
	23	332.8	318.8	325.0	325.5	7.0	320.3	310.0	306.3	312.2	7.3
	24	336.5	322.5	328.8	329.3	7.0	324.0	312.5	306.3	314.3	9.0
	25	336.5	321.3	327.5	328.4	7.6	325.3	313.8	308.8	316.0	8.5
	28	345.3	323.8	328.8	332.6	11.3	336.5	322.5	311.3	323.4	12.6
	29	350.3	320.0	330.0	333.4	15.4	339.0	325.0	312.5	325.5	13.3
	30	359.0	331.3	332.5	340.9	15.7	345.3	330.0	315.0	330.1	15.2
	31	361.5	332.5	332.5	342.2	16.7	345.3	328.8	316.3	330.1	14.5
Aug.	1	370.3	337.5	333.8	347.2	20.1	347.8	333.8	315.0	332.2	16.5
	4	371.5	348.8	333.8	351.4	19.0	357.8	342.5	318.8	339.7	19.7
	6	399.0	365.0	350.0	371.3	25.1	372.8	352.5	322.5	349.3	25.3
	7	411.5	370.0	352.5	378.0	30.3	377.8	357.5	323.8	353.0	27.3
	8	420.3	377.5	360.0	385.9	31.0	391.5	370.0	325.0	362.2	33.9
	11	464.0	395.0	378.8	412.6	45.2	405.3	380.0	335.0	373.4	35.6
	12	494.0	407.5	383.8	428.4	58.0	420.3	387.5	338.8	382.2	41.0
	13	537.8	433.8	386.3	452.6	77.5	444.0	408.8	341.3	398.0	52.2
	15	501.5	412.5	361.3	425.1	70.9	426.5	371.3	341.3	379.7	43.2
	18	477.8	395.0	357.5	410.1	61.6	426.5	373.8	345.0	381.8	41.3
	19	487.8	418.8	362.5	423.0	62.8	437.8	385.0	345.0	389.3	46.5
	20	479.0	432.5	361.3	424.3	59.3	435.3	382.5	345.0	387.6	45.4
	21	479.0	417.5	356.3	417.6	61.4	434.0	387.5	340.0	387.2	47.0
	22	481.5	421.3	362.5	421.7	59.4	437.8	391.3	347.5	392.2	45.2
	26	535.3	438.8	358.8	444.3	88.4	466.5	431.3	350.0	390.7	57.5
	27	511.5	420.0	358.8	430.1	76.8	429.0	392.5	350.0	390.5	39.5
	29	511.5	426.3	362.5	433.4	74.8	449.0	397.5	352.5	399.7	48.3
Sep.	2	662.8	432.5	365.0	486.8	156.1	455.3	407.5	353.8	405.5	50.8
	3	682.8	442.5	372.5	499.3	162.8	475.3	433.8	356.3	421.8	60.4
	6	769.0	426.3	358.8	518.0	219.9	459.0	403.8	355.0	405.9	52.0
	8	749.0	441.3	363.8	518.0	203.7	475.3	428.8	358.5	420.9	58.8
	9	744.0	436.3	362.5	514.3	202.3	469.0	411.3	357.5	412.6	55.8

Table 4. (continued)

	F61									
	130 cm					150 cm				
	Plot			$\bar{X}$	S	Plot			$\bar{X}$	S
Date	56	63	65			56	63	65		
July 1	272.8	227.5	223.8	241.4	27.3	272.8	231.3	228.8	244.3	24.7
2	271.5	253.8	226.3	250.5	22.8	271.5	242.5	237.5	250.5	18.4
7	280.3	267.5	232.5	260.1	24.7	285.3	253.8	243.8	261.0	21.7
8	280.3	260.0	233.8	258.0	23.3	282.8	255.0	242.5	260.1	20.6
9	275.3	252.5	232.5	253.4	21.4	276.5	251.3	237.5	255.1	19.8
10	276.5	247.5	233.8	252.6	21.8	275.3	248.8	237.5	253.9	19.4
11	277.8	252.5	235.0	255.1	21.5	277.8	250.0	237.5	255.1	20.6
14	281.5	257.5	238.8	259.3	21.4	282.8	255.0	241.3	259.7	21.1
15	282.8	258.8	240.0	260.5	21.5	284.0	257.5	242.5	261.3	21.0
16	285.3	260.0	243.8	263.0	20.9	285.3	261.3	245.0	263.9	20.3
17	287.8	265.0	246.3	266.4	20.8	289.0	266.3	247.5	267.6	20.8
18	290.3	268.8	250.0	269.7	20.2	290.3	270.0	253.8	271.4	18.3
21	299.0	283.8	258.8	280.5	20.3	297.8	283.8	261.3	281.0	18.4
23	302.8	281.3	261.3	281.8	20.8	300.3	286.3	267.5	284.7	16.5
24	305.3	282.5	263.8	283.9	20.8	302.8	287.5	272.5	287.6	15.2
25	306.5	286.3	266.3	286.4	20.1	304.0	288.8	270.0	287.6	17.0
28	307.8	292.5	273.8	291.4	17.0	305.3	296.3	281.3	294.3	12.1
29	310.3	295.0	275.0	293.4	17.7	306.5	297.5	285.0	296.3	10.8
30	312.8	298.8	278.8	296.8	17.1	310.3	302.5	291.3	301.4	9.6
31	314.0	300.0	278.8	297.6	17.7	310.3	301.3	288.8	300.1	10.8
Aug. 1	314.0	303.8	281.3	299.7	16.7	311.5	303.8	292.5	302.6	9.6
4	319.0	308.8	286.3	304.7	16.7	314.0	307.5	295.0	305.5	9.7
6	326.5	316.3	290.0	310.9	18.8	320.3	308.8	302.5	310.5	9.0
7	330.0	318.8	298.8	315.9	15.8	322.8	316.3	305.0	314.7	9.0
8	334.0	321.3	293.8	316.4	20.5	329.0	320.0	310.0	319.7	9.5
11	356.5	331.3	305.0	330.9	25.8	340.3	328.8	317.5	328.9	11.4
12	365.3	338.8	308.8	337.6	28.3	347.8	332.5	323.8	334.7	12.2
13	375.3	346.3	312.5	344.7	31.4	355.3	338.8	336.3	343.5	10.3
15	364.0	341.3	315.0	340.1	24.5	350.3	341.3	315.0	335.5	18.3
18	351.5	343.8	318.8	338.0	17.1	349.0	343.8	306.3	333.0	23.3
19	359.0	347.5	323.8	343.4	17.9	350.3	343.8	325.0	339.7	13.1
20	357.8	351.3	325.0	344.7	17.4	350.3	348.8	325.0	341.4	14.2
21	359.0	328.8	333.8	340.5	16.2	352.8	321.3	321.3	331.8	18.2
22	361.5	355.0	328.8	348.4	17.3	373.8	352.5	333.8	353.4	20.0
26	372.8	363.8	333.8	356.8	20.4	352.8	353.8	327.5	344.7	14.9
27	364.0	357.5	337.5	353.0	13.8	356.5	357.5	333.8	349.3	13.4
29	364.0	362.5	337.5	354.7	14.9	364.0	363.8	342.5	356.8	12.4
Sep. 2	369.0	363.8	347.5	360.1	11.2	361.5	363.8	348.8	358.0	8.1
3	379.0	375.0	350.0	368.0	15.7	372.5	371.3	361.3	368.4	6.1
6	367.8	353.8	341.3	354.3	13.3	359.0	366.3	332.5	352.6	17.8
8	379.0	357.5	347.5	361.3	16.1	385.3	366.3	358.8	370.1	13.7
9	374.0	353.8	350.0	359.3	12.9	360.3	363.8	352.5	358.9	5.8

Table 5. Total water in the 150 cm soil profile as a function of depth and time under five grain sorghum varieties (cm).

RS610						
Date	Depth (cm)	Plot 51	Plot 55	Plot 59	$\bar{X}$	S
June 19	0-11	3.60	3.53	3.47	3.53	0.07
	11-22	4.06	4.00	4.12	4.06	0.06
	22-37	5.90	5.87	5.81	5.86	0.05
	37-52	5.24	5.57	6.08	5.63	0.42
	52-67	4.32	4.25	5.06	4.54	0.45
	67-82	4.32	4.08	4.22	4.21	0.12
	82-97	4.11	3.79	4.06	3.99	0.17
	97-112	4.46	4.13	3.75	4.11	0.36
	112-127	4.82	4.46	4.43	4.57	0.22
	127-142	4.68	4.96	3.58	4.41	0.73
	142-150	2.67	2.31	2.08	2.35	0.30
	Total	48.18	46.95	46.66	47.26	0.81
July 1	0-11	3.14	3.53	2.73	3.13	0.40
	11-22	3.64	3.55	3.59	3.59	0.04
	22-37	5.84	5.86	5.61	5.77	0.14
	37-52	5.22	5.63	5.86	5.57	0.32
	52-67	4.55	4.11	4.97	4.54	0.43
	67-82	4.68	3.90	4.08	4.22	0.41
	82-97	4.19	3.83	4.02	4.01	0.18
	97-112	4.47	4.10	5.54	4.70	0.75
	112-127	4.83	4.61	4.36	4.60	0.24
	127-142	4.80	4.90	3.52	4.41	0.77
	142-150	2.72	2.33	2.11	2.39	0.31
	Total	48.08	46.35	46.39	46.94	0.99

Table 5. (continued)

RS610						
		Plot				
Date	Depth (cm)	51	55	59	$\bar{X}$	S
Aug. 1	0-11	2.57	2.61	2.26	2.48	0.19
	11-22	3.38	3.15	3.24	3.26	0.12
	22-37	5.15	5.06	4.56	4.92	0.32
	37-52	4.34	4.94	4.78	4.69	0.31
	52-67	2.87	2.78	5.51	3.72	1.55
	67-82	2.96	2.42	2.87	2.75	0.29
	82-97	2.93	2.48	2.95	2.79	0.27
	97-112	3.57	3.30	2.79	3.22	0.40
	112-127	2.61	3.78	3.70	3.36	0.65
	127-142	4.34	4.39	3.11	3.95	0.73
	142-150	2.52	2.14	1.84	2.17	0.34
	Total	37.24	37.05	37.61	37.30	0.28
Aug. 20	0-11	4.05	3.74	3.44	3.74	0.31
	11-22	3.72	3.84	3.99	3.85	0.14
	22-37	5.68	5.57	5.23	5.49	0.23
	37-52	4.86	5.39	5.26	5.17	0.28
	52-67	3.20	5.36	4.31	4.29	1.08
	67-82	2.93	2.63	2.62	2.73	0.18
	82-97	2.30	2.34	2.18	2.27	0.08
	97-112	2.83	2.51	1.95	2.43	0.45
	112-127	2.42	2.92	3.23	2.86	0.41
	127-142	3.90	3.56	2.82	3.43	0.55
	142-150	2.42	1.83	1.80	2.02	0.35
	Total	38.31	39.69	36.83	38.28	1.43

Table 5. (continued)

NC42Y						
		Plot				
Date	Depth (cm)	57	61	64	$\bar{X}$	S
June 19	0-11	3.33	3.75	3.77	3.62	0.25
	11-22	4.21	4.33	4.48	4.34	0.14
	22-37	6.19	6.26	6.38	6.28	0.10
	37-52	6.27	6.07	6.34	6.23	0.14
	52-67	6.61	4.81	5.71	5.71	0.90
	67-82	6.10	4.53	5.04	5.22	0.80
	82-97	4.15	4.80	5.20	4.72	0.53
	97-112	3.34	4.88	5.38	4.53	1.06
	112-127	3.94	5.11	5.33	4.79	0.75
	127-142	4.87	5.76	5.64	5.42	0.48
	142-150	2.61	2.86	2.77	2.75	0.13
	Total	51.62	53.16	56.04	53.61	2.24
July 1	0-11	3.14	3.29	4.93	3.79	0.99
	11-22	3.60	4.25	4.19	4.01	0.36
	22-37	5.61	6.10	6.29	6.00	0.35
	37-52	5.92	6.09	6.38	6.13	0.23
	52-67	5.95	4.70	5.77	5.47	0.68
	67-82	5.87	4.44	5.12	5.14	0.72
	82-97	4.08	4.72	5.17	4.66	0.55
	97-112	3.34	4.90	5.58	4.61	1.15
	112-127	4.00	4.97	5.50	4.82	0.76
	127-142	4.94	5.73	5.69	5.45	0.45
	142-150	2.95	2.92	2.80	2.89	0.08
	Total	49.40	52.11	57.42	52.98	4.08

Table 5. (continued)

NC42Y						
Date	Depth (cm)	Plot 57	Plot 61	Plot 64	$\bar{X}$	S
Aug. 1	0-11	2.87	2.68	2.99	2.85	0.16
	11-22	2.30	3.60	3.55	3.15	0.74
	22-37	4.79	5.12	5.47	5.13	0.34
	37-52	4.56	5.45	5.81	5.27	0.64
	52-67	5.37	3.87	5.27	4.84	0.84
	67-82	5.04	3.45	4.43	4.31	0.80
	82-97	3.18	3.63	4.37	3.73	0.60
	97-112	2.53	4.40	5.02	3.98	1.30
	112-127	3.51	4.54	4.91	4.32	0.73
	127-142	4.52	5.33	5.32	5.06	0.46
	142-150	2.42	2.67	2.60	2.56	0.13
	Total	41.09	44.74	49.74	45.19	4.34
Aug. 20	0-11	3.99	3.19	4.07	3.75	0.49
	11-22	3.99	4.23	4.20	4.14	0.13
	22-37	4.86	5.80	6.20	5.62	0.69
	37-52	4.47	5.66	6.03	5.39	0.82
	52-67	5.25	3.86	5.09	4.73	0.76
	67-82	4.17	3.31	3.89	3.79	0.44
	82-97	2.35	3.16	4.22	3.24	0.94
	97-112	2.15	3.92	4.76	3.61	1.33
	112-127	3.32	4.43	4.68	4.14	0.72
	127-142	4.30	5.24	5.21	4.92	0.53
	142-150	2.24	2.63	2.59	2.49	0.21
	Total	41.09	45.43	50.94	45.82	4.94

Table 5. (continued)

Pioneer 846						
		Plot				
Date	Depth (cm)	52	58	62	$\bar{X}$	S
June 19	0-11	3.45	3.56	3.46	3.49	0.06
	11-22	4.34	4.00	4.16	4.17	0.17
	22-37	6.24	5.85	5.95	6.01	0.20
	37-52	6.24	5.22	6.07	5.84	0.55
	52-67	5.18	4.25	5.06	4.83	0.51
	67-82	4.31	4.12	4.71	4.38	0.30
	82-97	3.74	4.01	4.99	4.25	0.66
	97-112	4.36	3.63	4.76	4.25	0.57
	112-127	5.29	5.11	5.48	5.29	0.19
	127-142	4.71	4.89	5.53	5.04	0.43
	142-150	2.72	2.48	2.85	2.68	0.19
	Total	50.58	47.12	53.02	50.24	2.96
July 1	0-11	3.30	3.25	3.39	3.31	0.07
	11-22	3.73	3.89	3.94	3.85	0.11
	22-37	5.95	5.84	5.89	5.89	0.06
	37-52	6.11	5.24	6.18	5.84	0.52
	52-67	5.15	4.20	5.14	4.83	0.55
	67-82	4.22	3.82	4.82	4.29	0.50
	82-97	3.82	3.86	4.79	4.16	0.55
	97-112	4.39	3.57	4.71	4.22	0.59
	112-127	5.26	5.13	5.54	5.31	0.21
	127-142	4.64	4.71	5.67	5.01	0.58
	142-150	2.78	2.45	2.84	2.69	0.21
	Total	49.35	45.96	52.91	49.41	3.48

Table 5. (continued)

Pioneer 846						
Date	Depth (cm)	Plot 52	Plot 58	Plot 62	$\bar{X}$	S
Aug. 1	0-11	2.54	2.26	2.48	2.43	0.15
	11-22	3.29	2.97	3.23	3.16	0.17
	22-37	5.20	4.61	4.80	4.87	0.30
	37-52	5.39	3.48	5.55	4.81	1.15
	52-67	3.77	1.89	4.30	3.32	1.27
	67-82	2.73	2.19	3.69	2.87	0.76
	82-97	2.67	2.56	2.39	2.54	0.14
	97-112	3.56	2.53	4.03	3.37	0.77
	112-127	4.70	4.58	4.99	4.76	0.21
	127-142	4.25	4.14	5.03	4.47	0.49
	142-150	2.52	2.16	2.71	2.46	0.28
	Total	40.62	33.37	43.20	39.06	5.10
Aug. 20	0-11	3.82	3.75	3.48	3.68	0.18
	11-22	4.09	3.33	3.97	3.80	0.41
	22-37	5.57	5.21	5.37	5.38	0.18
	37-52	5.39	3.46	5.67	4.84	1.20
	52-67	3.83	1.31	3.96	3.03	1.49
	67-82	2.41	1.15	3.28	2.28	1.07
	82-97	2.12	1.62	3.39	2.38	0.91
	97-112	3.09	2.23	3.71	3.01	0.74
	112-127	4.74	4.45	4.52	4.57	0.15
	127-142	4.01	4.08	4.79	4.29	0.43
	142-150	2.44	2.12	2.68	2.41	0.28
	Total	41.51	32.71	44.82	39.68	6.26

Table 5. (continued)

Date	Depth (cm)	F65A Plot 53	54	60	$\bar{X}$	S
June 19	0-11	3.46	3.48	3.65	3.53	0.10
	11-22	4.34	4.30	4.10	4.25	0.13
	22-37	6.24	6.02	5.87	6.04	0.19
	37-52	5.99	5.27	6.06	5.77	0.44
	52-67	4.46	4.51	6.62	5.20	1.23
	67-82	3.89	4.12	5.05	4.35	0.61
	82-97	3.50	4.32	3.83	3.88	0.41
	97-112	4.26	4.20	4.20	4.22	0.03
	112-127	5.08	4.74	4.07	4.63	0.51
	127-142	5.12	5.06	4.86	5.01	0.14
	142-150	2.38	2.60	2.74	2.57	0.18
	Total	48.72	48.62	51.05	49.46	1.38
July 1	0-11	3.19	3.18	2.87	3.08	0.18
	11-22	3.94	4.19	3.17	3.77	0.53
	22-37	6.05	5.95	5.58	5.86	0.25
	37-52	6.07	5.20	6.03	5.77	0.49
	52-67	4.32	4.39	6.41	5.04	1.19
	67-82	3.81	4.02	5.15	4.33	0.72
	82-97	3.44	4.36	3.74	3.85	0.47
	97-112	4.18	4.11	4.16	4.15	0.04
	112-127	4.92	4.61	4.16	4.56	0.38
	127-142	5.21	5.15	5.04	5.13	0.09
	142-150	2.40	2.65	2.78	2.61	0.19
	Total	47.53	47.81	49.09	48.14	0.83

Table 5. (continued)

F65A						
Date	Depth (cm)	Plot 53	Plot 54	Plot 60	$\bar{X}$	S
Aug. 1	0-11	2.67	2.24	2.59	2.50	0.23
	11-22	3.43	3.27	3.33	3.34	0.08
	22-37	5.29	4.79	5.09	5.06	0.25
	37-52	5.11	3.13	3.81	4.02	1.01
	52-67	2.27	1.90	5.82	3.33	2.16
	67-82	2.00	2.07	4.26	2.78	1.29
	82-97	2.14	3.50	2.73	2.79	0.68
	97-112	3.36	3.39	3.33	3.36	0.03
	112-127	4.53	3.91	3.37	3.94	0.58
	127-142	4.73	4.64	4.56	4.64	0.09
	142-150	2.22	2.43	2.59	2.41	0.19
	Total	37.75	35.27	41.48	38.17	3.13
Aug. 20	0-11	3.85	4.10	3.80	3.92	0.16
	11-22	4.08	4.10	4.04	4.07	0.03
	22-37	5.67	5.64	5.87	5.73	0.13
	37-52	5.47	3.68	5.74	4.96	1.12
	52-67	2.67	1.67	6.21	3.52	2.39
	67-82	1.61	1.48	4.32	2.47	1.60
	82-97	1.42	2.22	2.35	2.00	0.50
	97-112	2.45	2.33	2.92	2.57	0.31
	112-127	3.66	3.05	2.87	3.19	0.41
	127-142	4.23	4.17	4.27	4.22	0.05
	142-150	1.99	2.18	2.48	2.22	0.25
	Total	37.10	34.62	44.87	38.86	5.35

Table 5. (continued)

		F61				
		Plot				
Date	Depth (cm)	56	63	65	$\bar{X}$	S
June 19	0-11	3.52	3.74	3.75	3.67	0.13
	11-22	4.21	4.34	4.39	4.31	0.09
	22-37	6.12	5.89	6.35	6.12	0.23
	37-52	6.02	5.28	6.54	5.95	0.63
	52-67	4.69	4.53	6.00	5.07	0.81
	67-82	3.97	4.57	5.57	4.70	0.81
	82-97	3.75	4.33	5.52	4.53	0.90
	97-112	4.23	4.98	5.73	4.98	0.75
	112-127	4.54	5.20	5.68	5.14	0.57
	127-142	5.63	4.79	5.53	5.32	0.46
	142-150	2.78	2.61	2.86	2.75	0.13
	Total	49.46	50.26	57.92	52.55	4.67
July 1	0-11	3.27	3.53	3.10	3.30	0.22
	11-22	3.74	4.00	4.12	3.95	0.19
	22-37	6.00	6.00	6.26	6.09	0.15
	37-52	5.98	5.37	6.49	5.95	0.56
	52-67	4.68	4.53	5.79	5.00	0.69
	67-82	3.88	4.67	5.72	4.76	0.92
	82-97	3.54	4.41	5.40	4.45	0.93
	97-112	4.17	5.21	5.71	5.03	0.79
	112-127	4.59	5.30	5.61	5.17	0.52
	127-142	5.63	4.88	5.64	5.38	0.44
	142-150	2.79	2.71	2.92	2.81	0.11
	Total	48.27	50.61	56.76	51.88	4.39

Table 5. (continued)

Date	Depth (cm)	F61 Plot 56	F61 Plot 63	F61 Plot 65	$\bar{X}$	S
Aug. 1	0-11	2.46	2.78	2.84	2.69	0.20
	11-22	3.34	3.46	3.26	3.35	0.10
	22-37	5.03	5.13	5.40	5.19	0.19
	37-52	4.84	4.48	5.63	4.98	0.59
	52-67	2.91	3.34	5.14	3.80	1.18
	67-82	2.30	3.24	4.58	3.37	1.15
	82-97	2.40	3.75	4.25	3.47	0.96
	97-112	3.44	4.42	4.43	4.10	0.57
	112-127	4.08	4.78	5.00	4.62	0.48
	127-142	5.16	4.32	5.21	4.90	0.50
	142-150	2.52	2.36	2.75	2.54	0.20
	Total	38.48	42.06	48.49	43.01	5.07
Aug. 20	0-11	3.80	3.89	3.58	3.76	0.16
	11-22	4.03	4.01	4.04	4.03	0.02
	22-37	5.56	5.60	5.86	5.67	0.16
	37-52	4.98	4.28	6.10	5.12	0.92
	52-67	2.42	3.15	4.91	3.49	1.28
	67-82	1.41	3.00	3.59	2.67	1.13
	82-97	1.65	3.50	3.40	2.85	1.04
	97-112	3.08	4.07	3.47	3.54	0.50
	112-127	3.84	4.48	4.52	4.28	0.38
	127-142	4.91	4.10	4.98	4.66	0.49
	142-150	2.33	2.22	2.71	2.42	0.26
	Total	38.01	42.30	47.16	42.49	4.58

Table 6. Available water in the 150 cm soil profile as a function of depth and time under five grain sorghum varieties (cm).

RS610						
		Plot				
Date	Depth (cm)	51	55	59	$\bar{X}$	S
June 19	0-11	1.70	1.63	1.57	1.63	0.07
	11-22	1.95	1.95	1.95	1.95	0.00
	22-37	2.73	2.73	2.73	2.73	0.00
	37-52	2.10	2.43	2.76	2.43	0.33
	52-67	2.08	2.01	2.82	2.30	0.45
	67-82	3.22	3.08	3.22	3.17	0.08
	82-97	2.63	2.63	2.63	2.63	0.00
	97-112	2.82	2.82	2.82	2.82	0.00
	112-127	3.57	3.51	3.48	3.52	0.05
	127-142	3.63	3.63	2.61	3.29	0.59
	142-150	1.88	1.88	1.67	1.81	0.12
	Total	28.31	28.30	28.26	28.29	0.03
July 1	0-11	1.24	1.63	0.83	1.23	0.40
	11-22	1.63	1.54	1.58	1.58	0.05
	22-37	2.73	2.73	2.69	2.72	0.02
	37-52	2.08	2.49	2.72	2.43	0.32
	52-67	2.31	1.87	2.73	2.30	0.43
	67-82	3.22	2.90	3.08	3.07	0.16
	82-97	2.63	2.63	2.63	2.63	0.00
	97-112	2.82	2.82	2.82	2.82	0.00
	112-127	3.57	3.57	3.41	3.52	0.09
	127-142	3.63	3.63	2.55	3.27	0.62
	142-150	1.88	1.88	1.70	1.82	0.10
	Total	27.74	27.69	26.74	27.39	0.56

Table 6. (continued)

RS610						
		Plot				
Date	Depth (cm)	51	55	59	$\bar{X}$	S
Aug. 1	0-11	0.67	0.71	0.36	0.58	0.19
	11-22	1.37	1.14	1.23	1.25	0.12
	22-37	2.23	2.14	1.64	2.00	0.32
	37-52	1.20	1.80	1.64	1.55	0.31
	52-67	0.63	0.54	3.00	1.39	1.40
	67-82	1.96	1.42	1.87	1.75	0.29
	82-97	1.95	1.50	1.97	1.81	0.27
	97-112	2.65	2.38	1.87	2.30	0.40
	112-127	1.66	2.83	2.75	2.41	0.65
	127-142	3.37	3.42	2.14	2.98	0.73
	142-150	1.88	1.73	1.43	1.68	0.23
	Total	19.57	19.61	19.90	19.69	0.18
Aug. 20	0-11	2.05	1.84	1.54	1.81	0.26
	11-22	1.71	1.83	1.95	1.83	0.12
	22-37	2.73	2.65	2.31	2.56	0.22
	37-52	1.72	2.25	2.12	2.03	0.28
	52-67	0.96	3.00	2.07	2.01	1.02
	67-82	1.93	1.63	1.62	1.73	0.18
	82-97	1.32	1.36	1.20	1.29	0.08
	97-112	1.91	1.59	1.03	1.51	0.45
	112-127	1.47	1.97	2.28	1.91	0.41
	127-142	2.93	2.59	1.85	2.46	0.55
	142-150	1.88	1.42	1.39	1.56	0.27
	Total	20.61	22.13	19.36	20.70	1.39

Table 6. (continued)

NC42Y						
Date	Depth (cm)	Plot 57	Plot 61	Plot 64	$\bar{X}$	S
June 19	0-11	1.43	1.85	1.87	1.72	0.25
	11-22	1.95	1.95	1.95	1.95	0.00
	22-37	2.73	2.73	2.73	2.73	0.00
	37-52	2.76	2.76	2.76	2.76	0.00
	52-67	3.00	2.57	3.00	2.86	0.25
	67-82	3.22	3.22	3.22	3.22	0.00
	82-97	2.63	2.63	2.63	2.63	0.00
	97-112	2.42	2.82	2.82	2.69	0.23
	112-127	2.99	3.57	3.57	3.38	0.33
	127-142	3.63	3.63	3.63	3.63	0.00
	142-150	1.88	1.88	1.88	1.88	0.00
	Total	28.64	29.61	30.06	29.44	0.73
July 1	0-11	1.24	1.39	2.05	1.56	0.43
	11-22	1.59	1.95	1.95	1.83	0.21
	22-37	2.69	2.73	2.73	2.72	0.02
	37-52	2.76	2.76	2.76	2.76	0.00
	52-67	3.00	2.46	3.00	2.82	0.31
	67-82	3.22	3.22	3.22	3.22	0.00
	82-97	2.63	2.63	2.63	2.63	0.00
	97-112	2.42	2.82	2.82	2.69	0.23
	112-127	3.05	3.57	3.57	3.40	0.30
	127-142	3.63	3.63	3.63	3.63	0.00
	142-150	1.88	1.88	1.88	1.88	0.00
	Total	28.11	29.04	30.24	29.13	1.07

Table 6. (continued)

Date	Depth (cm)	NC42Y Plot 57	61	64	$\bar{X}$	S
Aug. 1	0-11	0.97	0.78	1.09	0.95	0.16
	11-22	0.29	1.59	1.54	1.14	0.74
	22-37	1.87	2.20	2.55	2.21	0.34
	37-52	1.42	2.31	2.67	2.13	0.64
	52-67	3.00	1.63	3.00	2.54	0.79
	67-82	3.22	2.45	3.22	2.96	0.44
	82-97	2.20	2.63	2.63	2.49	0.25
	97-112	1.61	2.82	2.82	2.42	0.70
	112-127	2.56	3.57	3.57	3.23	0.58
	127-142	3.55	3.63	3.63	3.60	0.05
	142-150	1.88	1.88	1.88	1.88	0.00
	Total	22.57	25.49	28.60	25.55	3.02
Aug. 20	0-11	2.05	1.29	2.05	1.80	0.44
	11-22	1.95	1.95	1.95	1.95	0.00
	22-37	1.94	2.73	2.73	2.47	0.46
	37-52	1.33	2.52	2.76	2.20	0.77
	52-67	3.00	1.62	2.85	2.49	0.76
	67-82	3.17	2.21	2.89	2.76	0.49
	82-97	1.37	2.18	2.63	2.06	0.64
	97-112	1.23	2.82	2.82	2.29	0.92
	112-127	2.37	3.48	3.57	3.14	0.67
	127-142	3.33	3.63	3.63	3.53	0.17
	142-150	1.83	1.88	1.88	1.86	0.03
	Total	23.57	26.31	29.76	26.55	3.10

Table 6. (continued)

Pioneer 846						
		Plot				
Date	Depth (cm)	52	58	62	$\bar{X}$	S
June 19	0-11	1.55	1.66	1.56	1.59	0.06
	11-22	1.95	1.95	1.95	1.95	0.00
	22-37	2.73	2.73	2.73	2.73	0.00
	37-52	2.76	2.08	2.76	2.53	0.39
	52-67	2.94	2.01	2.82	2.59	0.51
	67-82	3.22	3.12	3.22	3.19	0.06
	82-97	2.63	2.63	2.63	2.63	0.00
	97-112	2.82	2.71	2.82	2.78	0.06
	112-127	3.57	3.57	3.57	3.57	0.00
	127-142	3.63	3.63	3.63	3.63	0.00
	142-150	1.88	1.88	1.88	1.88	0.00
	Total	29.68	27.97	29.57	29.07	0.96
July 1	0-11	1.40	1.35	1.49	1.41	0.07
	11-22	1.72	1.88	1.93	1.84	0.11
	22-37	2.73	2.73	2.73	2.73	0.00
	37-52	2.76	2.10	2.76	2.54	0.38
	52-67	2.91	1.96	2.90	2.59	0.55
	67-82	3.22	2.82	3.22	3.09	0.23
	82-97	2.63	2.63	2.63	2.63	0.00
	97-112	2.82	2.65	2.82	2.76	0.10
	112-127	3.57	3.57	3.57	3.57	0.00
	127-142	3.63	3.63	3.63	3.63	0.00
	142-150	1.88	1.88	1.88	1.88	0.00
	Total	29.27	27.20	29.56	28.68	1.29

Table 6. (continued)

Pioneer 846						
		Plot				
Date	Depth (cm)	52	58	62	$\bar{X}$	S
Aug. 1	0-11	0.64	0.36	0.58	0.53	0.15
	11-22	1.28	0.96	1.22	1.15	0.17
	22-37	2.28	1.69	1.88	1.95	0.30
	37-52	2.25	0.34	2.41	1.67	1.15
	52-67	1.50	-0.35	2.06	1.07	1.26
	67-82	1.73	1.19	2.69	1.87	0.76
	82-97	1.69	1.58	1.41	1.56	0.14
	97-112	2.64	1.61	2.82	2.36	0.65
	112-127	3.57	3.57	3.57	3.57	0.00
	127-142	3.28	3.17	3.63	3.36	0.24
	142-150	1.88	1.75	1.88	1.84	0.08
	Total	22.74	15.87	24.15	20.92	4.43
Aug. 20	0-11	1.92	1.85	1.58	1.78	0.18
	11-22	1.95	1.32	1.95	1.74	0.36
	22-37	2.65	2.29	2.45	2.46	0.18
	37-52	2.25	0.32	2.53	1.70	1.20
	52-67	1.59	-0.93	1.72	0.79	1.49
	67-82	1.41	0.15	2.28	1.28	1.07
	82-97	1.14	0.64	2.41	1.40	0.91
	97-112	2.17	1.31	2.79	2.09	0.74
	112-127	3.57	3.50	3.57	3.55	0.04
	127-142	3.04	3.11	3.63	3.26	0.32
	142-150	1.88	1.71	1.88	1.82	0.10
	Total	23.57	15.27	26.79	21.88	5.94

Table 6. (continued)

F65A						
		Plot				
Date	Depth (cm)	53	54	60	$\bar{X}$	S
June 19	0-11	1.56	1.58	1.75	1.63	0.10
	11-22	1.95	1.95	1.95	1.95	0.00
	22-37	2.73	2.73	2.73	2.73	0.00
	37-52	2.76	2.13	2.76	2.55	0.36
	52-67	2.22	2.27	3.00	2.50	0.44
	67-82	2.89	3.12	3.22	3.08	0.17
	82-97	2.52	2.63	2.63	2.59	0.06
	97-112	2.82	2.82	2.82	2.82	0.00
	112-127	3.57	3.57	3.12	3.42	0.26
	127-142	3.63	3.63	3.63	3.63	0.00
	142-150	1.88	1.88	1.88	1.88	0.00
	Total	28.53	28.31	29.49	28.78	0.63
July 1	0-11	1.29	1.28	0.97	1.18	0.18
	11-22	1.93	1.95	1.16	1.68	0.45
	22-37	2.73	2.73	2.66	2.71	0.04
	37-52	2.76	2.06	2.76	2.53	0.40
	52-67	2.08	2.15	3.00	2.41	0.51
	67-82	2.81	3.02	3.22	3.02	0.21
	82-97	2.46	2.63	2.63	2.57	0.10
	97-112	2.82	2.82	2.82	2.82	0.00
	112-127	3.57	3.57	3.21	3.45	0.21
	127-142	3.63	3.63	3.63	3.63	0.00
	142-150	1.88	1.88	1.88	1.88	0.00
	Total	27.96	27.72	27.94	27.87	0.13

Table 6. (continued)

Date	Depth (cm)	F65A Plot 53	54	60	$\bar{X}$	S
Aug. 1	0-11	0.77	0.34	0.69	0.60	0.23
	11-22	1.42	1.26	1.32	1.33	0.08
	22-37	2.37	1.87	2.17	2.14	0.25
	37-52	1.97	-0.01	0.67	0.88	1.01
	52-67	0.03	-0.34	3.00	0.90	1.83
	67-82	1.00	1.07	3.22	1.76	1.26
	82-97	1.16	2.52	1.75	1.81	0.68
	97-112	2.44	2.47	2.41	2.44	0.03
	112-127	3.57	2.96	2.42	2.98	0.58
	127-142	3.63	3.63	3.59	3.62	0.02
	142-150	1.81	1.88	1.88	1.86	0.04
	Total	20.17	17.65	23.12	20.31	2.74
Aug. 20	0-11	1.95	2.05	1.90	1.97	0.08
	11-22	1.95	1.95	1.95	1.95	0.00
	22-37	2.73	2.72	2.73	2.73	0.01
	37-52	2.33	0.54	2.60	1.82	1.12
	52-67	0.43	-0.57	3.00	0.95	1.84
	67-82	0.61	0.48	3.22	1.44	1.55
	82-97	0.44	1.24	1.37	1.02	0.50
	97-112	1.53	1.41	2.00	1.65	0.31
	112-127	2.71	2.10	1.97	2.26	0.40
	127-142	3.26	3.20	3.30	3.25	0.05
	142-150	1.58	1.77	1.88	1.74	0.15
	Total	19.52	16.89	25.92	20.78	4.64

Table 6. (continued)

		F61				
		Plot				
Date	Depth (cm)	56	63	65	$\bar{X}$	S
June 19	0-11	1.62	1.84	1.85	1.77	0.13
	11-22	1.95	1.95	1.95	1.95	0.00
	22-37	2.73	2.73	2.73	2.73	0.00
	37-52	2.76	2.14	2.76	2.55	0.36
	52-67	2.45	2.29	3.00	2.58	0.37
	67-82	2.97	3.22	3.22	3.14	0.14
	82-97	2.63	2.63	2.63	2.63	0.00
	97-112	2.82	2.82	2.82	2.82	0.00
	112-127	3.57	3.57	3.57	3.57	0.00
	127-142	3.63	3.63	3.63	3.63	0.00
	142-150	1.88	1.88	1.88	1.88	0.00
	Total	29.01	28.70	30.04	29.25	0.70
July 1	0-11	1.37	1.63	1.20	1.40	0.22
	11-22	1.73	1.95	1.95	1.88	0.13
	22-37	2.73	2.73	2.73	2.73	0.00
	37-52	2.76	2.23	2.76	2.58	0.31
	52-67	2.44	2.29	3.00	2.58	0.37
	67-82	2.88	3.22	3.22	3.11	0.20
	82-97	2.56	2.63	2.63	2.61	0.04
	97-112	2.82	2.82	2.82	2.82	0.00
	112-127	3.57	3.57	3.57	3.57	0.00
	127-142	3.63	3.63	3.63	3.63	0.00
	142-150	1.88	1.88	1.88	1.88	0.00
	Total	28.37	28.58	29.39	28.78	0.54

Table 6. (continued)

Date	Depth (cm)	F61 Plot 56	63	65	$\bar{X}$	S
Aug. 1	0-11	0.56	0.88	0.94	0.79	0.20
	11-22	1.33	1.45	1.25	1.34	0.10
	22-37	2.11	2.21	2.48	2.27	0.19
	37-52	1.70	1.34	2.49	1.84	0.59
	52-67	0.67	1.10	2.90	1.56	1.18
	67-82	1.30	2.24	3.22	2.25	0.96
	82-97	1.42	2.63	2.63	2.23	0.70
	97-112	2.52	2.82	2.82	2.72	0.17
	112-127	3.13	3.57	3.57	3.42	0.25
	127-142	3.63	3.35	3.63	3.54	0.16
	142-150	1.88	1.88	1.88	1.88	0.00
	Total	20.25	23.47	27.81	23.84	3.79
Aug. 20	0-11	1.90	1.99	1.68	1.86	0.16
	11-22	1.95	1.95	1.95	1.95	0.00
	22-37	2.64	2.68	2.73	2.68	0.05
	37-52	1.84	1.14	2.76	1.91	0.81
	52-67	0.18	0.91	2.67	1.25	1.28
	67-82	0.41	2.00	2.59	1.67	1.13
	82-97	0.67	2.52	2.42	1.87	1.04
	97-112	2.16	2.82	2.55	2.51	0.33
	112-127	2.89	3.53	3.57	3.33	0.38
	127-142	3.63	3.13	3.63	3.46	0.29
	142-150	1.88	1.81	1.88	1.86	0.04
	Total	20.15	24.48	28.43	24.35	4.14

Table 7. Rainfall at Ashland Evapotranspiration Laboratory research site during the 1975 growing season (cm)

Date	May	June	July	August	September
1					
2		0.38			
3	2.67	3.56			
4					
5					6.48
6					
7		0.97			
8		5.59			
9					
10	0.76				
11		3.68			1.23
12				4.32	
13	0.03			2.29	
14	0.66				
15	0.05				0.38
16					
17		1.91		2.34	
18					
19					
20			0.25		
21					
22	1.88	7.62			
23		0.15			
24					
25				1.65	
26	1.07				
27	0.03				
28	1.42			1.07	1.27
29	1.12		0.23	0.71	
30	1.12				
31	0.05				

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APPENDICES

Table A1(a). Grain sorghum root dry matter as a function of depth and time in irrigated and nonirrigated plots (g/1.08 dm^2 soil surface)

Irrigated

Date	Depth (cm)	Plot						$\bar{X}$	S
		21/1	21/2	21/3	41/1	41/2	41/3		
June 19	0-15	.070	.120		.080	.180		.113	.050
June 25	0-15	.690	.390		.190	.740		.503	.259
	15-30	T*	T		-	T		-	-
	TOTAL	.690	.390		.190	.740		.503	.259
June 30	0-7.5	1.040	.830		.800	1.072		.936	.140
	7.5-15	.025	.030		.024	.020		.025	.004
	15-30	.005	.040		.020	.011		.019	.015
	30-45	.010	T		T	T		.003	.005
	45-60	T	T		T	.012		.003	.006
	TOTAL	1.080	.900		.844	1.115		.985	.133
July 8	0-7.5	4.466	4.842		1.412	5.243		3.991	1.748
	7.5-15	.068	.070		.050	.050		.060	.011
	15-30	.068	.072		.018	.100		.065	.034
	30-45	.073	.044		.049	.061		.057	.013
	45-60	.035	.045		.019	.051		.038	.014
	60-75	.015	.038		.010	.031		.024	.013
	75-90	.005	.010		.009	.014		.010	.004
	90-105	T	.018		.012	.009		.010	.008
	105-120	T	.004		.004	.002		.003	.002
	120-135	T	T		.005	T		.001	.003
	135-150	T	T		T	T		-	-
	TOTAL	4.730	5.143		1.588	5.561		4.256	1.810
July 16	0-7.5	9.011	13.184		6.268	8.025		9.122	2.936
	7.5-15	.156	.588		.188	.037		.242	.239
	15-30	.121	.206		.090	.072		.122	.059
	30-45	.048	.082		.113	.069		.078	.027
	45-60	.063	.064		.047	.039		.053	.012
	60-75	.037	.028		.031	.031		.032	.004
	75-90	.016	.015		.010	.016		.014	.003
	90-105	.008	.003		.007	.006		.006	.002
	105-120	.010	.001		.004	.021		.009	.009
	120-135	.003	.003		.016	.008		.008	.006
	135-150	.015	T		.002	.025		.011	.012
	150-165	-	-		T	.017		.004	.009
	TOTAL	9.488	14.174		6.776	8.366		9.701	3.183

*T = Trace

Table A1(a). (continued)

Date	Depth (cm)	Plot						$\bar{X}$	S
		21/1	21/2	21/3	41/1	41/2	41/3		
July 25	0-7.5	8.951	6.005	6.604	11.345	9.292	12.388	9.098	2.519
	7.5-15	.460	.728	.549	.823	1.008	.537	.684	.208
	15-30	.349	.235	.306	.283	.330	.496	.333	.089
	30-45	.177	.126	.128	.218	.182	.181	.169	.036
	45-60	.108	.075	.148	.122	.090	.190	.122	.042
	60-75	.287	.178	.155	.154	.090	.186	.175	.064
	75-90	.073	.037	.093	.149	.046	.080	.080	.040
	90-105	.034	.043	.026	.037	.045	.010	.033	.013
	105-120	.024	.005	.017	.016	.017	.014	.016	.006
	120-135	.020	T	.012	.009	.006	.008	.009	.007
	135-150	T	-	.012	T	.002	.009	.004	.005
	150-165	-	-	T	T	-	.014	.002	.006
	TOTAL	10.483	7.432	8.050	13.156	11.108	14.113	10.724	2.668
Aug. 1	0-7.5	13.408	13.500	17.179	15.040	12.414	14.052	14.266	1.666
	7.5-15	1.624	.714	.789	1.116	1.548	1.290	1.180	.379
	15-30	2.227	.345	.360	.268	.342	.231	.629	.785
	30-45	.366	.258	.302	.188	.357	.209	.280	.075
	45-60	.260	.281	.220	.261	.162	.202	.231	.045
	60-75	.201	.110	.158	.295	.200	.172	.189	.062
	75-90	.109	.107	.060	.252	.096	.131	.126	.066
	90-105	.063	.066	.059	.084	.059	.076	.068	.010
	105-120	.035	.057	.036	.059	.062	.054	.051	.012
	120-135	.014	.059	.020	.029	.018	.009	.025	.018
	135-150	-	.013	-	-	-	-	.002	.006
	150-165	-	-	-	-	-	-	-	-
	165-180	-	-	-	-	-	-	-	-
	TOTAL	18.307	15.510	19.183	17.592	15.258	16.426	17.046	1.575
Aug. 6	0-7.5	12.467	12.077	9.418	19.657	14.750	10.146	13.086	3.727
	7.5-15	.549	.822	.537	.497	.406	.134	.491	.223
	15-30	.346	.391	.218	.298	.134	.206	.266	.096
	30-45	.196	.214	.185	.161	.139	.171	.178	.027
	45-60	.138	.158	.171	.080	.087	.129	.127	.037
	60-75	.186	.103	.141	.089	.078	.081	.113	.043
	75-90	.199	.112	.132	.074	.141	.234	.149	.058
	90-105	.095	.080	.080	.057	.067	.049	.071	.017
	105-120	.085	.039	.037	.015	.024	.027	.038	.025
	120-135	.045	.057	.070	.001	.012	.002	.031	.030
	135-150	.038	.027	.020	-	.007	-	.015	.016
	TOTAL	14.344	14.030	11.009	20.929	15.845	11.179	14.556	3.649

Table A1(a). (continued)

Date	Depth (cm)	Plot						$\bar{X}$	S
		21/1	21/2	21/3	41/1	41/2	41/3		
Aug. 19	0-7.5	11.221	12.240	8.169	13.119	8.138	9.987	10.479	2.082
	7.5-15	.623	.906	1.350	4.723	.455	1.936	1.666	1.591
	15-30	.177	.211	.247	.869	.338	.357	.367	.256
	30-45	.097	.107	.146	.107	.222	.203	.147	.054
	45-60	.084	.114	.113	.117	.146	.129	.117	.020
	60-75	.122	.164	.076	.128	.120	.165	.129	.033
	75-90	.100	.104	.103	.158	.167	.219	.142	.048
	90-105	.059	.032	.058	.162	.080	.121	.085	.048
	105-120	.055	.025	.029	.041	.046	.044	.040	.011
	120-135	.051	.033	.096	.017	.033	.028	.043	.028
	135-150	T	.009	.046	.007	.012	.015	.015	.016
	150-165	-	-	-	-	.005	-	.001	.002
	TOTAL	12.589	13.945	10.433	19.448	9.762	13.204	13.230	3.448
Aug. 30	0-7.5	8.365	5.718	8.582	22.073	7.032	10.636	10.401	5.950
	7.5-15	.345	.321	.836	.530	.339	.649	.503	.209
	15-30	.146	.218	.232	.207	.294	1.060	.360	.346
	30-45	.083	.125	.130	.111	.119	.296	.144	.076
	45-60	.109	.114	.115	.073	.121	.064	.099	.024
	60-75	.143	.118	.119	.107	.083	.129	.117	.020
	75-90	.082	.123	.062	.142	.089	.119	.103	.030
	90-105	.040	.066	.047	.157	.159	.112	.097	.054
	105-120	.051	.119	.058	.062	.063	.013	.061	.034
	120-135	.019	.032	.059	.012	.009	.017	.025	.019
	135-150	.006	.001	-	.003	.010	.006	.004	.004
	150-165	-	-	-	-	-	-	-	-
	TOTAL	9.389	6.955	10.240	23.477	8.318	13.101	11.913	6.030
Sep. 13	0-7.5	12.565	14.770			11.126	14.588	13.262	1.740
	7.5-15	1.024	.508			.841	1.466	.960	.399
	15-30	.243	.133			.296	.107	.195	.090
	30-45	.089	.151			.107	.063	.103	.037
	45-60	.088	.094			.093	.103	.095	.006
	60-75	.097	.091			.099	.089	.094	.005
	75-90	.176	.147			.114	.138	.144	.026
	90-105	.109	.119			.143	.107	.120	.017
	105-120	.086	.033			.005	.051	.044	.034
	120-135	.078	.023			.047	.037	.046	.023
	135-150	.068	.027			T	.003	.025	.031
	150-165	.008	-			-	-	.001	.004
	TOTAL	14.631	16.096			12.871	16.752	15.088	1.723

Table A1(a). (continued)

Nonirrigated

Date	Depth (cm)	Plot						$\bar{X}$	S
		20/1	20/2	20/3	40/1	40/2	40/3		
June 19	0-15	.090	.140		.070	.110		.103	.030
June 25	0-15	.690	1.230		.500	.240		.665	.419
	15-30	.030	.020		T	.020		.018	.013
	TOTAL	.720	1.250		.500	.260		.683	.366
June 30	0-7.5	.930	1.080		2.120	2.030		1.540	.622
	7.5-15	.028	.090		.053	.035		.052	.028
	15-30	.018	.010		.024	.024		.019	.007
	30-45	T	T		T	T		-	-
	45-60	T	.003		.003	T		.002	.002
	TOTAL	.976	1.183		2.200	2.089		1.612	.662
July 8	0-7.5	4.064	3.611		2.390	3.572		3.409	.715
	7.5-15	.032	.051		.056	.040		.045	.011
	15-30	.088	.033		.064	.080		.066	.024
	30-45	.024	.016		.030	.045		.029	.012
	45-60	.010	.009		.030	.043		.023	.016
	60-75	.020	.003		.006	T		.007	.009
	75-90	.010	.010		T	T		.005	.006
	90-105	.006	.007		T	.007		.005	.003
	105-120	.004	T		T	T		.001	.002
	120-135	T	T		-	T		-	-
	135-150	-	T		-	-		-	-
	TOTAL	4.258	3.740		2.576	3.787		3.590	.715
July 16	0-7.5	6.361	6.188		8.754	10.172		7.869	1.931
	7.5-15	.062	.163		.150	.593		.242	.238
	15-30	.075	.105		.063	.062		.076	.017
	30-45	.100	.115		.034	.062		.078	.037
	45-60	.061	.065		.034	.060		.055	.014
	60-75	.059	.111		.017	.039		.057	.040
	75-90	.032	.066		.009	.047		.039	.024
	90-105	.027	.004		.005	.002		.010	.012
	105-120	.025	.014		.002	T		.010	.012
	120-135	.002	T		T	-		.001	.001
	135-150	T	-		-	-		-	-
	150-165	-	-		-	-		-	-
	TOTAL	6.804	6.831		9.068	11.037		8.435	2.033

Table A1(a). (continued)

Date	Depth (cm)	Plot						$\bar{X}$	S
		20/1	20/2	20/3	40/1	40/2	40/3		
July 25	0-7.5	9.262	7.241	7.220	8.855	6.661	9.153	8.065	1.149
	7.5-15	.450	.650	.648	.310	.437	.255	.458	.165
	15-30	.131	.391	.440	.164	.333	.187	.274	.130
	30-45	.088	.474	.389	.097	.276	.324	.275	.156
	45-60	.154	.120	.248	.107	.220	.738	.265	.238
	60-75	.136	.079	.235	.110	.059	.570	.198	.192
	75-90	.160	.110	.086	.072	.010	.076	.086	.049
	90-105	.105	.118	.128	.010	.008	.104	.079	.055
	105-120	.002	.022	.044	.025	T	.053	.024	.021
	120-135	T	.003	.001	.016	-	T	.003	.006
	135-150	T	-	-	.013	-	-	.002	.005
	150-165	-	-	-	-	-	-	-	-
	TOTAL	10.488	9.208	9.439	9.779	8.004	11.460	9.730	1.175
Aug. 1	0-7.5	11.445	8.684	6.924	14.783	9.813	8.058	9.951	2.827
	7.5-15	.274	.237	.365	.248	.488	.117	.288	.126
	15-30	.141	.094	.074	.161	.113	.076	.110	.035
	30-45	.252	.042	.120	.117	.087	.107	.121	.070
	45-60	.191	.202	.116	.207	.054	.150	.153	.060
	60-75	.198	.084	.053	.205	.206	.175	.154	.068
	75-90	.172	.119	.200	.117	.095	.047	.125	.055
	90-105	.199	.161	.147	.032	.083	.031	.109	.071
	105-120	.176	.054	.037	.011	.008	.017	.051	.064
	120-135	.116	.004	.109	.010	.029	T	.045	.054
	135-150	.071	T	-	-	T	-	.012	.029
	150-165	.049	-	-	-	-	-	.008	.020
	165-180	.026	-	-	-	-	-	.004	.011
	TOTAL	13.310	9.631	8.145	15.891	10.976	8.778	11.122	2.971
Aug. 6	0-7.5	12.506	10.440	14.927	8.215	7.874	12.725	11.115	2.772
	7.5-15	.156	.141	.168	.511	.076	.255	.218	.155
	15-30	.187	.096	.116	.148	.145	.301	.166	.073
	30-45	.046	.104	.039	.157	.146	.138	.105	.052
	45-60	.092	.101	.212	.024	.272	.292	.166	.109
	60-75	.122	.194	.065	.089	.113	.215	.133	.059
	75-90	.084	.224	.140	.036	.090	.043	.103	.070
	90-105	.283	.259	.218	.034	.048	.005	.141	.125
	105-120	.144	.151	.171	.005	.021	.012	.084	.079
	120-135	.013	-	.059	.003	.005	.004	.014	.022
	135-150	T	-	.018	-	-	-	.003	.007
	TOTAL	13.633	11.710	16.133	9.222	8.790	13.990	12.246	2.879

Table A1(a). (continued)

Date	Depth (cm)	Plot						$\bar{X}$	S
		20/1	20/2	20/3	40/1	40/2	40/3		
Aug. 19	0-7.5	6.725	7.194	7.636	11.514	11.122	9.633	8.971	2.074
	7.5-15	.265	1.178	.502	.667	.572	.293	.580	.333
	15-30	.127	.249	.661	.252	.100	.221	.268	.203
	30-45	.108	.125	.081	.123	.079	.071	.098	.024
	45-60	.077	.083	.087	.169	.210	.079	.118	.057
	60-75	.195	.081	.101	.107	.120	.094	.116	.041
	75-90	.182	.161	.090	.054	.043	.050	.097	.061
	90-105	.245	.302	.203	.014	.048	.042	.142	.123
	105-120	.058	.075	.124	.040	.054	.035	.064	.032
	120-135	.067	.007	-	.032	.019	.031	.026	.024
	135-150	-	.002	-	-	T	.007	.002	.003
	150-165	-	-	-	-	-	-	-	-
	TOTAL	8.049	9.457	9.485	12.972	12.367	10.556	10.481	1.883
Aug. 30	0-7.5	5.915	5.464	3.678	3.482	6.479	7.267	5.381	1.521
	7.5-15	.188	.673	.321	.157	.864	.476	.447	.280
	15-30	.088	.096	.169	.079	.091	.301	.137	.087
	30-45	.074	.116	.879	.102	.073	.091	.223	.322
	45-60	.111	.193	.095	.132	.123	.200	.142	.044
	60-75	.101	.067	.086	.173	.206	.218	.142	.065
	75-90	.144	.062	.086	.199	.063	.129	.114	.054
	90-105	.134	.126	.287	.117	.037	.138	.140	.081
	105-120	.095	.080	.027	.116	.033	.118	.078	.040
	120-135	.008	.006	.006	.072	.041	.054	.031	.029
	135-150	-	-	-	.005	.019	.002	.004	.007
	150-165	-	-	-	.002	-	-	-	-
	TOTAL	6.858	6.883	5.634	4.636	8.029	8.994	6.839	1.573
Sep. 13	0-7.5	9.690	8.798	7.582	10.723	14.379	12.987	10.693	2.574
	7.5-15	.270	.286	.209	.205	.902	1.325	.533	.470
	15-30	.338	.159	.121	.080	.495	.135	.221	.161
	30-45	.055	.100	.096	.068	.105	.070	.082	.021
	45-60	.141	.069	.060	.123	.170	.186	.125	.052
	60-75	.243	.117	.082	.075	.154	.131	.134	.061
	75-90	.084	.097	.092	.035	.090	.068	.078	.023
	90-105	.148	.199	.140	.010	.081	.074	.109	.067
	105-120	.068	.026	.012	.051	.070	.055	.047	.023
	120-135	.008	.014	.005	.018	.048	.005	.016	.016
	135-150	-	.010	.013	T	.016	.002	.007	.007
	150-165	-	-	-	-	-	-	-	-
	TOTAL	11.045	9.875	8.412	11.388	16.510	15.038	12.045	3.106

Table A1(b). Percentage of grain sorghum root dry matter as a function of depth and time under irrigated and nonirrigated conditions.

Date	Depth (cm)												Total
	0-7.5	7.5-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	120-135	135-150	150-165	165-180	
Irrigated														
June 19	100	(0-15)*												100
June 25	100	(0-15)*												100
June 30	95.0	2.5	1.9	0.3	0.3									100
July 8	93.8	1.4	1.5	1.3	0.9	0.6	0.2	0.2	0.1					100
July 16	94.0	2.5	1.3	0.8	0.6	0.3	0.1	0.1	0.1	0.1	0.1			100
July 25	84.8	6.4	3.1	1.6	1.1	1.6	0.8	0.3	0.2	0.1				100
Aug. 1	83.7	6.9	3.7	1.6	1.4	1.1	0.7	0.4	0.3	0.2				100
Aug. 6	89.8	3.4	1.8	1.2	0.9	0.8	1.0	0.5	0.3	0.2	0.1			100
Aug. 19	79.2	12.6	2.8	1.1	0.9	1.0	1.1	0.6	0.3	0.3	0.1			100
Aug. 30	87.3	4.2	3.0	1.2	0.8	1.0	0.9	0.8	0.5	0.2				100
Sep. 13	87.9	6.4	1.3	0.7	0.6	0.6	1.0	0.8	0.3	0.3	0.2			100
Nonirrigated														
June 19	100	(0-15)*												100
June 25	97.4	(0-15)*	2.6											100
June 30	95.5	3.2	1.2	-	0.1									100
July 8	95.0	1.3	1.8	0.8	0.6	0.2	0.1	0.1						100
July 16	93.3	2.9	0.9	0.9	0.7	0.7	0.5	0.1	0.1					100
July 25	82.9	4.7	2.8	2.8	2.7	2.0	0.9	0.8	0.3					100
Aug. 1	89.4	2.6	1.0	1.1	1.4	1.4	1.1	1.0	0.5	0.4	0.1	0.1		100
Aug. 6	90.7	1.8	1.4	0.9	1.4	1.1	0.8	1.2	0.7	0.1				100
Aug. 19	85.6	5.5	2.6	0.9	1.1	1.1	0.9	1.4	0.6	0.3				100
Aug. 30	78.7	6.5	2.0	3.3	2.1	2.1	1.7	2.0	1.1	0.5	0.1			100
Sep. 13	88.8	4.4	1.8	0.7	1.0	1.1	0.7	0.9	0.4	0.1	0.1			100

*The top 15 cm was not partitioned into 7.5 cm sections on the first 2 sampling dates.

Table A1(c). Grain sorghum in-row maximum rooting depth as a function of time in irrigated and nonirrigated plots (cm)

Irrigated

Date	Plot						$\bar{X}$	S	$S/\sqrt{n}$
	21/1	21/2	21/3	41/1	41/2	41/3			
June 19	13	13		10	11		11.75	1.50	0.75
June 25	28	23		-	30		27.00	3.61	2.09
June 30	58	50		62	60		57.50	5.26	2.63
July 8	135	142		182	144		150.75	21.19	10.59
July 16	151	155		143	150		149.75	4.99	2.50
July 25	153	128	150	160	150	162	150.50	12.13	4.95
Aug. 1	139	150	131	133	125	137	135.80	8.50	3.47
Aug. 6	151	146	145	128	133	136	139.80	8.84	3.61
Aug. 19	140	143	150	147	167	141	148.00	10.04	4.10
Aug. 30	152	132	138	149	144	144	143.17	7.28	2.97
Sep. 13	152	148	-	-	141	145	146.50	4.65	2.33

Nonirrigated

Date	Plot						$\bar{X}$	S	$S/\sqrt{n}$
	20/1	20/2	20/3	40/1	40/2	40/3			
June 19	15	13		11	14		13.25	1.71	0.86
June 25	27	28		24	30		27.25	2.50	1.25
June 30	67	59		54	55		58.75	5.91	2.96
July 8	131	173		120	136		140.00	22.99	11.50
July 16	136	132		129	123		130.00	5.48	2.74
July 25	150	135	135	155	122	127	137.30	12.85	5.25
Aug. 1	129	119	134	135	105	129	125.17	11.39	4.65
Aug. 6	157	122	143	130	128	120	133.33	14.14	5.77
Aug. 19	122	133	138	133	130	135	131.83	5.49	2.24
Aug. 30	132	127	124	162	142	150	139.50	14.67	5.99
Sep. 13	135	148	143	130	123	142	136.80	9.28	3.79

Table A1(d). Grain sorghum in-row effective rooting depth as a function of time in irrigated and nonirrigated plots (cm)

Irrigated

Date	Plot						$\bar{X}$	S	$S/\sqrt{n}$
	21/1	21/2	21/3	41/1	41/2	41/3			
June 19	13	13		10	11		11.75	1.50	0.75
June 25	28	23		-	30		27.00	3.61	2.09
June 30	15	30		30	30		26.25	7.50	3.75
July 8	90	-		75	75		80.00	8.66	5.00
July 16	120	105		90	120		108.75	14.36	7.18
July 25	135	120	135	135	120	120	127.50	8.22	3.36
Aug. 1	135	135	135	135	125	137	133.70	4.32	1.76
Aug. 6	151	146	145	120	133	120	135.80	13.62	5.56
Aug. 19	140	143	150	147	167	129	146.00	12.59	5.14
Aug. 30	152	132	138	135	120	135	135.33	10.31	4.21
Sep. 13	152	148	-	-	135	135	142.50	8.81	4.41

Nonirrigated

Date	Plot						$\bar{X}$	S	$S/\sqrt{n}$
	20/1	20/2	20/3	40/1	40/2	40/3			
June 19	15	13		11	14		13.25	1.71	0.86
June 25	27	28		24	30		27.25	2.50	1.25
June 30	30	30		30	30		30.00	-	-
July 8	75	-		60	60		65.00	8.66	5.00
July 16	120	105		90	90		101.25	14.36	7.18
July 25	105	120	120	150	105	120	120.00	16.43	6.71
Aug. 1	129	119	134	135	105	129	125.20	11.39	4.65
Aug. 6	120	122	143	120	120	-	125.00	10.10	4.52
Aug. 19	122	130	120	90	120	130	118.67	14.79	6.04
Aug. 30	132	127	124	135	142	135	132.50	6.41	2.62
Sep. 13	120	148	143	120	105	120	126.00	16.26	6.64

Table A2(a). Sorghum plant top parameters measured during the season in irrigated and nonirrigated plots

	Irrigated							Nonirrigated						
	Plot				$\bar{X}$	S	$S/\sqrt{n}$	Plot				$\bar{X}$	S	$S/\sqrt{n}$
	21/1	21/2	41/1	41/2				20/1	20/2	40/1	40/2			
June 19														
DM† tops*	.58	.94	.65	.47	.66	.20	.10	.49	.79	.49	.77	.63	.17	.09
DM leaves	.44	.66	.48	.35	.48	.13	.07	.37	.56	.37	.55	.46	.11	.06
DM stems	.14	.28	.17	.12	.17	.07	.04	.12	.24	.12	.21	.17	.06	.03
Height (cm)	12.00	14.50	11.63	11.75	12.47	1.36	.68	12.38	13.75	10.50	13.25	12.47	1.43	.72
LAI	.20	.26	.20	.16	.20	.04	.02	.19	.26	.18	.25	.22	.04	.02
No. nodes	5.50	5.75	5.50	5.50	5.56	.13	.06	5.50	6.00	5.25	5.75	5.63	.32	.16
June 25														
DM tops*	3.32		2.88		3.10	.31	.22	3.31		3.06		3.18	.18	.13
DM leaves	2.14		1.86		2.00	.20	.14	2.06		2.03		2.05	.02	.02
DM stems	1.18		1.01		1.09	.12	.08	1.25		1.03		1.14	.16	.11
Height (cm)	27.25	23.75	25.50	25.00	25.38	1.45	.73	27.00	25.88	24.38	24.88	25.53	1.16	.58
LAI	.38		.67		.52	.21	.15	.82		.78		.80	.02	.02
No. nodes	8.00	8.00	7.25	7.50	7.69	.38	.19	8.00	7.75	7.75	7.50	7.75	.20	.10
July 2														
DM tops*	10.60	13.64	10.85	8.31	10.85	2.18	1.09	11.85	12.28	12.21	11.41	11.93	.40	.20
DM leaves	6.88	8.32	6.48	4.89	6.64	1.41	.71	6.98	6.98	7.16	6.44	6.89	.31	.16
DM stems	3.72	5.32	4.37	3.43	4.21	.84	.42	4.87	5.29	5.05	4.97	5.04	.18	.09
Height (cm)	42.38	42.38	39.75	42.50	41.75	1.34	.67	39.38	39.75	43.50	41.00	40.91	1.86	.93
LAI	1.83	2.25	1.67	1.40	1.79	.35	.18	2.04	2.20	2.18	1.95	2.09	.12	.06
No. nodes	8.50	8.00	8.75	7.75	8.25	.46	.23	8.00	8.50	7.75	8.75	8.25	.46	.23

†DM = Dry matter in grams/plant.

*DM tops includes DM leaves and DM stems.

Table A2(a). (continued)

	Irrigated							Nonirrigated						
	Plot				$\bar{X}$	S	$S/\sqrt{n}$	Plot				$\bar{X}$	S	$S/\sqrt{n}$
	21/1	21/2	41/1	41/2				20/1	20/2	40/1	40/2			
July 9														
DM tops*	31.24		30.96		31.10	.20	.14	28.30		31.75		30.03	2.44	1.73
DM leaves	16.48		16.34		16.41	.10	.07	16.61		14.90		15.76	1.21	.86
DM stems	14.76		14.63		14.69	.10	.07	15.14		13.40		14.27	1.40	.99
Height (cm)	56.75	56.50	54.75	55.25	55.84	.99	.50	58.50	57.25	56.75	56.50	57.25	.89	.45
LAI	4.04		3.89		3.96	.10	.07	4.14		4.12		4.13	.01	.01
No. nodes	10.75	10.00	10.25	10.75	10.44	.38	.19	10.75	10.00	10.25	10.75	10.44	.38	.19
July 16														
DM tops*	47.89		45.81	48.78	47.49	1.52	.88	42.16	48.58	42.35		44.36	3.65	2.11
DM leaves	23.49		22.70	24.11	23.44	.71	.41	21.05	21.95	20.81		21.27	.60	.35
DM stems	24.39		23.11	24.66	24.06	.83	.48	21.11	26.63	21.55		23.10	3.07	1.77
Height (cm)	64.00	60.50	63.25	57.00	61.19	3.17	1.59	59.00	59.50	56.00	62.50	59.25	2.66	1.33
LAI	5.16		4.85	4.94	4.98	.16	.09	4.84	4.96	5.08		4.96	.12	.07
No. nodes	14.50	13.50	13.75	13.50	13.81	.47	.24	14.00	13.75	13.00	14.25	13.75	.54	.27
July 21														
DM tops**	61.33	60.25	68.35	69.18	64.78	4.64	2.32	56.55	61.10	62.05	56.90	59.15	2.83	1.42
DM leaves	24.20	21.05	24.00	24.60	23.46	1.63	.81	20.08	22.15	22.43	20.05	21.18	1.29	.65
DM stems	30.73	29.65	35.08	36.08	32.88	3.17	1.58	27.58	31.65	31.60	28.68	29.88	2.07	1.04
DM panicles	6.40	9.55	9.28	8.50	8.43	1.43	.71	8.90	7.30	8.03	8.18	8.10	.66	.33
Height (cm)	72.00	80.00	77.75	80.00	77.44	3.78	1.89	73.75	71.25	72.25	71.00	72.06	1.25	.62
LAI	4.69	4.51	4.38	4.97	4.64	.25	.13	4.45	4.48	4.97	4.18	4.52	.33	.16
No. nodes	15.00	15.75	15.50	15.50	15.44	.32	.16	15.25	14.50	15.00	15.00	14.94	.32	.16

** DM tops includes DM leaves, DM stems and DM panicles.

Table A2(a). (continued)

	Irrigated							Nonirrigated						
	Plot				$\bar{X}$	S	$S/\sqrt{n}$	Plot				$\bar{X}$	S	$S/\sqrt{n}$
	21/1	21/2	41/1	41/2				20/1	20/2	40/1	40/2			
August 1														
DM tops**	90.90	92.15	91.05	108.33	95.61	8.50	4.25	79.45	72.33	78.93	85.78	79.12	5.50	2.75
DM leaves	29.55	27.23	28.25	31.50	29.13	1.84	.92	20.60	21.93	23.40	26.15	23.02	2.38	1.19
DM stems	44.65	46.70	46.48	57.03	48.71	5.62	2.81	42.65	37.05	40.70	44.10	41.13	3.05	1.53
DM panicles	16.70	18.23	16.33	19.80	17.76	1.59	.79	16.20	13.35	14.83	15.53	14.98	1.22	.61
Height (cm)	115.25	113.00	97.50	116.25	110.50	8.77	4.39	91.50	86.75	88.50	91.75	89.63	2.42	1.21
LAI	3.94	4.31	3.89	4.09	4.06	.19	.10	3.09	2.72	3.20	3.71	3.18	.41	.20
No. nodes	16.00	16.25	16.25	16.25	16.19	.13	.06	16.00	16.25	15.75	16.50	16.13	.32	.16
August 6														
DM tops**	89.18	102.05	100.45	103.70	98.84	6.58	3.29	82.45	72.50	78.58	76.33	77.46	4.16	2.08
DM leaves	25.15	26.78	27.40	28.70	27.01	1.48	.74	19.48	19.50	20.18	19.65	19.70	.33	.16
DM stems	39.68	48.38	43.80	53.88	46.43	6.10	3.05	40.00	34.08	34.65	35.33	36.01	2.71	1.35
DM panicles	24.35	26.90	29.25	21.13	25.41	3.49	1.74	22.98	18.93	23.75	21.35	21.75	2.13	1.07
Height (cm)	110.25	109.75	111.25	117.75	112.25	3.72	1.86	94.75	88.50	93.50	87.75	91.13	3.52	1.76
LAI	3.36	3.96	3.62	4.44	3.84	.47	.23	2.80	2.73	2.31	2.44	2.57	.23	.12
No. nodes	16.25	16.25	16.50	16.50	16.38	.14	.07	16.00	16.25	16.25	16.00	16.13	.14	.07
August 18														
DM tops**	140.45	129.05	119.48	120.40	127.34	9.74	4.87	112.50	93.10	113.45	96.40	103.86	10.62	5.31
DM leaves	24.08	26.18	23.45	23.73	24.36	1.24	.62	21.05	17.85	23.20	25.40	21.88	3.22	1.61
DM stems	39.40	33.65	33.38	34.33	35.19	2.84	1.42	23.35	34.65	30.33	25.93	28.56	4.98	2.49
DM panicles	76.98	69.23	62.65	62.35	67.80	6.89	3.45	68.10	40.60	59.93	45.08	53.43	12.80	6.40
Height (cm)	115.75	116.50	111.50	113.00	114.19	2.34	1.17	93.75	84.75	91.75	86.75	89.25	4.20	2.10
LAI	3.35	3.60	2.77	3.58	3.33	.39	.20	2.94	1.27	2.84	2.94	2.50	.82	.41
No. nodes	16.50	16.25	16.25	16.00	16.25	.20	.10	16.00	16.00	16.25	16.25	16.13	.14	.07

Table A2(a). (continued)

	Irrigated							Nonirrigated						
	Plot				$\bar{X}$	S	$S/\sqrt{n}$	Plot				$\bar{X}$	S	$S/\sqrt{n}$
	21/1	21/2	41/1	41/2				20/1	20/2	40/1	40/2			
August 25														
DM tops**	150.88	152.18	120.58	146.88	142.63	14.87	7.44	126.38	120.90	120.58	137.30	126.29	7.81	3.91
DM leaves	25.80	24.55	20.10	24.53	23.74	2.50	1.25	22.95	21.95	23.95	22.63	22.87	.83	.42
DM stems	37.48	36.80	27.83	36.25	34.59	4.54	2.27	31.95	30.48	32.40	32.53	31.84	.94	.47
DM panicles	87.60	90.83	72.65	86.10	84.29	8.09	4.01	71.48	68.48	64.23	82.15	71.58	7.65	3.82
Height (cm)	115.00	119.00	116.50	113.25	115.94	2.44	1.22	93.00	91.25	92.75	89.00	91.50	1.84	.92
LAI	3.07	3.27	2.57	3.21	3.30	.32	.16	2.65	1.73	1.93	2.49	2.20	.44	.22
No. nodes	16.00	16.50	16.50	16.00	16.25	.29	.15	16.00	16.25	16.25	16.00	16.13	.14	.07
August 30														
DM tops**	153.98	171.98	147.25	151.68	156.22	10.87	5.43	127.05	127.73	135.90	115.50	126.54	8.39	4.20
DM leaves	24.73	25.33	23.68	23.98	24.43	.75	.37	22.85	22.23	22.18	20.88	22.03	.83	.42
DM stems	35.63	36.70	37.38	35.63	36.33	.86	.43	31.45	32.80	32.53	30.15	31.73	1.20	.60
DM panicles	93.63	109.95	86.20	92.08	95.46	10.17	5.09	72.75	72.70	81.20	64.48	72.78	6.83	3.41
Height (cm)	118.00	118.50	111.00	112.00	114.88	3.92	1.96	93.00	90.00	97.00	89.00	92.25	3.59	1.80
LAI	2.88	3.43	2.94	3.28	3.13	.26	.13	2.15	1.66	2.41	2.14	2.09	.31	.16
No. nodes	16.25	16.00	16.00	16.00	16.06	.13	.06	16.25	16.25	16.25	15.50	16.06	.38	.19
September 6														
DM tops**	137.18	155.35	143.20	138.95	143.67	8.19	4.09	132.15	117.70	122.23	127.30	124.84	6.25	3.13
DM leaves	21.2	20.73	20.58	21.83	21.08	.56	.28	23.78	19.83	19.58	18.95	20.53	2.19	1.10
DM stems	37.53	43.55	42.13	31.48	38.67	5.44	2.72	34.88	35.58	34.58	37.00	35.51	1.08	.54
DM panicles	78.45	91.08	80.50	85.65	83.92	5.65	2.83	73.50	62.30	68.08	71.35	68.98	4.86	2.43
Height (cm)	116.50	117.25	113.75	114.50	115.50	1.65	.82	94.50	91.75	91.00	91.25	92.13	1.61	.81
LAI	2.27	2.42	2.05	2.19	2.23	.15	.08	2.40	1.60	2.00	2.11	2.03	.33	.17
No. nodes	16.00	15.50	15.75	16.00	15.81	.24	.12	16.25	15.75	15.75	15.75	15.88	.25	.13

Table A2(a). (continued)

	Irrigated							Nonirrigated						
	Plot				$\bar{X}$	S	$S/\sqrt{n}$	Plot				$\bar{X}$	S	$S/\sqrt{n}$
	21/1	21/2	41/1	41/2				20/1	20/2	40/1	40/2			
September 13														
DM tops**	154.33	157.78	165.33	151.80	157.31	5.88	2.94	136.90	135.68	124.25	137.90	133.68	6.35	3.18
DM leaves	21.38	22.18	22.73	21.43	21.93	.65	.32	20.63	19.95	21.38	20.35	20.58	.60	.30
DM stems	37.75	40.30	40.18	37.55	38.94	1.50	.75	33.85	38.50	35.38	37.30	36.26	2.06	1.03
DM panicles	95.20	95.30	102.43	92.83	96.44	4.15	2.08	69.78	79.45	80.15	78.03	76.85	4.80	2.40
Height (cm)	115.25	114.25	111.50	117.25	114.56	2.39	1.20	93.50	93.25	94.50	94.00	93.81	.55	.28
LAI	2.50	2.28	2.35	2.42	2.39	.09	.05	2.06	2.03	2.41	1.66	2.04	.31	.15
No. nodes	16.25	15.75	15.50	16.00	15.88	.32	.16	15.75	15.75	15.75	16.00	15.81	.13	.06

Table A2(b). Sorghum grain yield and seed weight at 12.5% moisture content for irrigated and nonirrigated plots

Irrigated			Nonirrigated		
Plot	Grain yield (kg/ha)	Wt of 1000 seeds (g)	Plot	Grain yield (kg/ha)	Wt of 1000 seeds (g)
21/1	8650	25.46	20/1	6665	21.37
21/2	8255	25.09	20/2	5103	23.22
41/1	7980	24.19	40/1	5554	23.48
41/2	7405	25.19	40/2	7335	23.73
$\bar{X}$	8073	24.98	$\bar{X}$	6164	22.95
S	523	0.55	S	1020	1.07

Table A3(a). Total water in the 150 cm soil profile as a function of depth and time in irrigated and nonirrigated plots (cm)

Date	Depth (cm)	Irrigated				Nonirrigated			
		Plot		$\bar{X}$	S	Plot		$\bar{X}$	S
		21	41			20	40		
June 19	0-11	3.52	3.13	3.33	0.28	3.03	3.08	3.06	0.04
	11-22	4.04	4.39	4.22	0.25	3.77	4.16	3.97	0.28
	22-37	6.23	6.26	6.25	0.02	5.32	5.98	5.65	0.47
	37-52	6.20	6.34	6.27	0.10	4.02	6.29	5.16	1.61
	52-67	4.90	5.93	5.42	0.73	3.25	5.70	4.48	1.73
	67-82	4.32	5.01	4.67	0.49	2.87	4.79	3.83	1.36
	82-97	4.05	4.32	4.19	0.19	4.41	3.85	4.13	0.40
	97-112	4.39	4.61	4.50	0.16	4.34	4.62	4.48	0.20
	112-127	4.29	4.87	4.58	0.41	4.45	4.62	4.54	0.12
	127-142	4.40	4.31	4.36	0.06	5.17	5.07	5.12	0.07
	142-150	2.45	2.80	2.63	0.25	2.28	2.54	2.41	0.18
	TOTAL	48.79	51.97	50.38	2.25	42.91	50.70	46.81	5.51
June 30	0-11	3.41	3.35	3.38	0.04	3.28	3.36	3.32	0.06
	11-22	3.68	4.11	3.90	0.30	3.46	3.95	3.71	0.35
	22-37	6.05	5.96	6.01	0.06	5.25	5.82	5.54	0.40
	37-52	6.14	6.30	6.22	0.11	3.80	6.15	4.98	1.66
	52-67	4.59	5.68	5.14	0.77	3.06	5.59	4.33	1.79
	67-82	4.17	4.61	4.39	0.31	2.70	4.40	3.55	1.20
	82-97	3.84	4.11	3.98	0.19	4.27	3.61	3.94	0.47
	97-112	4.27	4.43	4.35	0.11	4.33	4.52	4.43	0.13
	112-127	4.11	4.75	4.43	0.45	4.32	4.61	4.47	0.21
	127-142	4.57	4.20	4.39	0.26	5.10	4.89	5.00	0.15
	142-150	2.55	2.64	2.60	0.06	2.23	2.51	2.37	0.20
	TOTAL	47.38	50.14	48.76	1.95	41.80	49.41	45.61	5.38
July 7	0-11	2.34	2.59	2.47	0.18	2.16	2.87	2.52	0.50
	11-22	2.90	3.13	3.02	0.16	2.71	3.12	2.92	0.29
	22-37	5.34	5.33	5.34	0.01	4.70	4.78	4.74	0.06
	37-52	5.89	6.07	5.98	0.13	3.56	5.65	4.61	1.48
	52-67	4.48	5.78	5.13	0.92	2.78	5.30	4.04	1.78
	67-82	3.88	4.67	4.28	0.56	2.42	4.37	3.40	1.38
	82-97	3.50	3.89	3.70	0.28	4.03	3.36	3.70	0.47
	97-112	4.03	4.28	4.16	0.18	4.19	4.34	4.27	0.11
	112-127	4.08	4.54	4.31	0.33	4.24	4.42	4.33	0.13
	127-142	4.56	4.26	4.41	0.21	5.06	4.86	4.96	0.14
	142-150	2.46	2.72	2.59	0.18	2.22	2.52	2.37	0.21
	TOTAL	43.46	47.26	45.36	2.69	38.07	45.59	41.83	5.32

Table A3(a). (continued)

Date	Depth (cm)	Irrigated				Nonirrigated			
		Plot		$\bar{X}$	S	Plot		$\bar{X}$	S
		21	41			20	40		
July 16	0-11	2.06	2.50	2.28	0.31	1.32	1.43	1.38	0.08
	11-22	3.57	3.64	3.61	0.05	2.25	2.76	2.51	0.36
	22-37	5.41	5.32	5.37	0.06	3.66	4.21	3.94	0.39
	37-52	5.77	5.81	5.79	0.03	2.12	4.93	3.53	1.99
	52-67	4.35	5.71	5.03	0.96	1.49	4.82	3.16	2.35
	67-82	3.59	4.51	4.05	0.65	1.66	3.47	2.57	1.28
	82-97	3.12	3.77	3.45	0.46	3.61	2.60	3.11	0.71
	97-112	3.82	4.08	3.95	0.18	3.96	3.79	3.88	0.12
	112-127	3.93	4.67	4.30	0.52	4.18	4.34	4.26	0.11
	127-142	4.33	4.15	4.24	0.13	4.91	4.69	4.80	0.16
	142-150	2.40	2.64	2.52	0.17	2.17	2.47	2.32	0.21
	TOTAL	42.35	46.80	44.58	3.15	31.33	39.51	35.42	5.78
July 24	0-11	3.97	4.09	4.03	0.08	1.50	2.03	1.77	0.37
	11-22	4.33	4.11	4.22	0.16	2.09	2.60	2.35	0.36
	22-37	6.05	5.59	5.82	0.33	3.33	3.94	3.64	0.43
	37-52	5.90	5.66	5.78	0.17	1.68	4.37	3.03	1.90
	52-67	4.03	5.44	4.74	1.00	0.97	3.28	2.13	1.63
	67-82	3.09	4.11	3.60	0.72	1.05	1.99	1.52	0.66
	82-97	2.56	3.31	2.94	0.53	2.45	1.86	2.16	0.42
	97-112	2.97	3.56	3.27	0.42	3.05	3.39	3.22	0.24
	112-127	3.76	4.35	4.06	0.42	3.85	4.17	4.01	0.23
	127-142	4.07	3.95	4.01	0.08	4.61	4.49	4.55	0.08
	142-150	2.24	2.58	2.41	0.24	1.95	2.35	2.15	0.28
	TOTAL	42.97	46.75	44.86	2.67	26.53	34.47	30.50	5.61
July 31	0-11	2.72	2.18	2.45	0.38	1.46	1.73	1.60	0.19
	11-22	3.19	3.23	3.21	0.03	2.01	2.48	2.25	0.33
	22-37	5.22	4.88	5.05	0.24	3.10	3.68	3.39	0.41
	37-52	5.45	5.34	5.40	0.08	1.69	4.07	2.88	1.68
	52-67	3.66	5.27	4.47	1.14	0.94	2.90	1.92	1.39
	67-82	2.80	3.94	3.37	0.81	0.83	1.50	1.17	0.47
	82-97	2.37	2.98	2.68	0.43	1.74	1.54	1.64	0.14
	97-112	2.88	3.38	3.13	0.35	2.14	3.33	2.74	0.84
	112-127	3.60	4.30	3.95	0.49	3.44	3.99	3.72	0.39
	127-142	4.01	3.92	3.97	0.06	4.53	4.42	4.48	0.08
	142-150	2.22	2.50	2.36	0.20	1.81	2.26	4.04	0.32
	TOTAL	38.12	41.92	40.02	2.69	23.69	31.90	27.80	5.81

Table A3(a). (continued)

Date	Depth (cm)	Irrigated				Nonirrigated			
		Plot		$\bar{X}$	S	Plot		$\bar{X}$	S
		21	41			20	40		
Aug. 5	0-11	2.12	1.88	2.00	0.17	1.15	2.31	1.73	0.82
	11-22	2.93	3.01	2.97	0.06	1.96	2.38	2.17	0.30
	22-37	4.67	4.61	4.64	0.04	3.06	3.54	3.30	0.34
	37-52	5.14	5.17	5.16	0.02	1.72	3.96	2.84	1.58
	52-67	3.18	5.00	4.09	1.29	0.88	2.72	1.80	1.30
	67-82	2.09	3.39	2.74	0.92	0.78	1.31	1.05	0.37
	82-97	2.01	2.71	2.36	0.49	1.44	1.27	1.36	0.12
	97-112	2.63	2.88	2.76	0.18	1.97	2.74	2.36	0.54
	112-127	3.59	4.05	3.82	0.33	3.24	3.72	3.48	0.34
	127-142	3.90	3.93	3.92	0.02	4.33	4.24	4.29	0.06
	142-150	2.19	2.53	2.36	0.24	1.71	2.22	1.97	0.36
	TOTAL	34.45	39.16	36.81	3.33	22.24	30.41	26.33	5.78
Aug. 20	0-11	3.28	3.03	3.16	0.18	3.03	3.28	3.16	0.18
	11-22	3.98	4.11	4.05	0.09	3.29	3.86	3.58	0.40
	22-37	5.93	5.67	5.80	0.18	4.32	5.25	4.79	0.66
	37-52	5.97	5.57	5.77	0.28	2.61	5.43	4.02	1.99
	52-67	3.48	5.11	4.30	1.15	1.48	4.08	2.78	1.84
	67-82	2.30	3.17	2.74	0.62	0.81	1.98	1.40	0.83
	82-97	1.86	2.48	2.17	0.44	1.42	1.24	1.33	0.13
	97-112	2.54	2.83	2.69	0.21	1.83	2.57	2.20	0.52
	112-127	3.51	4.12	3.82	0.43	2.97	3.38	3.18	0.29
	127-142	3.91	3.84	3.88	0.05	4.10	3.87	3.99	0.16
	142-150	2.16	2.43	2.30	0.19	1.62	2.09	1.86	0.33
	TOTAL	38.92	42.36	40.64	2.43	27.48	37.03	32.26	6.75
Sep. 1	0-11	2.50	2.55	2.53	0.04	2.36	2.53	2.45	0.12
	11-22	3.07	3.38	3.23	0.22	2.51	3.09	2.80	0.41
	22-37	4.83	5.00	4.92	0.12	3.81	4.48	4.15	0.47
	37-52	5.18	5.31	5.25	0.09	2.09	4.80	3.45	1.92
	52-67	2.94	4.86	3.90	1.36	1.16	3.45	2.31	1.62
	67-82	1.93	3.05	2.49	0.79	0.80	1.52	1.16	0.51
	82-97	1.76	2.47	2.12	0.50	1.48	1.16	1.32	0.23
	97-112	2.51	2.81	2.66	0.21	1.91	2.60	2.26	0.49
	112-127	3.40	3.40	3.40	0.00	2.99	3.34	3.17	0.25
	127-142	3.89	3.76	3.83	0.09	4.02	3.88	3.95	0.10
	142-150	2.12	2.42	2.27	0.21	1.68	1.98	1.83	0.21
	TOTAL	34.13	39.01	36.57	3.45	24.81	32.83	28.82	5.67

Table A3(a). (continued)

Date	Depth (cm)	Irrigated				Nonirrigated			
		Plot		$\bar{X}$	S	Plot		$\bar{X}$	S
		21	41			20	40		
Sep. 13	0-11	3.51	3.57	3.54	0.04	3.20	3.51	3.36	0.22
	11-22	3.91	3.87	3.89	0.03	3.35	3.83	3.59	0.34
	22-37	5.52	5.19	5.36	0.23	4.61	4.94	4.78	0.23
	37-52	5.40	5.31	5.36	0.06	2.65	5.23	3.94	1.82
	52-67	3.28	4.91	4.10	1.15	1.45	3.57	2.51	1.50
	67-82	1.90	3.01	2.46	0.78	0.87	1.63	1.25	0.54
	82-97	2.25	2.31	2.28	0.04	1.40	1.16	1.28	0.17
	97-112	2.45	2.72	2.59	0.19	2.04	2.56	2.30	0.37
	112-127	3.33	3.85	3.59	0.37	2.96	3.47	3.22	0.36
	127-142	3.82	3.60	3.71	0.16	4.10	3.82	3.96	0.20
	142-150	2.03	2.40	2.22	0.26	1.54	2.02	1.78	0.34
	TOTAL	37.40	40.74	39.07	2.36	28.17	35.74	31.96	5.35

Table A3(b). Available water in the 150 cm soil profile as a function of depth and time in irrigated and nonirrigated plots (cm).

Date	Depth (cm)	Irrigated				Nonirrigated			
		Plot		$\bar{X}$	S	Plot		$\bar{X}$	S
		21	41			20	40		
June 19	0-11	1.62	1.23	1.43	0.28	1.13	1.18	1.16	0.04
	11-22	1.95	1.95	1.95	0.00	1.76	1.95	1.86	0.13
	22-37	2.73	2.73	2.73	0.00	2.40	2.73	2.57	0.23
	37-52	2.76	2.76	2.76	0.00	0.88	2.76	1.82	1.33
	52-67	2.66	3.00	2.83	0.24	1.01	3.00	2.01	1.41
	67-82	3.22	3.22	3.22	0.00	1.87	3.22	2.55	0.95
	82-97	2.63	2.63	2.63	0.00	2.63	2.63	2.63	0.00
	97-112	2.82	2.82	2.82	0.00	2.82	2.82	2.82	0.00
	112-127	3.34	3.57	3.46	0.16	3.50	3.57	3.54	0.05
	127-142	3.43	3.34	3.39	0.06	3.63	3.63	3.63	0.00
	142-150	1.88	1.88	1.88	0.00	1.87	1.88	1.88	0.01
	Total	29.04	29.13	29.09	0.06	23.50	29.37	26.44	4.15
June 30	0-11	1.51	1.45	1.48	0.04	1.38	1.46	1.42	0.06
	11-22	1.67	1.95	1.81	0.20	1.45	1.94	1.70	0.35
	22-37	2.73	2.73	2.73	0.00	2.33	2.73	2.53	0.28
	37-52	2.76	2.76	2.76	0.00	0.66	2.76	1.71	1.48
	52-67	2.35	3.00	2.68	0.46	0.82	3.00	1.91	1.54
	67-82	3.17	3.22	3.20	0.04	1.70	3.22	2.46	1.07
	82-97	2.63	2.63	2.63	0.00	2.63	2.63	2.63	0.00
	97-112	2.82	2.82	2.82	0.00	2.82	2.82	2.82	0.00
	112-127	3.16	3.57	3.37	0.29	3.37	3.57	3.47	0.14
	127-142	3.60	3.23	3.42	0.26	3.63	3.63	3.63	0.00
	142-150	1.88	1.88	1.88	0.00	1.82	1.88	1.85	0.04
	Total	28.28	29.24	28.76	0.68	22.61	29.64	26.13	4.97
July 7	0-11	0.44	0.69	0.57	0.18	0.26	0.97	0.62	0.50
	11-22	0.89	1.12	1.01	0.16	0.70	1.11	0.91	0.29
	22-37	2.42	2.41	2.42	0.01	1.78	1.86	1.82	0.06
	37-52	2.75	2.76	2.76	0.01	0.42	2.51	1.47	1.48
	52-67	2.24	3.00	2.62	0.54	0.54	3.00	1.77	1.74
	67-82	2.88	3.22	3.05	0.24	1.42	3.22	2.32	1.27
	82-97	2.52	2.63	2.58	0.08	2.63	2.38	2.51	0.18
	97-112	2.82	2.82	2.82	0.00	2.82	2.82	2.82	0.00
	112-127	3.13	3.57	3.35	0.31	3.29	3.47	3.38	0.13
	127-142	3.59	3.29	3.44	0.21	3.63	3.63	3.63	0.00
	142-150	1.88	1.88	1.88	0.00	1.81	1.88	1.85	0.05
	Total	25.56	27.39	26.48	1.29	19.30	26.85	23.08	5.34

Table A3(b). (continued)

Date	Depth (cm)	Irrigated Plot 21	Irrigated Plot 41	Irrigated $\bar{X}$	Irrigated S	Nonirrigated Plot 20	Nonirrigated Plot 40	Nonirrigated $\bar{X}$	Nonirrigated S
July 16	0-11	0.16	0.60	0.38	0.31	-0.58	-0.47	-0.53	0.08
	11-22	1.56	1.63	1.60	0.05	0.24	0.75	0.50	0.36
	22-37	2.49	2.40	2.45	0.06	0.74	1.29	1.01	0.39
	37-52	2.63	2.67	2.65	0.03	-1.02	1.79	0.39	1.99
	52-67	2.11	3.00	2.56	0.63	-0.75	2.58	0.92	2.35
	67-82	2.59	3.22	2.91	0.45	0.66	2.47	1.57	1.28
	82-97	2.14	2.63	2.39	0.35	2.63	1.62	2.13	0.71
	97-112	2.82	2.82	2.82	0.00	2.82	2.82	2.82	0.00
	112-127	2.98	3.57	3.28	0.42	3.23	3.39	3.31	0.11
	127-142	3.36	3.18	3.27	0.13	3.63	3.63	3.63	0.00
	142-150	1.88	1.88	1.88	0.00	1.76	1.88	1.82	0.08
	Total	24.72	27.60	26.16	2.04	13.36	21.75	17.56	5.93
July 24	0-11	2.05	2.05	2.05	0.00	-0.40	0.13	-0.14	0.37
	11-22	1.95	1.95	1.95	0.00	0.08	0.59	0.34	0.36
	22-37	2.73	2.67	2.70	0.04	0.41	1.02	0.72	0.43
	37-52	2.76	2.52	2.64	0.17	-1.46	1.23	-0.12	1.90
	52-67	1.79	3.00	2.40	0.86	-1.27	1.04	-0.12	1.63
	67-82	2.09	3.11	2.60	0.72	0.05	0.99	0.52	0.66
	82-97	1.58	2.33	1.96	0.53	1.47	0.88	1.18	0.42
	97-112	2.05	2.64	2.35	0.42	2.13	2.47	2.30	0.24
	112-127	2.81	3.40	3.11	0.42	2.90	3.22	3.06	0.23
	127-142	3.10	2.98	3.04	0.08	3.63	3.52	3.58	0.08
	142-150	1.83	1.88	1.86	0.04	1.54	1.88	1.71	0.24
	Total	24.74	28.53	26.64	2.68	9.08	16.97	13.03	5.58
July 31	0-11	0.82	0.28	0.55	0.38	-0.44	-0.17	-0.31	0.19
	11-22	1.18	1.22	1.20	0.03	0.00	0.47	0.24	0.33
	22-37	2.30	1.96	2.11	0.24	0.18	0.76	0.47	0.41
	37-52	2.31	2.20	2.26	0.08	-1.45	0.93	-0.26	1.68
	52-67	1.42	3.00	2.21	1.12	-1.30	0.66	-0.32	1.39
	67-82	1.80	2.94	2.37	0.81	-0.17	0.50	0.17	0.47
	82-97	1.39	2.00	1.70	0.43	0.76	0.56	0.66	0.14
	97-112	1.96	2.46	2.21	0.35	1.22	2.41	1.82	0.84
	112-127	2.65	3.35	3.00	0.49	2.49	3.04	2.77	0.39
	127-142	3.04	2.95	3.00	0.06	3.56	3.45	3.51	0.08
	142-150	1.81	1.88	1.85	0.05	1.40	1.85	1.63	0.32
	Total	20.68	24.24	22.46	2.52	6.25	14.46	10.36	5.81

Table A3(b). (continued)

Date	Depth (cm)	Irrigated Plot 21	Irrigated Plot 41	Irrigated $\bar{X}$	Irrigated S	Nonirrigated Plot 20	Nonirrigated Plot 40	Nonirrigated $\bar{X}$	Nonirrigated S
Aug. 5	0-11	0.22	-0.02	0.10	0.17	-0.75	0.41	-0.17	0.82
	11-22	0.92	1.00	0.96	0.06	-0.05	0.37	0.16	0.30
	22-37	1.75	1.69	1.72	0.04	0.14	0.62	0.38	0.34
	37-52	2.00	2.03	2.02	0.02	-1.42	0.82	-0.30	1.58
	52-67	0.94	2.76	1.85	1.29	-1.36	0.48	-0.44	1.30
	67-82	1.09	2.39	1.74	0.92	-0.22	0.31	0.05	0.37
	82-97	1.03	1.73	1.38	0.49	0.46	0.29	0.38	0.12
	97-112	1.71	1.96	1.84	0.18	1.05	1.82	1.44	0.54
	112-127	2.64	3.10	2.87	0.33	2.29	2.77	2.53	0.34
	127-142	2.93	2.96	2.95	0.02	3.36	3.27	3.32	0.06
	142-150	1.78	1.88	1.83	0.07	1.30	1.81	1.56	0.36
	Total	17.01	21.48	19.25	3.16	4.80	12.97	8.89	5.78
Aug. 20	0-11	1.38	1.13	1.26	0.18	1.13	1.38	1.26	0.18
	11-22	1.95	1.95	1.95	0.00	1.28	1.85	1.57	0.40
	22-37	2.73	2.73	2.73	0.00	1.40	2.33	1.87	0.66
	37-52	2.76	2.43	2.60	0.23	-0.53	2.29	0.88	1.99
	52-67	1.24	2.87	2.06	1.15	-0.76	1.84	0.54	1.84
	67-82	1.30	2.17	1.74	0.62	-0.19	0.98	0.40	0.83
	82-97	0.88	1.50	1.19	0.44	-0.44	0.26	0.35	0.13
	97-112	1.62	1.91	1.77	0.21	-0.91	1.65	1.28	0.52
	112-127	2.56	3.17	2.87	0.43	2.02	2.43	2.23	0.29
	127-142	2.94	2.87	2.91	0.05	3.13	2.90	3.02	0.16
	142-150	1.75	1.88	1.82	0.09	1.21	1.68	1.45	0.33
	Total	21.11	24.61	22.86	2.47	10.04	19.59	14.82	6.75
Sep. 1	0-11	0.60	0.65	0.63	0.04	0.46	0.63	0.55	0.12
	11-22	1.06	1.37	1.22	0.22	0.50	1.08	0.79	0.41
	22-37	1.91	2.08	2.00	0.12	0.89	1.56	1.23	0.47
	37-52	2.04	2.17	2.11	0.09	-1.05	1.66	0.31	1.92
	52-67	0.70	2.62	1.66	1.36	-1.08	1.21	0.07	1.62
	67-82	0.93	2.05	1.49	0.79	-0.20	0.52	0.16	0.51
	82-97	0.78	1.49	1.14	0.50	0.50	0.18	0.34	0.23
	97-112	1.59	1.89	1.74	0.21	0.99	1.68	1.34	0.49
	112-127	2.45	2.45	2.45	0.00	2.04	2.39	2.22	0.25
	127-142	2.92	2.79	2.86	0.09	3.05	2.91	2.98	0.10
	142-150	1.71	1.88	1.80	0.12	1.27	1.57	1.42	0.21
	Total	16.69	21.44	19.07	3.36	7.37	15.39	11.38	5.67

Table A3(b). (continued)

Date	Depth (cm)	Irrigated Plot 21	Irrigated Plot 41	Irrigated $\bar{X}$	Irrigated S	Nonirrigated Plot 20	Nonirrigated Plot 40	Nonirrigated $\bar{X}$	Nonirrigated S
Sep. 13	0-11	1.61	1.67	1.64	0.04	1.30	1.61	1.46	0.22
	11-22	1.90	1.86	1.88	0.03	1.34	1.82	1.58	0.34
	22-37	2.60	2.27	2.44	0.23	1.69	2.02	1.86	0.23
	37-52	2.26	2.17	2.22	0.06	-0.49	2.09	0.80	1.82
	52-67	1.04	2.67	1.86	1.15	-0.79	1.33	0.27	1.50
	67-82	0.90	2.01	1.46	0.78	-0.13	0.63	0.25	0.54
	82-97	1.27	1.33	1.30	0.04	0.42	0.18	0.30	0.17
	97-112	1.53	1.80	1.67	0.19	1.12	1.64	1.38	0.37
	112-127	2.38	2.90	2.64	0.37	2.01	2.52	2.27	0.36
	127-142	2.85	2.63	2.74	0.16	3.13	2.85	2.99	0.20
	142-150	1.62	1.88	1.75	0.18	1.13	1.61	1.37	0.34
	Total	19.96	23.19	21.58	2.28	10.73	18.30	14.52	5.35

Table A4. Irrigation and water schedule

Date	Stage	Water (in.)	Water (cm)
July 9	3.9	4.02	10.2
July 22	5.4	4.02	10.2
Aug. 8	7.0	4.41	11.2
Total		12.45	31.6

Table B1. Root dry matter, combined values of samples in row and 1/3 row, as a function of depth and time under five varieties of grain sorghum (g/1.08 dm^2 soil surface).

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Date	Depth (cm)	Plot 51/1	51/2	55/1	55/2	59/1	59/2	$\bar{X}$	S
July 1	0-7.5	0.840	2.608	0.610	0.780	3.240	1.410	1.581	1.093
	7.5-15	.010	.049	.010	.035	.070	.041	.036	.023
	15-30	.010	.020	T	.010	.029	.030	.017	.012
	30-45	T*	T	T	T	T	T	-	-
	45-60	T	T	T	T	T	T	-	-
	60-75	-	-	-	-	T	T	-	-
	Total	0.860	2.677	0.620	0.825	3.339	1.481	1.634	1.123
July 30	0-7.5	5.933	9.721	10.467	5.478	9.681	8.214	8.249	2.106
	7.5-15	.576	.421	.751	.438	.708	.342	.539	.166
	15-30	.657	.183	.191	.229	.672	.153	.348	.247
	30-45	.157	.176	.180	.171	.105	.076	.144	.043
	45-60	.309	.186	.313	.196	.132	.129	.211	.082
	60-75	.373	.528	.297	.184	.241	.239	.310	.124
	75-90	.278	.268	.184	.200	.082	.034	.174	.098
	90-105	.145	.066	.123	.190	.062	.032	.103	.060
	105-120	.085	.033	.176	.113	.020	.029	.076	.061
	120-135	.031	.011	.056	.036	.016	.011	.027	.018
	135-150	.014	.002	.013	.014	.007	.002	.009	.006
	150-165	T	T	.006	T	-	-	.001	.002
	Total	8.558	11.595	12.757	7.249	11.726	9.261	10.191	2.149
Aug. 20	0-7.5	6.432	5.512	10.640	3.742	6.618	5.652	6.418	2.306
	7.5-15	.219	.162	.210	1.360	.868	.435	.542	.479
	15-30	.133	.122	.134	.229	.155	.111	.147	.043
	30-45	.100	.136	.110	.155	.085	.110	.116	.025
	45-60	.111	.181	.130	.172	.124	.099	.136	.033
	60-75	.110	.208	.199	.119	.123	.269	.171	.064
	75-90	.108	.172	.119	.198	.167	.057	.137	.052
	90-105	.057	.092	.140	.162	.079	.031	.094	.050
	105-120	.024	.034	.158	.127	.040	.024	.068	.059
	120-135	.006	.018	.143	.126	.010	.009	.052	.064
	135-150	T	.011	.020	.006	.006	.003	.008	.007
	150-165	-	-	T	.002	.001	-	.001	.001
	Total	7.300	6.648	12.003	6.398	8.276	6.800	7.904	2.115

*T = Trace

Table B1. (continued)

Date	Depth (cm)	NC42Y Plot 57/1	57/2	61/1	61/2	64/1	64/2	$\bar{X}$	S
July 1	0-7.5	0.607	0.353	0.280	0.980	1.302	0.720	0.707	0.386
	7.5-15	.046	.018	.021	.081	.030	.026	.037	.024
	15-30	.014	.029	.030	.016	.006	.021	.019	.009
	30-45	T	T	.050	.018	.005	T	.012	.020
	45-60	T	-	T	.022	T	T	.004	.009
	60-75	-	-	-	.004	T	-	.001	.002
	75-90	-	-	-	T	-	-	-	-
	Total	0.667	0.400	0.381	1.121	1.343	0.767	0.780	0.387
July 30	0-7.5	13.580	5.632	9.392	8.771	12.132	9.749	9.876	2.767
	7.5-15	.997	.262	.222	.180	.809	.418	.481	.342
	15-30	.132	.183	.124	.183	.286	.205	.186	.059
	30-45	.267	.123	.128	.165	.175	.166	.171	.052
	45-60	.153	.125	.180	.245	.142	.101	.158	.050
	60-75	.119	.270	.223	.228	.166	.215	.204	.053
	75-90	.184	.215	.188	.103	.123	.197	.168	.045
	90-105	.100	.057	.036	.032	.102	.116	.074	.037
	105-120	.102	.063	.047	.071	.086	.045	.069	.022
	120-135	.074	.052	.077	.040	.057	.078	.063	.016
	135-150	.043	.048	.055	.026	.026	.048	.041	.012
	150-165	.019	.017	.028	.009	.017	.069	.027	.022
	165-180	.012	.005	.003	.002	.017	.013	.009	.006
	180-195	.004	-	-	-	-	.002	.001	.002
	Total	15.786	7.052	10.703	10.055	14.138	11.422	11.526	3.093
Aug. 20	0-7.5	13.123	11.500	10.820	4.971	8.109	9.535	9.676	2.868
	7.5-15	1.624	.254	.685	2.065	.122	.183	.822	.828
	15-30	.154	.215	.152	.180	.101	.126	.155	.040
	30-45	.128	.096	.093	.100	.234	.082	.122	.057
	45-60	.220	.170	.112	.105	.157	.148	.152	.042
	60-75	.094	.091	.095	.113	.275	.386	.176	.125
	75-90	.229	.180	.125	.055	.165	.160	.152	.058
	90-105	.196	.165	.081	.100	.107	.136	.131	.043
	105-120	.152	.120	.061	.072	.082	.138	.104	.038
	120-135	.057	.034	.033	.026	.054	.081	.048	.021
	135-150	.026	.017	.023	.011	.073	.057	.035	.025
	150-165	.008	.007	.011	.003	.017	.013	.010	.005
	165-180	.001	.002	T	.001	.006	.003	.002	.002
	180-195	T	-	-	-	.002	T	.000	.001
	Total	16.012	12.851	12.291	7.802	9.504	11.048	11.585	2.851

Table B1. (continued)

Date	Depth (cm)	Pioneer 846 Plot 52/1	52/2	58/1	58/2	62/1	62/2	$\bar{X}$	S
July 1	0-7.5	2.160	1.307	1.270	1.400	0.888	0.942	1.328	0.457
	7.5-15	.005	.040	.052	.030	.031	.026	.031	.016
	15-30	.029	.005	.049	.028	.017	.032	.027	.015
	30-45	T	.005	.030	.002	.026	.026	.015	.014
	45-60	T	T	T	T	T	.019	.003	.008
	60-75	-	-	T	-	-	-	-	-
	Total	2.194	1.357	1.401	1.460	0.962	1.045	1.403	0.437
July 30	0-7.5	14.536	15.220	7.058	7.172	7.049	12.087	10.520	3.897
	7.5-15	.354	.463	.354	.205	1.101	.593	.512	.316
	15-30	.250	.136	.104	.089	.181	.128	.148	.059
	30-45	.058	.091	.118	.113	.161	.127	.111	.035
	45-60	.105	.119	.135	.168	.209	.273	.168	.064
	60-75	.088	.080	.175	.297	.326	.121	.181	.107
	75-90	.131	.045	.049	.231	.124	.067	.108	.071
	90-105	.066	.047	.050	.060	.051	.053	.055	.007
	105-120	.037	.023	.035	.030	.087	.135	.058	.044
	120-135	.029	.015	.022	.015	.041	.061	.031	.018
	135-150	.018	.002	.015	.007	.008	.016	.011	.006
	150-165	-	.007	-	-	T	.002	.002	.003
	Total	15.672	16.248	8.115	8.387	9.338	13.663	11.904	3.728
Aug. 20	0-7.5	5.951	8.794	7.086	6.985	9.888	8.526	7.872	1.445
	7.5-15	1.796	.465	.338	.856	1.096	.173	.787	.600
	15-30	.198	.237	.147	.305	.130	.077	.182	.082
	30-45	.138	.131	.090	.073	.110	.115	.110	.025
	45-60	.159	.200	.153	.069	.140	.160	.147	.043
	60-75	.126	.088	.079	.100	.147	.149	.115	.030
	75-90	.136	.128	.230	.111	.167	.173	.158	.043
	90-105	.043	.038	.089	.045	.112	.099	.071	.033
	105-120	.032	.029	.034	.037	.098	.129	.060	.043
	120-135	.012	.016	.016	.023	.037	.046	.025	.014
	135-150	.004	.007	.003	.003	.011	.007	.006	.003
	150-165	-	.002	-	-	T	.002	.001	.001
	Total	8.595	10.135	8.265	8.607	11.936	9.656	9.532	1.378

Table B1. (continued)

Date	Depth (cm)	F65A Plot 53/1	53/2	54/1	54/2	60/1	60/2	$\bar{X}$	S
July 1	0-7.5	1.670	1.610	0.209	2.130	0.400	0.992	1.169	0.763
	7.5-15	.140	.078	.075	.110	.046	.080	.088	.033
	15-30	T	.020	.020	.010	.030	.020	.017	.010
	30-45	.006	.020	.008	T	T	.010	.007	.007
	45-60	.002	T	T	T	.004	T	.001	.002
	60-75	-	-	-	-	T	T	-	-
	Total	1.818	1.728	0.312	2.250	0.480	1.102	1.282	0.780
July 30	0-7.5	12.649	11.805	7.808	6.411	13.107	14.901	11.114	3.292
	7.5-15	1.312	.354	.372	.835	.984	.803	.777	.368
	15-30	.380	.107	.133	.412	.413	.319	.294	.139
	30-45	.199	.073	.135	.141	.191	.143	.147	.045
	45-60	.161	.098	.328	.376	.124	.181	.211	.114
	60-75	.288	.198	.213	.169	.165	.137	.195	.053
	75-90	.315	.184	.392	.132	.295	.198	.253	.097
	90-105	.144	.211	.078	.211	.126	.038	.135	.070
	105-120	.081	.143	.095	.154	.016	.008	.083	.061
	120-135	.103	.070	.067	.051	.009	.007	.051	.037
	135-150	.028	.031	.052	.030	.004	.001	.024	.019
	150-165	.011	.037	-	.012	.004	-	.014	.016
	Total	15.671	13.311	9.673	8.934	15.438	16.736	13.294	3.293
Aug. 20	0-7.5	12.810	8.105	7.375	6.720	7.140	6.660	8.135	2.350
	7.5-15	.416	.550	1.820	.650	.860	.140	.739	.581
	15-30	.105	.136	.080	.239	1.051	.163	.296	.374
	30-45	.068	.146	.085	.130	.265	.106	.133	.071
	45-60	.074	.185	.210	.160	.085	.270	.164	.075
	60-75	.168	.170	.170	.085	.305	.088	.164	.080
	75-90	.088	.340	.040	.065	.248	.199	.163	.118
	90-105	.131	.164	.045	.085	.249	.260	.156	.087
	105-120	.168	.110	.040	.115	.107	.079	.103	.042
	120-135	.063	.050	.035	.045	.040	.020	.042	.014
	135-150	.005	.016	.080	.023	.007	.008	.023	.029
	150-165	.010	.003	T	.003	-	.002	.003	.004
	165-180	-	-	-	-	-	T	-	-
	Total	14.106	9.975	9.980	8.320	10.357	7.995	10.122	2.179

Table B1. (continued)

Date	Depth (cm)	F61 Plot 56/1	56/2	63/1	63/2	65/1	65/2	$\bar{X}$	S
July 1	0-7.5	0.710	0.490	0.619	1.066	1.316	0.562	0.794	0.326
	7.5-15	.052	.018	.007	.056	.032	.030	.033	.019
	15-30	.023	.012	.016	.043	.026	.007	.021	.013
	30-45	T	.016	.004	.003	T	.002	.004	.006
	45-60	-	-	.003	.004	T	T	.001	.002
	60-75	-	-	T	T	-	-	-	-
	Total	0.785	0.536	0.649	1.172	1.374	0.601	0.853	0.342
July 30	0-7.5	9.371	5.941	11.292	12.101	10.333	10.991	10.005	2.193
	7.5-15	.452	1.059	1.950	.561	.220	.236	.746	.664
	15-30	.446	.222	.329	.574	.194	.427	.365	.145
	30-45	.185	.095	.128	.215	.149	.214	.164	.049
	45-60	.141	.120	.222	.271	.094	.272	.187	.078
	60-75	.162	.266	.179	.302	.259	.083	.209	.082
	75-90	.302	.178	.092	.165	.048	.063	.141	.095
	90-105	.125	.057	.081	.051	.074	.066	.076	.027
	105-120	.150	.064	.059	.048	.072	.036	.072	.040
	120-135	.146	.087	.030	.020	.030	.043	.059	.049
	135-150	.047	.027	.031	.015	.017	.020	.026	.012
	150-165	.022	.022	.011	.009	.013	.013	.015	.006
	165-180	.003	.004	.002	.003	T	.003	.003	.001
	Total	11.552	8.142	14.406	14.335	11.503	12.467	12.068	2.314
Aug. 20	0-7.5	6.910	8.081	7.845	5.850	8.170	9.060	7.653	1.120
	7.5-15	1.340	.330	.308	.931	.735	.828	.745	.390
	15-30	.145	.140	.166	.182	.414	.146	.199	.107
	30-45	.160	.055	.169	.169	.199	.115	.145	.052
	45-60	.110	.115	.126	.195	.110	.356	.169	.097
	60-75	.230	.168	.260	.146	.260	.346	.235	.072
	75-90	.190	.109	.176	.125	.085	.060	.124	.051
	90-105	.175	.095	.111	.070	.105	.136	.115	.036
	105-120	.056	.097	.066	.081	.197	.118	.103	.051
	120-135	.070	.090	.068	.031	.045	.063	.061	.021
	135-150	.055	.080	.018	.031	.025	.044	.042	.023
	150-165	.025	.031	.008	.006	.006	.012	.015	.011
	165-180	T	.002	-	-	T	-	.000	.001
	Total	9.466	9.393	9.321	7.817	10.351	11.284	9.605	1.159

Table B2(a). Plant top parameters measured during the season for five sorghum varieties.

RS610

	Plot			$\bar{X}$	S		Plot			$\bar{X}$	S
	51	55	59				51	55	59		
July 2						Aug. 18					
DM† tops*	28.62	50.21	44.97	41.27	11.26		499.80	530.80	595.80	542.13	48.99
DM leaves	17.98	27.84	27.74	24.52	5.66		86.90	82.90	107.50	92.43	13.20
DM stems	10.64	22.37	17.23	16.75	5.88		137.80	159.80	191.10	162.90	26.79
DM panicles	---	---	---	---	---		275.10	288.10	297.20	286.80	11.11
Height (cm)	33.5	44.0	41.0	39.50	5.41		102.0	97.5	95.0	98.17	3.55
LAI	1.27	1.60	1.84	1.57	.29		2.90	2.77	3.45	3.04	.36
No. nodes	8	7	7	7.33	.58		14	14	14	14.00	0
July 22						Sep. 1					
DM tops**	236.70	277.40	292.50	268.86	28.86		688.40	517.00	811.90	672.43	148.10
DM leaves	80.10	82.30	90.30	84.23	5.37		95.50	68.90	107.70	90.70	19.84
DM stems	117.90	114.60	133.70	132.07	13.43		154.50	125.40	117.40	152.43	26.06
DM panicles	38.70	50.50	48.50	45.90	6.32		438.40	323.60	526.80	429.60	101.89
Height (cm)	70.0	80.0	68.0	72.67	6.43		99.0	106.5	99.0	101.5	4.33
LAI	3.87	4.30	4.01	4.06	.22		2.53	2.43	2.84	2.60	.21
No. nodes	14	13	13	13.33	.58		13	14	13	13.33	.58
Aug. 1						Sep. 16					
DM tops	367.50	321.60	293.70	327.60	37.26		773.30	696.10	642.90	704.10	65.57
DM leaves	98.70	83.30	84.10	88.70	8.67		90.40	96.50	81.90	89.60	7.33
DM stems	187.40	162.30	141.50	163.73	22.98		233.80	176.90	179.00	196.57	32.26
DM panicles	81.40	76.00	68.10	75.17	6.69		449.10	422.70	382.00	417.93	33.80
Height (cm)	92.0	92.5	87.5	90.67	2.75		105.0	104.0	86.0	98.33	10.69
LAI	3.92	3.05	3.21	3.39	.46		3.41	2.67	1.97	2.68	.72
No. nodes	14	14	13	13.67	.58		14	13	13	13.33	.58

†DM = Dry matter in g/1/2 m sample (a 1/2 m sample usually contained 5 plants).

*DM tops includes DM leaves and DM stems.

**DM tops includes DM leaves, DM stems, and DM panicles, for this and all sampling dates thereafter.

Table B2(a). (continued)

	NC42Y									
	Plot			$\bar{X}$	S		Plot			$\bar{X}$	S
	57	61	64				57	61	64		
July 2						Aug. 18					
DM† tops*	39.12	11.14	24.33	24.86	14.00		479.30	495.50	346.00	440.26	82.04
DM leaves	22.78	7.15	15.18	15.04	7.82		111.20	91.90	79.00	94.03	16.21
DM stems	16.34	3.99	9.16	9.83	6.20		131.80	138.90	107.30	126.00	16.58
DM panicles	---	---	---	---	---		236.30	264.80	159.70	220.27	54.35
Height (cm)	39.5	27.5	34.5	33.83	6.03		119.0	117.5	105.0	113.83	7.69
LAI	1.58	.54	1.01	1.04	.52		3.62	3.09	3.00	3.24	.34
No. nodes	7	6	6	6.33	.58		15	14	15	14.67	.58
July 22						Sep. 1					
DM tops**	271.70	156.50	229.60	219.26	58.29		587.60	566.10	672.20	608.63	56.09
DM leaves	104.70	74.20	95.20	91.37	15.61		87.70	74.50	111.60	91.27	18.81
DM stems	139.60	80.00	116.20	111.93	30.03		141.10	125.50	150.0	138.87	12.40
DM panicles	27.40	2.30	18.20	15.97	12.70		358.80	366.10	410.60	378.50	28.04
Height (cm)	74.0	53.0	66.0	64.33	10.60		117.0	110.5	117.0	114.83	3.75
LAI	5.27	3.88	4.80	4.65	.71		2.74	1.96	3.70	2.80	.87
No. nodes	15	13	14	14.00	1.00		14	13	15	14.00	1.00
Aug. 1						Sep. 16					
DM tops	448.20	244.30	307.70	333.40	104.35		651.90	629.70	509.70	597.10	76.50
DM leaves	144.70	63.80	105.10	104.53	40.45		97.90	81.30	75.40	84.87	11.67
DM stems	215.90	113.60	134.90	154.80	53.98		175.40	168.00	142.60	162.00	17.20
DM panicles	87.60	66.90	67.70	74.07	11.73		378.60	380.40	291.70	350.23	50.70
Height (cm)	109.0	106.0	101.0	105.33	4.04		120.0	110.0	119.0	116.33	5.51
LAI	6.99	5.06	4.31	5.46	1.38		3.18	2.00	2.50	2.56	.59
No. nodes	13	13	13	13.00	0		14	14	14	14.00	0

†DM = Dry matter in g/1/2 m sample (a 1/2 m sample usually contained 5 plants).

*DM tops includes DM leaves and DM stems.

**DM tops includes DM leaves, DM stems, and DM panicles, for this and all sampling dates thereafter.

Table B2(a). (continued)

	Pioneer 846									
	Plot			$\bar{X}$	S		Plot			$\bar{X}$	S
	52	58	62				52	58	62		
July 2						Aug. 18					
DM† tops*	37.78	57.33	27.84	40.98	15.00		640.80	544.90	530.90	572.20	59.82
DM leaves	22.47	31.78	16.49	23.58	7.71		117.90	102.50	101.80	107.40	9.10
DM stems	15.32	25.55	11.44	17.44	7.29		160.10	140.00	170.80	156.97	15.64
DM panicles	---	---	---	---	---		362.80	302.40	258.30	307.83	52.46
Height (cm)	37.0	39.0	32.5	36.16	3.33		94.5	98.0	101.0	97.83	3.25
LAI	1.45	2.05	1.08	1.53	.49		3.79	3.31	2.94	3.35	.43
No. nodes	7	8	7	7.33	.58		16	15	16	15.67	.58
July 22						Sep. 1					
DM tops**	251.70	256.10	211.00	239.60	24.87		672.80	881.20	579.40	711.13	154.51
DM leaves	107.90	103.10	88.40	99.80	10.16		121.20	139.80	91.30	117.43	24.47
DM stems	124.60	128.60	103.40	118.87	13.54		163.20	198.20	134.30	166.90	29.62
DM panicles	16.20	24.40	19.20	19.93	4.15		415.40	543.20	348.80	435.80	98.79
Height (cm)	60.5	70.0	66.0	65.5	4.77		103.0	110.0	107.0	106.67	3.51
LAI	5.08	4.82	4.52	4.81	.28		3.83	4.35	3.32	3.83	.52
No. nodes	14	15	14	14.33	.58		15	15	15	15.00	0
Aug. 1						Sep. 16					
DM tops	359.60	230.50	295.90	295.33	64.55		849.70	641.80	507.70	666.40	172.32
DM leaves	113.20	88.70	102.50	101.47	12.28		96.00	93.00	79.80	89.60	8.62
DM stems	178.90	104.20	133.00	138.70	37.68		226.40	175.00	140.20	180.53	43.37
DM panicles	67.50	37.60	60.40	55.17	15.62		527.30	373.80	287.70	396.27	121.37
Height (cm)	105.5	83.0	102.5	97.0	12.22		103.0	106.0	101.0	103.33	2.52
LAI	4.09	3.86	4.20	4.05	.17		3.12	2.94	2.40	2.82	.37
No. nodes	16	16	12	14.67	2.31		15	14	15	14.67	.58

†*DM = Dry matter in g/1/2 m (a 1/2 m sample usually contained 5 plants).

**DM tops includes DM leaves and DM stems.

DM tops includes DM leaves, DM stems, and DM panicles, for this and all sampling dates thereafter.

Table B2(a). (continued)

F65A

	Plot			$\bar{X}$	S		Plot			$\bar{X}$	S
	53	54	60				53	54	60		
July 2						Aug. 18					
DM† tops*	58.00	44.67	54.09	52.25	6.85		567.20	395.00	513.60	491.93	88.12
DM leaves	33.05	25.70	34.02	30.92	4.55		125.90	98.50	100.70	108.37	15.22
DM stems	24.95	18.98	20.07	21.33	3.18		210.00	117.40	139.00	155.47	48.45
DM panicles	---	---	---	---	---		231.30	179.10	273.90	228.10	47.48
Height (cm)	40.5	40.0	41.0	40.5	.50		109.5	102.5	97.0	103.00	6.27
LAI	2.11	1.66	2.14	1.97	.27		4.14	3.17	4.06	3.79	.54
No. nodes	7	7	7	7.00	0		14	14	15	14.33	.58
July 22						Sep. 1					
DM tops**	174.80	224.90	269.60	223.10	47.43		656.30	734.80	659.70	683.60	44.37
DM leaves	79.70	89.80	99.70	89.73	10.00		105.60	122.50	104.60	110.90	10.06
DM stems	87.40	105.90	126.20	106.50	19.41		173.10	179.50	194.50	182.37	10.98
DM panicles	7.70	29.20	43.70	26.87	18.11		377.60	432.80	360.60	390.33	37.75
Height (cm)	53.5	66.5	75.0	65.00	10.83		102.5	107.5	100.0	103.33	3.82
LAI	3.57	4.31	4.31	4.06	.42		3.46	2.77	2.32	2.85	.57
No. nodes	14	14	14	14.00	0		14	13	15	14.00	1.00
Aug. 1						Sep. 16					
DM tops	410.40	351.10	364.90	375.46	31.03		627.50	695.80	665.60	663.00	34.23
DM leaves	135.00	107.10	110.00	117.37	15.34		93.50	98.10	93.30	94.97	2.72
DM stems	184.10	180.10	190.10	184.77	5.03		170.80	181.90	195.20	182.63	12.22
DM panicles	91.30	63.90	64.80	73.33	15.57		363.20	415.80	377.10	385.37	27.26
Height (cm)	90.0	88.50	97.50	92.00	4.82		99.0	101.2	98.5	99.6	1.44
LAI	5.05	4.46	3.98	4.50	.54		2.42	2.65	2.64	2.57	.13
No. nodes	14	13	15	14.00	1.00		14	14	15	14.33	.58

†*DM = Dry matter in g/1/2 m sample (a 1/2 m sample usually contained 5 plants).

**DM tops includes DM leaves and DM stems.
DM tops includes DM leaves, DM stems, and DM panicles, for this and all sampling dates thereafter.

Table B2(a). (continued)

F61

	Plot			$\bar{X}$	S		Plot			$\bar{X}$	S
	56	63	65				56	63	65		
July 2						Aug. 18					
DM† tops*	20.71	28.67	34.65	28.01	6.99		503.50	469.50	336.60	436.53	88.20
DM leaves	12.51	16.93	19.96	16.47	3.75		101.60	88.00	74.20	87.93	13.70
DM stems	8.20	11.74	14.69	11.54	3.25		164.40	151.50	108.00	141.30	29.55
DM panicles	---	---	---	---	---		237.50	230.00	154.40	207.30	45.97
Height (cm)	36.5	41.0	43.5	40.33	3.55		106.0	109.5	107.0	107.5	1.80
LAI	.87	.98	1.25	1.04	.20		2.91	2.67	2.34	2.64	.29
No. nodes	7	6	7	6.67	.58		13	13	14	13.33	.58
July 22						Sep. 1					
DM tops**	151.80	150.30	237.90	180.00	50.15		574.50	458.60	677.60	570.23	109.56
DM leaves	71.00	62.00	72.90	68.63	5.82		84.70	85.50	97.20	89.13	7.00
DM stems	71.00	84.20	120.70	91.97	25.74		144.60	110.00	167.70	140.77	29.04
DM panicles	9.80	4.30	44.30	19.47	21.68		345.20	263.10	412.70	340.33	74.92
Height (cm)	53.0	58.5	82.0	64.50	15.40		105.50	101.00	104.50	103.67	2.36
LAI	3.49	2.74	3.10	3.11	.38		1.47	1.78	2.30	1.85	.42
No. nodes	12	13	14	13.00	1.00		13	14	14	13.67	.58
Aug. 1						Sep. 16					
DM tops	232.90	253.50	339.00	275.13	56.26		588.30	535.90	545.20	556.46	27.96
DM leaves	81.70	94.40	106.20	94.10	12.25		89.80	78.10	74.50	80.80	8.00
DM stems	113.60	107.70	159.30	126.87	28.24		157.50	144.90	141.50	147.97	8.43
DM panicles	37.60	51.40	73.50	54.17	18.11		341.00	312.90	329.20	327.70	14.11
Height (cm)	99.0	89.0	101.5	96.50	6.61		107.0	102.0	102.0	103.67	2.89
LAI	3.43	2.97	4.11	3.51	.57		2.16	1.87	1.70	1.91	.23
No. nodes	13	14	13	13.33	.58		13	15	14	14.00	1.00

†DM = Dry matter in g/1/2 m sample (a 1/2 m sample usually contained 5 plants).

*DM tops includes DM leaves and DM stems.

**DM tops includes DM leaves, DM stems, and DM panicles, for this and all sampling dates thereafter.

Table B2(b). Grain yield at 12.5% moisture content for five varieties of grain sorghum.

RS610		NC42Y		Pioneer 846		F65A		F61	
Plot	Grain yield (kg/ha)	Plot	Grain yield (kg/ha)	Plot	Grain yield (kg/ha)	Plot	Grain yield (kg/ha)	Plot	Grain yield (kg/ha)
51	6684	57	7817	52	7537	53	7285	56	6798
55	7210	61	6271	58	7207	54	7750	63	4842
59	6412	64	6214	62	5866	60	6659	65	5466
$\bar{X}$	6769	$\bar{X}$	6767	$\bar{X}$	6870	$\bar{X}$	7231	$\bar{X}$	5702
S	406	S	910	S	885	S	548	S	999

Table B3. Hydraulic gradients in the 130-150 cm depth increment under five varieties of grain sorghum.

Date	RS610 Plot 51	RS610 Plot 55	RS610 Plot 59	RS610 $\bar{X}$	RS610 S	NC42Y Plot 57	NC42Y Plot 61	NC42Y Plot 64	NC42Y $\bar{X}$	NC42Y S
July 1	.06	.13	.75	.31	.38	--	- .69	.13	- .28	.58
2	.19	.31	1.00	.50	.44	--	-1.07	.38	- .35	1.03
7	.31	.44	1.38	.71	.58	--	- .69	.63	- .03	.93
8	.32	1.31	.75	.79	.50	- .13	- .44	.19	- .13	.32
9	.31	.06	.19	.19	.13	- .07	- .07	.00	- .05	.04
10	.38	.07	.06	.17	.18	- .13	- .07	- .19	- .13	.06
11	.25	.07	.00	.11	.13	- .31	- .06	- .13	- .17	.13
14	.19	.13	- .19	.04	.20	- .81	- .06	- .19	- .35	.40
15	.13	.06	- .19	.00	.17	-1.13	.07	- .13	- .40	.64
16	.06	.00	- .32	- .09	.20	-1.57	- .07	- .25	- .63	.82
17	.00	.07	- .50	- .14	.31	-1.88	.00	- .25	- .71	1.02
18	- .13	.00	- .57	- .23	.30	-2.13	- .06	- .32	- .84	1.13
21	- .38	.13	- .75	- .33	.44	-2.94	- .06	- .07	-1.02	1.66
23	- .50	.06	- .69	- .38	.39	-2.31	.07	.00	- .75	1.35
24	- .56	.19	- .63	- .33	.45	-2.38	.00	- .06	- .81	1.36
25	- .38	.19	- .69	- .29	.45	-2.13	- .07	- .07	- .76	1.19
28	- .32	.38	- .63	- .19	.52	-1.88	.00	.13	- .58	1.12
29	- .07	1.94	- .63	.41	1.35	-1.94	- .06	.13	- .62	1.14
30	- .13	.50	- .57	- .07	.54	-2.00	- .13	.19	- .65	1.18
31	.19	.38	- .63	- .02	.54	- .69	- .13	- .13	- .32	.32
Aug. 1	.19	.32	- .69	- .06	.55	-2.00	- .19	- .25	- .81	1.03
4	- .07	.19	- .82	- .23	.52	-2.07	- .06	- .07	- .73	1.16
6	.13	.06	- .82	- .21	.53	-2.38	- .13	- .13	- .88	1.30
7	.07	.00	- .94	- .29	.56	-2.38	- .13	- .13	- .88	1.30
8	- .07	- .13	- .88	- .36	.45	-2.44	- .13	- .13	- .90	1.33
11	.00	- .57	-1.32	- .63	.66	-2.50	- .25	- .44	-1.06	1.25
12	.56	- .56	-1.63	- .54	1.10	-2.75	- .19	- .63	-1.19	1.37
13	1.82	-1.07	-1.88	- .38	1.95	-3.13	- .31	- .44	-1.29	1.59
15	-2.56	-1.13	-1.63	-1.77	.73	-1.94	- .25	- .56	- .92	.90
18	-3.32	-1.07	-1.00	-1.80	1.32	-1.69	- .19	- .57	- .82	.78
19	-2.88	- .50	-1.07	-1.48	1.24	-1.75	- .13	- .56	- .81	.84
20	-2.69	- .63	- .88	-1.40	1.12	-1.75	- .19	- .63	- .86	.80
21	-2.57	- .44	- .75	-1.25	1.15	-1.69	-2.32	- .13	-1.38	1.13
22	-2.44	- .32	- .75	-1.17	1.12	-1.63	- .19	- .94	- .92	.72
26	-2.88	- .07	-1.06	-1.34	1.43	-1.75	- .31	- .69	- .92	.75
27	-3.81	- .69	- .63	-1.71	1.82	-1.63	- .25	- .81	- .90	.69
29	-3.69	-1.06	- .31	-1.69	1.78	-1.56	- .13	- .94	- .88	.72
Sep. 2	-3.69	- .44	- .38	-1.50	1.89	-1.63	- .25	- .88	- .92	.69
3	-3.82	- .44	- .94	-1.73	1.82	-1.81	- .31	- .75	- .96	.77
6	-4.31	-2.82	- .38	-2.50	1.98	-1.63	- .13	- .75	- .84	.75
8	--	- .94	- .63	- .79	.22	-1.75	.00	- .44	- .73	.91
9	--	-1.19	- .50	- .85	.49	-1.69	.07	- .75	- .79	.88

Table B3. (continued)

Date		Pioneer 846 Plot 52	Plot 58	Plot 62	$\bar{X}$	S	F65A Plot 53	Plot 54	Plot 60	$\bar{X}$	S
July	1	.31	.13	.19	.21	.09	.19	- .13	.50	.19	.32
	2	.50	- .06	.13	.19	.28	.13	- .13	.44	.15	.29
	7	.25	.13	.07	.15	.09	- .13	- .32	.44	.00	.40
	8	.19	.07	.00	.09	.10	- .19	- .19	.44	.02	.36
	9	.07	- .13	.06	.00	.11	.13	.07	.13	.11	.03
	10	.13	- .06	.06	.04	.10	.00	.00	.06	.02	.03
	11	.19	- .06	.07	.07	.13	.00	.07	.06	.04	.04
	14	.13	.00	- .06	.02	.10	- .31	-1.06	- .19	- .52	.47
	15	- .06	- .13	.00	- .06	.07	- .06	- .06	- .32	- .15	.15
	16	.00	- .19	- .07	- .09	.10	- .19	- .13	- .38	- .23	.13
	17	- .06	- .19	.00	- .08	.10	- .19	- .13	- .38	- .23	.13
	18	- .19	- .07	- .06	- .11	.07	- .19	- .25	- .88	- .44	.38
	21	- .44	.07	- .20	- .19	.26	- .56	- .88	-1.19	- .88	.32
	23	- .38	.19	- .19	- .13	.29	- .63	- .44	- .94	- .67	.25
	24	.00	.19	- .25	- .02	.22	- .63	- .50	-1.13	- .75	.33
	25	- .13	.13	- .19	- .06	.17	- .56	- .38	- .94	- .63	.29
	28	- .06	.13	- .06	.00	.11	- .44	- .07	- .88	- .46	.41
	29	.13	.38	- .13	.13	.26	- .57	.25	- .88	- .40	.58
	30	.19	.44	- .07	.19	.26	- .69	- .07	- .88	- .55	.42
	31	- .19	.32	- .06	.02	.27	- .81	- .19	- .81	- .60	.36
Aug.	1	.19	.50	- .19	.17	.35	-1.13	- .19	- .94	- .75	.50
	4	.13	.50	- .19	.15	.35	- .69	- .32	- .75	- .59	.23
	6	- .57	.69	- .31	- .06	.67	-1.31	- .63	-1.38	-1.11	.41
	7	- .69	.75	- .57	- .17	.80	-1.69	- .63	-1.44	-1.25	.55
	8	- .69	.44	- .25	- .17	.57	-1.44	- .38	-1.75	-1.19	.72
	11	-1.25	- .31	- .32	- .63	.54	-2.94	- .75	-2.19	-1.96	1.11
	12	-1.19	- .25	- .25	- .56	.54	-3.69	-1.23	-2.25	-2.39	1.24
	13	- .69	.00	- .38	- .36	.35	-4.69	-1.25	-2.25	-2.73	1.77
	15	-1.13	- .13	- .44	- .57	.51	-3.75	-2.06	-1.00	-2.27	1.39
	18	-1.32	- .32	- .44	- .69	.55	-2.57	-1.06	- .63	-1.42	1.02
	19	2.31	.07	- .31	.69	1.42	-2.50	-1.69	- .88	-1.69	.81
	20	-1.07	- .13	- .31	- .50	.50	-2.19	-2.50	- .82	-1.84	.89
	21	-1.06	- .19	- .19	- .48	.50	-2.25	-1.50	- .82	-1.52	.72
	22	- .44	- .13	- .25	- .27	.16	-2.19	-1.50	- .75	-1.48	.72
	26	.31	- .32	- .25	- .09	.35	-3.44	- .38	- .44	-1.42	1.75
	27	- .38	- .63	- .32	- .44	.16	-4.13	-1.38	- .44	-1.98	1.92
	29	- .38	- .56	- .19	- .38	.19	-3.13	-1.44	- .50	-1.69	1.33
Sep.	2	- .50	- .57	- .38	- .48	.10	-10.38	-1.25	- .56	-4.06	5.48
	3	-1.00	- .44	- .63	- .69	.28	-10.38	- .44	- .81	-3.88	5.64
	6	.00	--	- .44	- .22	.31	-15.50	-1.38	- .19	-5.69	8.52
	8	- .38	--	--	- .38	--	-13.69	- .63	- .27	-4.86	7.65
	9	- .38	--	--	- .38	--	-13.75	-1.25	- .25	-5.08	7.52

Table B3. (continued)

Date	F61 Plot 56	63	65	$\bar{X}$	S
July 1	.00	.19	.25	.15	.13
2	.00	- .57	.56	.00	.57
7	.25	- .69	.57	.04	.65
8	.13	- .25	.44	.11	.35
9	.06	- .06	.25	.08	.16
10	- .06	.07	.19	.07	.13
11	.00	- .13	.13	.00	.13
14	.07	- .13	.13	.02	.14
15	.06	- .07	.13	.04	.10
16	.00	.07	.06	.04	.04
17	.06	.07	.06	.06	.01
18	.00	.06	.19	.08	.10
21	- .06	.00	.13	.02	.10
23	- .13	.25	.31	.14	.24
24	- .13	.25	.44	.19	.29
25	- .13	.13	.19	.06	.17
28	- .13	.19	.38	.15	.26
29	- .19	.13	.50	.15	.35
30	- .13	.19	.63	.23	.38
31	- .19	.07	.50	.13	.35
Aug. 1	- .13	.00	.56	.14	.37
4	- .25	- .07	.44	.04	.36
6	- .31	- .38	.63	- .02	.56
7	- .38	- .13	.31	- .07	.35
8	- .25	- .07	.81	.16	.57
11	- .81	- .13	.63	- .10	.72
12	- .88	- .32	.75	- .15	.83
13	-1.00	- .38	1.19	- .06	1.13
15	- .69	.00	.00	- .23	.40
18	- .13	.00	- .63	- .25	.33
19	- .44	- .19	.06	- .19	.25
20	- .38	- .13	.00	- .17	.19
21	- .31	- .38	- .63	- .44	.17
22	.62	- .13	.25	.25	.38
26	-1.00	- .50	- .32	- .61	.35
27	- .38	.00	- .19	- .19	.19
29	.00	.07	.25	.11	.13
Sep. 2	- .38	.00	.07	- .10	.24
3	- .33	- .19	.57	.02	.48
6	- .44	.63	- .44	- .08	.62
8	.32	.44	.57	.44	.13
9	- .69	.50	.13	- .02	.61

Table B4. Physiological stages of growth for five varieties of grain sorghum during the 1975 season.

	Physiological stage									
Variety	0	1	2	3	4	5	6	7	8	9
RS610	May 27	June 11	June 21	June 27	July 5	July 14	July 24	Aug. 3	Aug. 16	Aug. 26
NC42Y	May 27	June 11	June 21	July 2	July 10	July 18	July 28	Aug. 11	Aug. 26	Sep. 1
Pioneer 846	May 27	June 11	June 21	July 2	July 10	July 18	July 28	Aug. 9	Aug. 23	Sep. 1
F65A	May 27	June 11	June 21	July 5	July 14	July 21	July 30	Aug. 11	Aug. 29	Sep. 6
F61	May 27	June 11	June 21	July 2	July 10	July 18	July 28	Aug. 9	Aug. 29	Sep. 6

Description of Stages

Stage	Description
0	Emergence
1	3-leaf stage
2	5-leaf stage
3	Growing point differentiation
4	Flag leaf visible in whorl
5	Boot stage
6	Half-bloom
7	Soft dough
8	Hard dough
9	Physiological maturity

All varieties planted May 21.

Table GEN 1. Values of soil water content, soil water potential, and bulk density of Muir silt loam.*/

Soil water potential (bars)	Depth (cm)									
	0-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	120-135	135-150
	Soil water content cm^3/cm^3									
-.1	.391	.377	.405	.404	.379	.377	.377	.386	.411	.410
-.2	.359	.361	.392	.395	.304	.258	.223	.275	.327	.286
-.8	.329	.345	.375	.375	.194	.141	.141	.122	.206	.192
-1.4	.316	.336	.366	.368	.179	.133	.130	.112	.174	.161
-2.0	.301	.328	.357	.362	.171	.127	.125	.104	.160	.153
-5.0	.204	.237	.269	.266	.089	.065	.085	.056	.093	.059
-10.0	.189	.207	.235	.236	.081	.058	.078	.053	.085	.052
-15.0	.173	.193	.196	.223	.076	.057	.073	.049	.078	.051
	Soil bulk density g/cm^3									
	1.37	1.29	1.38	1.30	1.28	1.28	1.30	1.37	1.32	1.38

*/Randall Brady's values for Muir silt loam (Ashland Bottoms).

MEASURING ROOTING DEPTH AND DISTRIBUTION OF GRAIN SORGHUM FOR PREDICTING SOIL MOISTURE DEPLETION AND IRRIGATION SCHEDULING

by

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AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

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Manhattan, Kansas

1976

The relationship between depth and distribution of grain sorghum [Sorghum bicolor (L.) Moench cv. Pioneer 846] roots in the field and above ground morphological development (plant height, leaf area index, dry matter) was studied under irrigated and nonirrigated conditions. Such data could be used in conjunction with evapotranspiration data to predict the water requirements of the grain sorghum plant. Soil cores for root determination were collected with a tractor mounted coring machine throughout the season and roots washed free using 35 mesh screen. Plant tops were sampled for height, leaf area index, and dry weight. The tops were partitioned into leaves, stems and panicles. All dry weight was determined by oven drying at 100 C. Soil water was determined by neutron moderation and gravimetric sampling. Root development was characterized by rapid root penetration early in the season. Maximum depths of 150 cm in the irrigated and 140 cm in the nonirrigated sorghum were reached 7 weeks after planting. Root dry matter peaked to 17.1 g in the irrigated sorghum and 12.3 g in the nonirrigated sorghum at 10 and 11 weeks after planting, respectively, and then started to decline. An increase in both root and stem dry matter was observed after physiological maturity. Stem dry matter declined in both treatments during panicle development. Rate of dry matter accumulation in both roots and tops was higher in the irrigated treatment. High positive correlations were observed between effective root depth and top height and between root dry matter and top dry matter in both irrigated and nonirrigated grain sorghum.

Root development and soil water depletion of five grain sorghum varieties (cvs. RS610, NC42Y, Pioneer 846, F65A, and F61) were studied. All varieties received 11 cm of irrigation water applied 61 days after planting. Soil cores for root determination were collected at 41, 70, and 91 days after

planting. Soil water was determined by neutron moderation and gravimetric sampling at the time of root sampling. Hydraulic potential was determined with mercury manometer tensiometers placed at 130 cm and 150 cm depths in each plot. At 41 days after planting, between 95 and 98% of total root dry matter in all varieties was in the top 15 cm. At 91 days after planting, 88 to 91% of total root dry matter in all varieties was in the top 15 cm. There were no significant differences in total root dry matter among varieties on any of the sampling dates. There were no differences in rooting depth among varieties at 41 days after planting but significant differences were observed at 70 days after planting. NC42Y and F61 were significantly different from each other and from F65A, RS610 and Pioneer 846 at < 1% P. NC42Y had roots at 180 cm, F61 at 170 cm, F65A at 157 cm and both RS610 and Pioneer 846 at 150 cm, at 70 days after planting. The shallow rooted varieties (RS610, Pioneer 846 and F65A) used more water in the 0 to 150 cm soil profile than the deeper rooted varieties (NC42Y and F61).