EFFECT OF PLANT HEIGHT ON LIGHT INTERCEPTION, WATER USE, AND YIELD OF GRAIN SORGHUM IN PURE AND MIXED CANOPIES

by

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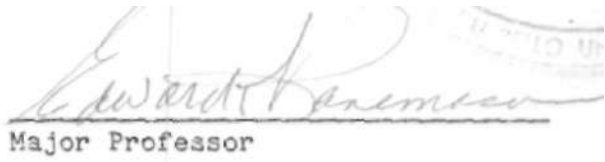
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INTRODUCTION

Sorghum was domesticated in Africa, but its growth has spread to India, China, the Middle East, Europe and, more recently, the USA. The original varieties introduced into the United States in about 1890 were late in maturity and too tall to be harvested conveniently by hand. Quinby (1974) reported that the Standard Yellow Milo, temperate in adaptation, and the Dwarf Yellow Milo, that is short enough to be headed conveniently by hand, originated by mutation and selection by Texas farmers in about 1900. Crosses of Milo and Kafir (about 1928) produced strains that were shorter than either parents. Backcrosses of some of these progenies to Milo gave a few short and early maturing varieties even before the demand for mechanically combined varieties arose. These selected varieties, however, did not increase yield.

The rapid progress in increasing sorghum yield in the last fifty years centers around--

i. breeding for higher harvest index,

ii. application of commercially fixed nutrients, and

iii. optimizing plant population to available nutrients and water.

Dwarf sorghums, aside from their adaptation to mechanical harvesting, do not lodge; therefore, they can support heavy application of commercial fertilizers. But even with these advantages of the dwarf over the tall lines of sorghum, a few questions still remain. First, can the alteration of the height genes cause any other morphological or physiological change? Second, if any other changes are affected, how do these affect sorghum yield? Last, realizing that the largest acreage of sorghum is in the developing countries where the crops are mainly hand-harvested and the straw used in building storage barns, what extent

of gain or loss in total grain and dry matter production results from alterations of the height genes?

Published studies involving sorghum height genes are largely restricted to comparing phenotypic effects, grain, and dry matter yields of different height isolines. Most of these experiments were conducted at low plant density (for example, Freeman, Hadley, and Seif, 1962; Casady, 1967; Graham and Lessman, 1966). In general, they found that the taller lines yielded more than the dwarf.

More recently, the emphasis of research in this area has shifted to looking at a "whole-canopy" assessment of the height isolines. Stickler and Younis (1966) and Shertz (1973) investigated interactions between sorghum height and row width and stand density.

This experiment is intended to go beyond comparing growth, development, and yield of three sorghum height isolines. It is, also, aimed at finding possible explanations for these differences through measurements of leaf temperature, crop water use and photosynthetic active radiation (PAR) balance.

Crop Mixtures

In many developing countries, most crops are grown in mixtures. This is a concept of raising two or more crops on the same land at the same time. It is often termed "intercropping." The arrangement of the crops varies and four classes can be distinguished as follows:

i. Mixed Intercropping - where there is no distinct row arrangement;

ii. Row Intercropping - where one or more crop is planted in rows;

iii. Strip Intercropping - where each crop is cultivated in strips wide enough for independent operation but narrow enough for crops to interact agronomically; and

iv. Relay Intercropping - where two or more crops are grown simultaneously only during part of the life cycle of each.

Reasons given for mixing crops include an exploitation of environmental factors, reduction of adverse conditions in the ecosystem, soil protection, and economic returns (Norman, 1972).

Theoretically, it appears feasible that mixtures of crops varying in height, rooting depth, and/or growing cycle could exploit more of the nutrients, water, and solar radiation available to the crops and, therefore, increase their yield relative to monocrops occupying equivalent land area. The extent of complementation will, however, depend on the intensity of interaction between the component plants of the mixture. For example, positioning the photosynthetic canopy (leaves and/or green stems) of one component at a higher level than those of another allows the taller canopy to intercept greater share of light. The growth of the taller canopy may, therefore, be promoted at the expense of the shorter canopy. The total mixture yield is increased only if the increased growth is more than the reduction in the shorter canopy.

Plant interactions in mixed crop communities, discussed by Trenbath (1976), indicate slight differences in height, even early in growth, can lead to strong competition effects. And while shading by a taller mixture component generally reduces photosynthesis rates in the lower canopy, the shaded canopy will grow and adapt to the low light levels provided the shading is not too intense. Competition for soil factors is probably more intense in sole crops as depletion zones of roots of

different plants interact. Similar spatial distribution may make some roots redundant for the uptake of mobile nutrients in sole crops, but this may not be true in intercrops. The response of mixtures to the above factors has led to the recognition of four classes--commensalistic, amensalistic, monopolistic, and inhibitory polycultures. These, respectively, refer to interactions where there is a net positive effect on one species and no observable effect on the others; a negative effect on one species and no observable effect on the others; a net positive effect on one species and a negative effect on the others; and where there is a negative effect on all species.

In their article on the radiation and microclimate relationships in multiple cropping systems, Allen, Sinclair, and Lemon (1976) wrote, "Research should extend beyond just determining which crops will work in a polyculture to the point of understanding reasons. Plant interactions, as a function of season, time of planting, stage of development, and climate factors need to be determined."

In this experiment, we study the growth and development of mixed-intercrop and row-intercrop canopies of three sorghum isolines varying only in height. Measurements include photosynthetic active radiation balance, water use, and flag-leaf temperature of component plants.

LITERATURE REVIEW

Quinby and Karper (1954) found that height in sorghum is determined by four independently inherited genes, Dw_1, Dw_2, Dw_3, and Dw_4; tallness is partially dominant, and shortened internodes were the only apparent effect of the recessive form of the four genes. They, along with Freeman, Hadley and Seif (1962), concluded that recessiveness had about the same effect with each of the four genes. Casady (1967) and Schertz (1973), however, found that the Dw_3 gene influenced culm diameter of the third, fourth, and fifth internodes from the top of the plant; peduncle length; and blade width, length, and area of the third, fourth, and fifth leaves from the top as well as culm height. But the Dw_3 gene did not affect maturity; and the effect of its Dw_3 allele on leaf blade length and area was influenced by environment and variety. Comparisons of growth rate of the same isolines (Campbell and Casady, 1970) showed that their culm elongation was slow and similar in the first 33 days after emergence, but the Dw_3 plants had much more rapid and extensive internode elongation thereafter. Brooks (1967), similarly, reported that the Dw_3 allele in "Wheatland" sorghum affects various internodes differently.

Hadley, Freeman, and Javier (1965) reported that in 8 of 10 comparisons of various height types of sorghum, the tall genotypes (DwDw and Dwdw) yielded 11 to 18% more grain that the dwarf (dwdw). They argued that their result was not caused by some heterogeneity in genetic background but acknowledged lack of information on the response of the genotypes under a different light and water regime. Similar results were reported by Casady (1965) and Graham and Lessman (1966). Casady seeded tall (2-dwarf) and short (3-dwarf) plants at a rate of 64600

plants/hectare at two sites. Grain yield in the tall canopy was significantly higher than in the short canopy even though there was no significant difference in the number of kernels per head. The tall plants had more secondary heads and their kernels were plumper. Graham and Lessman (1966) compared light interception in 3-dwarf and 2-dwarf canopies seeded at 34000 plants/hectare and concluded that the taller plants were more efficient in light utilization due to spatial arrangement of their leaves. Casady (1965), however, found a highly significant environment X height interaction for yield in one of his varieties, indicating that the tall plants might yield less than the short ones in some environments.

Plant density X height interaction for grain yield was confirmed by Stickler and Younis (1966). The short genotype (dw_3) performed better than the tall (Dw_3) at a density equal or greater than 129000 plants/hectare while the reverse was true at lower densities.

Eastin, Sullivan, Clegg and Ross (1970) determined the comparative performance of 2-, 3-, and 4-dwarf height isolines at row spacings of 45, 67.5, and 90 cm (equivalent to plant densities of 123500, 247000, and 370500 plants/hectare, respectively). While 3- and 4-dwarf grain yields were similar, grain yields were significantly (0.05 level) higher for the 2-dwarf. The 2-dwarf plants also produced more dry matter than either the 3- or 4-dwarf isolines. Influence of population on yield was significant only between 123500 and 370500 plants/hectare. Grain yields were 9616 and 8910 kg/ha in the high and low plant densities, respectively.

Pepe and Welsh (1979) studied dryland soil water depletion patterns of closely related height lines of hard red winter wheat cultivars over

two seasons and could not find a close relationship between soil water depletion and dwarfing genes, and root development or activity. Their result is supported by those of Cholich, Welsh and Cole (1977), Lipton and Bingham (1970), Lipton, Oliver, Ellis, Barnes, Howse, Welbank, and Taylor (1974) and Holbrook (1973).

Mixed Cropping

Multiple cropping, mainly in the form of intercropping, is the most widespread cropping system in Africa, Asia, and tropical America where very small farm holdings, resulting from low level technology, gives this system a high labor efficiency (Harwood and Price, 1976; Okigbo and Greenland, 1976; and Norman, 1968). Grain and biomass productivity of mixtures has attracted numerous studies (see reviews by Donald, 1963; Trenbath, 1974; and ASA publication #27, 1976) and gave inconsistent results (see Table 1 adapted from Trenbath, 1974). The results have not included mixtures of leguminous species. The mid-monoculture yield was denoted by $\bar{P}$. A mixture was said to have "overyielded" when the mixture biomass, M, exceeded that of the more productive culture, P_1; i.e., when $M > P_1$. The mixture was said to have "underyielded" when the mixture biomass fell below that of the less productive pure culture, P_2, i.e., when $M < P_2$. Both overyielding and underyielding occurred with a relatively low frequency compared with the cases where $P_1 > M > P_2$. The summary of the studies is described by Simmonds (1962) and Donald (1963) that often $M \simeq \bar{P}$, sometimes $P_1 > M > \bar{P}$, and occasionally $M > P_1$; but that negative interactions (i.e., $M < \bar{P}$) seemed to be rare.

Results of recent papers, not covered by references cited above,

Table 1—The distribution of biomass yields of varietal or interspecific mixtures compared with yields of their components' monocultures based on published data of 344 mixtures† (after Trenbath, 1974).

Crop	Below P_2	P_2 to $\bar{P}$	$\bar{P}$ to P_1	Above P_1	
Grasses	28	65	87	59	
Wheat			2	1	
Rice	9	12	11	4	
Flax and linseed	3	7	8	12	
Barley	1	4	5		
Rye	4	4	15	7	
Total	45	92	124	83	= 344

†P_1 and P_2 are the yields of the higher and lower yielding monocultures, respectively. $\bar{P}$ is the mid-monoculture yield.

still retain the inconsistency in yields of mixtures relative to their components' monocrops--suggesting the need for more definitive research into the various factors that control or influence crop productivity in mixtures. For example, Enyi (1972) intercropped maize and sorghum with pigeon peas or beans and found a reduction in the leaf area index (LAI), straw weight, and grain yield of the cereal crops. He noted that whereas intercropping maize decreased total grain (cereal and legume) per hectare, intercropping sorghum with pigeon peas increased total grain yield. Comparing sole sorghum and beans with mixtures of the same crops, Osiru and Willey (1972) reported up to 55% higher grain yield in the mixtures than could be achieved by growing the crops separately. Their replacement series study of pure maize, two-thirds maize, one-third maize, and pure beans (Phaseolus vulgaris) at four populations, also gave mixture yields that were 38% higher than that in pure plots (Willey and Osiru, 1972).

Mixture yields greater than the best of the components' monocrop have been explained with one or more of the following reasons:

i. Differing growth stages (Willey and Osiru, 1972);

ii. Mutual avoidance by adjacent root systems (Raper and Barber, 1970; and Baldwin and Tinker, 1972);

iii. Nutritional complementation--one component requiring an element of which the other needs little (Kolb, 1962; and Davies and Snaydon, 1973);

iv. More efficient light utilization due to contrasting leaf inclination (Rhodes, 1970; and Trenbath, 1972), different stem elongation rates (Iwaki, 1959) or different height (Eagles, 1972; Barla-Szabo and Hegedus, 1976).

Other reasons proposed include more efficient water use (Baldy, 1963), allelopathy (Roy, 1960), and greater tolerance of disease and pest attack (Leonard, 1969). Very few studies have, however, related any of

these factors to yield in the mixed canopy.

Prasad and Reddy (1973) and Sharma (1978) utilized the height variability in wheat genotypes in creating systematic mixed stands with prismatic and columnar canopy surfaces. They found that such mixtures gave higher grain yield than the mean yield in pure stands. The grain yield in the mixed stands, however, was about the same as that of the largest yielding genotype in its pure stand; the tall genotype produced more grain in the mixture than in pure stand while the dwarf genotype yielded less.

The objective of this experiment was to relate plant height and mixtures of plants differing only in height to water use, photosynthetic active radiation (PAR) balance, and grain yield.

GENERAL CONDITIONS OF THE EXPERIMENT

The experiment was conducted on the Kansas State University Ashland Agronomy Farm located about 14km southwest of Kansas State University. The elevation is about 350m above sea level. The soil was Muir silty clay loam (fine-silty, mixed mesic, Pachic Haplustoll) with a maximum available water holding capacity of 13.2% by weight.

The layout of the experiment is shown in Figure 1. The cropped area covered 0.24 ha. This was bordered by corn fields to the north and south; and grain sorghum and soybean fields to the west and east, respectively. Soil conditions at the site were homogeneous, so we used a completely randomized design with five treatments--

i. Double Dwarf (DW),

ii. Dwarf (SD),

iii. Tall (TA),

iv. Mixed (MIX), a 33% by weight mixed-intercrop of the three isoline seeds, and

v. Alternating Rows (ALT), row intercrops with the height isolines arranged in repetitions of a DW-SD-TA-TA-SD-DW pattern.

Treatments were replicated only three times because of limited seed supply. The genetic identity of the seeds is given in Table 2. The sorghum (Sorghum bicolor L. Moench) seeds were provided by J. R. Quinby of Pioneer Hi-Bred International Inc., Plainview, Texas, and F. Miller, Crops and Soil Department, Texas A & M, College Station, Texas.

The field was fertilized with a preplant application of 108 kg/ha nitrogen (anhydrous ammonium nitrate) in the spring of 1978 and 1979. We planted at a spacing of 75 cm between rows and 7.62 cm within row, giving a plant population of about 175,000 plants/ha. The rows were orientated north to south. Planting date was 18 May 1978 and 17 May

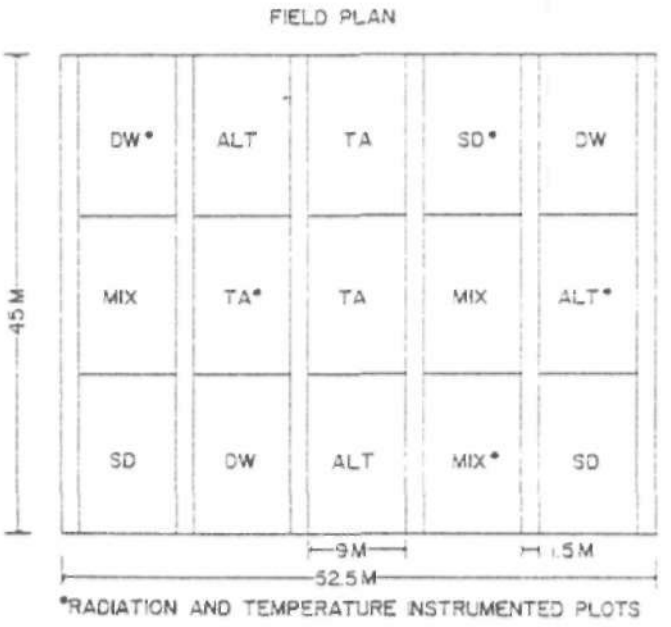


Fig. 1—The layout of experimental plots in both seasons.

Table 2—Genetic identity of isolines.

Lines	Genotype*	Height†
		-- cm --
Tall White Sooner Milo	$Dw_1Dw_2Dw_3dw_4$	195
Dwarf White Sooner Milo	$dw_1Dw_2Dw_3dw_4$	150
Double Dwarf White Sooner Milo	$dw_1dw_2Dw_3dw_4$	90

*From Quinby (1974)
†At physiological maturity

1979. Plant density samples taken during the growing seasons are presented in Table 3. It was difficult to separate some of the tillers from main plants while taking plant counts at the later dates (GS 7).

All measurements were taken during the two growing seasons--spanning the periods 18 May to 16 August, 1978 and 17 May to 20 August 1979. All photosynthetic active radiation (PAR) sensors were scanned every ten minutes an online calculator (Hewlett Packard model #9820) computed 30 minute averages which were printed by a typewriter (Teletype Printer ASR 35) housed about 100m east of the experimental field. Pressure chamber and diffusion porometer (Delta-T Devices) were used to measure xylem-water potential and stomatal resistance, respectively.

Leaf and air temperatures were scanned and printed once every half-hour on a digital recorder (Campbell CR 5). Water-use masurements were made gravimetrically to 152 cm deep at planting; neutron probe measurements at 15 cm increments to the same depth were made weekly thereafter. A summary of the weather conditions for the two seasons is given in the appendix. Results of the experiments are presented in the following two chapters.

Table 3—Mean plant density in the canopies*.

Date	Treatments					Remarks
	DW	SD	TA	MIX	ALT	
	(#plants/m^2)					
7/31/78	23.9	23.6	21.5	21.7	22.4	GS† 7
7/03/79	18.0	15.2	15.2	14.7	15.9	GS 4
7/19/79	20.1	15.3	15.5	18.7	17.7	GS 6
7/31/79	24.4	23.6	19.6	20.7	20.8	GS 7

*Planting density was 17.5 seeds/m^2
†Growth stage (Vanderlip, 1972)

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Chapter I

PLANT HEIGHT EFFECT ON THE LIGHT INTERCEPTION AND YIELD OF GRAIN SORGHUM IN PURE AND MIXED CANOPIES

-Paper submitted to Field Crops Research for publication.

PLANT HEIGHT EFFECT ON THE LIGHT INTERCEPTION AND YIELD OF GRAIN SORGHUM IN PURE AND MIXED CANOPIES [1/]

J. J. Owonubi and E. T. Kanemasu [2/]

ABSTRACT

Advantages of dwarf over tall sorghum include resistance to lodging and adaptation to mechanical harvesting. Grain yield comparison of sorghum height types are, however, less definite. An experiment was designed to relate sorghum height to growth and development in pure and mixed canopies. Photosynthetic light (PAR) interception, dry matter accumulation, and grain yield of three height isolines in pure, mixed and alternating rows were determined.

The population of about 175,000 plants/ha, gave LAI over 3.7 from half bloom through grain filling. Only the 3-dwarf plots had incomplete ground cover which allowed significantly higher PAR transmission than either the 1- or 2-dwarf canopies. PAR interception in the 3-dwarf canopy was, consequently, lower than in other treatments. Fewer tillers and loose arrangement of leaves on the 1-dwarf plants allowed higher PAR transmission and, therefore, lower PAR interception compared to the 2-dwarf canopy though these differences were not statistically significant. Intercepted PAR in the mixed and alternated rows were similar to that in 1- or 2-dwarf plots. Differences in dry matter accumulation between the treatments were mainly in the stem fraction; the tall plants producing about the same quantity of dry matter as the

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mixed and alternated plots. The 2-dwarf, with its lower dry matter, produced the most grain in both seasons. Tall plants yielded more grain in the mixed, than in either pure or alternated canopies. The short, 3-dwarf, plants in the mixed plots were, however, shaded and, therefore, yielded considerably low dry matter and grain.

INTRODUCTION

Quinby and Karper (1954) found that height in sorghum is determined by four independently inherited genes, Dw_1, Dw_2, Dw_3, and Dw_4; tallness is partially dominant, and shortened internodes were the only apparent effects of the recessive form of the genes. They, along with Freeman, Hadley, and Seif (1962), concluded that recessiveness had about the same effect with each of the four genes. Casady (1967) and Shertz (1973), however, found that the Dw_3 gene also influenced culm diameter, and peduncle length. The effect of the dw_3 allele on leaf blade length and area was influenced by environment and variety.

Yield comparisons of sorghum height isolines in low stand densities (Freeman, et al., 1962; Graham and Lessman, 1966; Casady, 1967) generally found that the taller lines yielded more than the dwarf. But "whole canopy" assessments of the height types reveal that the short genotypes perform better than the tall at high populations (Stickler and Younis, 1966; Eastin, Sullivan, Clegg and Ross, 1970).

Grain and biomass productivity of crop mixtures had attracted numerous studies and given very inconsistent results (see reviews by Donald, 1963; Trenbath, 1974; and ASA publication #27, 1976). Mixture yields greater than the best monocrop have been explained by one or more of the following reasons: a) differing growth stages, b) mutual avoidance by adjacent root systems, c) nutritional complementation, and d) more efficient light utilization due to contrasting leaf inclination. Prassad and Reddy (1973) and Sharma (1978) utilized the height variability in wheat genotypes in creating systematic mixed stands with prismatic and columnar canopy surfaces. They found that such mixtures gave higher grain yield than the mean yield in pure stands.

We designed an experiment to relate sorghum height to the interception of photosynthetically active radiation, water use, and grain yield in pure, mixed, and alternating rows. This paper discusses the photosynthetic active radiation balance, dry matter accumulation, yield and yield components.

MATERIALS AND METHODS

The experiment was conducted at Kansas State University Agronomy farm, Manhattan, Kansas. The genetic identity of the three height isolines of sorghum (Sorghum bicolor L. Moench) and their height at maturity are given in Table 1.1.

We used a completely randomized design with five treatments: 1-dwarf (TA), 2-dwarf (SD), 3-dwarf (DW), 33% seed-weight mixture of the three isolines (MIX), and alternating rows of the isolines in repetitions of a DW-SD-TA-TA-SD-DW pattern (ALT). Limited seed supply permitted only three replications of each treatment. The 9 x 15 m plots were sown with 75 cm between N-S rows and 7.62 cm within rows on 18 May, 1978 and 17 May 1979.

Leaf area and dry weight estimates were made from weekly samples of three representative plants per plot in the 1978 season. In 1979, samples were taken on a unit ground area basis to reduce errors introduced by tillers. Photosynthetic active radiation of the incoming (PAR), crop-reflected (RPAR), soil-reflected (RSPAR), and transmitted (TPAR) radiation in one of the three plots per treatment were determined with quantum sensors (Lambda LI-190S). The sensors were set up as described by Hodges, Kanemasu and Teare (1979) except an additional set of five sensors were added in the MIX and ALT canopies; three pointing upwards measured incoming PAR (PAR_2) and the other two, facing down, measured crop-reflected PAR ($RPAR_2$) at the height of double dwarf plants. This allowed estimation of intercepted PAR up to the height of double dwarf plants ($IPAR_2$) in the MIX and ALT canopies as:

$$IPAR_2 = PAR_2 - RPAR_2 - TPAR + RSPAR \quad [1]$$

Whole canopy PAR interception (IPAR) was calculated as:

Table 1.1—Genetic identity of isolines.

Lines	Genotype*	Height†
		-- cm --
Tall White Sooner Milo	$Dw_1Dw_2Dw_3dw_4$	195
Dwarf White Sooner Milo	$dw_1Dw_2Dw_3dw_4$	150
Double Dwarf White Sooner Milo	$dw_1dw_2Dw_3dw_4$	90

*From Quinby (1974)
†At physiological maturity

$$IPAR = PAR - RPAR - TPAR + RSPAR \qquad [2]$$

All light sensors were scanned every 10 minutes on clear days from half bloom, in the first season, and growing point differentiation in 1979, to physiological maturity. Data were averaged every half hour with an on-line computer (Hewlett Packard model #9820) and printed on a teletype (Teletype Printer ASR 35). Daily percent PAR balance was derived from data averaged from 0900 to 1800 hours. The daily summaries were pooled from half bloom (LAI ≥ 3.7) to physiological maturity and analyzed by multivariate analysis of variance to compare treatment means within and between seasons.

RESULTS AND DISCUSSIONS

Plant development was the same for each of the height isolines (Table 1.2). Leaf area indices for the canopies were similar (Fig. 1.1), though the DW plot had the highest during half bloom and soft dough. Despite the high LAI, however, the DW canopy did not completely shade the ground as was the case in the other plots (see 1979 TPAR values in Table 1.3). The high LAI of the DW plots was largely due to greater tillering.

Photosynthetic active radiation balance for the canopies during grain filling is presented in Table 1.3. The canopies reflected about equal amount of PAR. TPAR through the DW plot in 1978 was low compared to that of 1979 presumably due to sampling error. Sampling bias was reduced by changing the location of the PAR sensors weekly in 1979. The incomplete crop cover in the DW plots caused large variations in TPAR not only within each season but also between the two seasons. There was no significant difference in TPAR in the SD and TA plots. TPAR through the TA canopy was, however, consistently higher than that in the SD plots in both seasons, though the difference is not statistically significant. Fewer tillers and the loose arrangement of leaves on the tall plants allowed deeper penetration of light through the canopy. The length of the top 5 internodes (excepting the peduncle) averaged 21.0, 13.1, and 6.6 cm for the TA, SD, and DW plants. The next set of five internodes averaged only 11.8, 4.7, and 1.2 cm in the same order. RSPAR was less than 1% of incoming PAR in all plots.

Intercepted PAR was similar in the pure isoline canopies in 1978. In 1979, however, the large TPAR through the DW canopy caused significant differences in PAR interception between this plot and the

Table 1.2—Growth stages of three height isolines during the 1978 and 1979 growing seasons at Manhattan, Kansas.

GS*	Date 1978	Date 1979	Identifying Characteristic
0	May 24	May 26	Emergence
1	June 4	May 30	3rd leaf fully visible
2	12	June 9	5th leaf fully visible
3	21	18	Growing point differentiation
4	July 3	July 4	Final leaf (14th) visible in whorl
5	8	9	Boot
6	12	14	50% of plants in bloom
7	21	24	Soft dough
8	Aug. 5	Aug. 6	Hard dough
9	16	20	Physiological maturity

*Growth stages as classified by Vanderlip (1972)

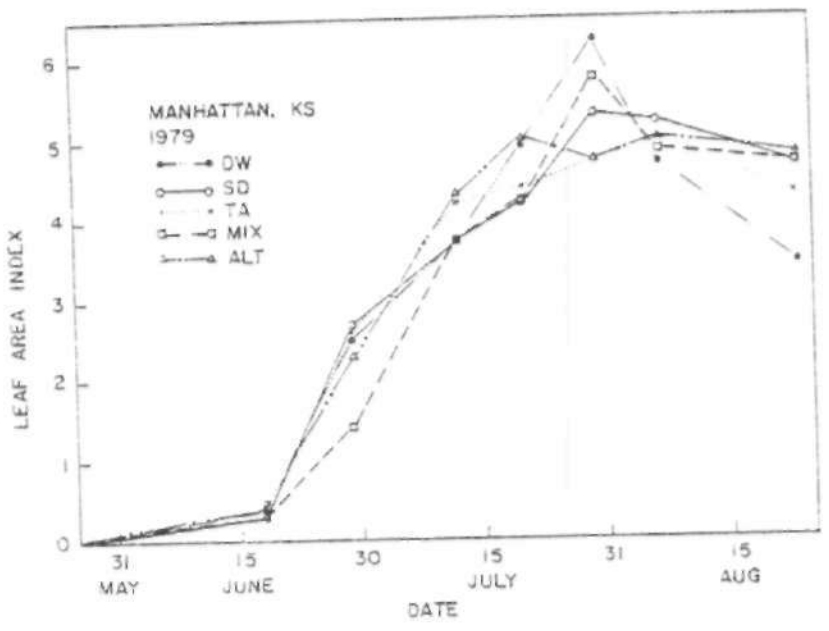


Fig. 1.1—Leaf area indices of three sorghum height isolines in pure and mixed canopies.

Table 1.3—Photosynthetic active radiation balance* of sorghum height isolines between half bloom to physiological maturity.

Plot	1978			1979		
	RPAR	TPAR	IPAR	RPAR	TPAR	IPAR
	---------- % ----------			---------- % ----------		
Double Dwarf	4.0	7.1	89.4	4.3	19.9	76.3
Dwarf	4.1	9.1	87.8	4.5	7.7	88.8
Tall	4.2	10.8	85.2	4.0	9.7	86.5
Mixed	3.9	7.6	88.7	4.7	8.0	87.6
Alternated	3.8	2.6	93.6	5.0	10.1	85.5

*Simultaneous confidence interval for differences between two means ranges between ± 0.74 to 0.81 for RPAR, ± 4.07 to 4.46 for TPAR and ± 4.25 to 4.65 for IPAR columns

other two. This difference is illustrated on a seasonal basis in Figure 1.2 Vegetative cover was sparse in all treatments on dates earlier than 26 June, thus giving highly fluctuating TPAR and very low IPAR. Figure 1.3 is typical of diurnal trends of IPAR in the pure canopies in 1979. All three canopies intercepted similar amounts of PAR from sunrise until 1000 CDT, and from 1600 CDT to sunset. During peak insolation, the incomplete cover in DW plots allowed large amounts of PAR transmission through the canopy resulting in lowered interception. Conversely, SD plots were denser and, therefore, intercepted more PAR than either DW or TA. Intercepted PAR in the ALT canopy was significantly higher than in TA, SD, and MIX plots in 1978 but this difference was not confirmed by 1979 data.

Figure 1.4 shows the similarity of IPAR in the MIX and ALT canopies in 1979. The lower canopy, consisting of leaves no higher than the double dwarf plants, intercepted an average of 26 and 32 percent of incoming PAR in the MIX and ALT treatments respectively, in 1978. $IPAR_2$ was only 10 and 30 percent of incoming PAR in the MIX and ALT canopies in 1979 (see diurnal trend of IPAR and $IPAR_2$ in Fig. 1.5). Double dwarf plants in the MIX were shaded more than those in the ALT.

Dry matter yields of the isolines in pure, MIX, and ALT canopies are presented in Figure 1.6. The difference in dry matter yield between the DW, SD, and TA isolines was mainly in the stem fraction. It appears that DW and SD isolines were sink limited from emergence to anthesis and, consequently, produced less vegetative dry matter compared to the TA in either pure, mixed or alternated canopies. The ALT canopy had the highest dry matter in both seasons though this did not vary significantly from that of the TA or MIX. Tall plants in the MIX canopy

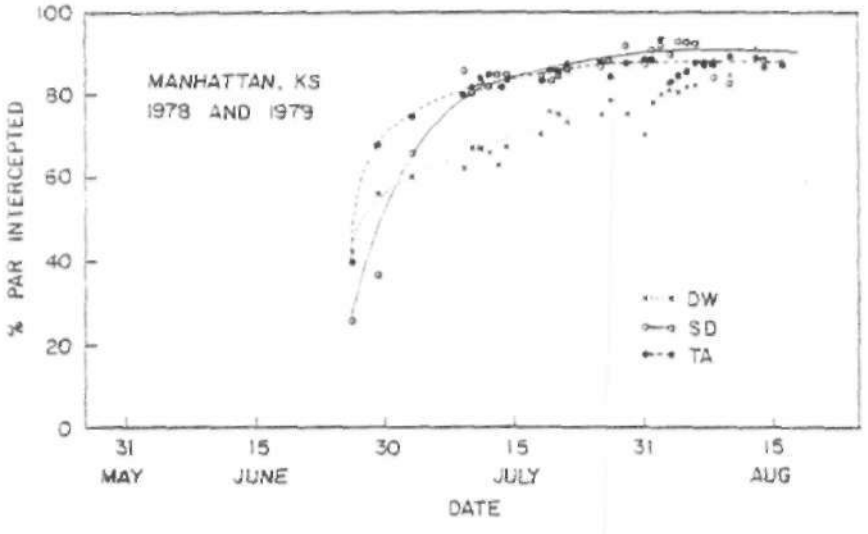


Fig. 1.2—Percent of incoming PAR intercepted in pure isoline canopies.

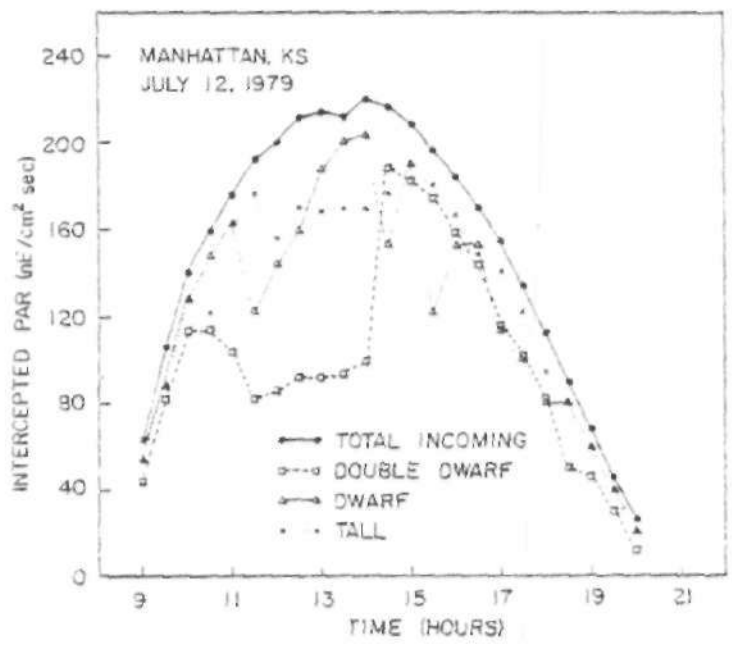


Fig. 1.3—Diurnal PAR interception in the pure isolines.

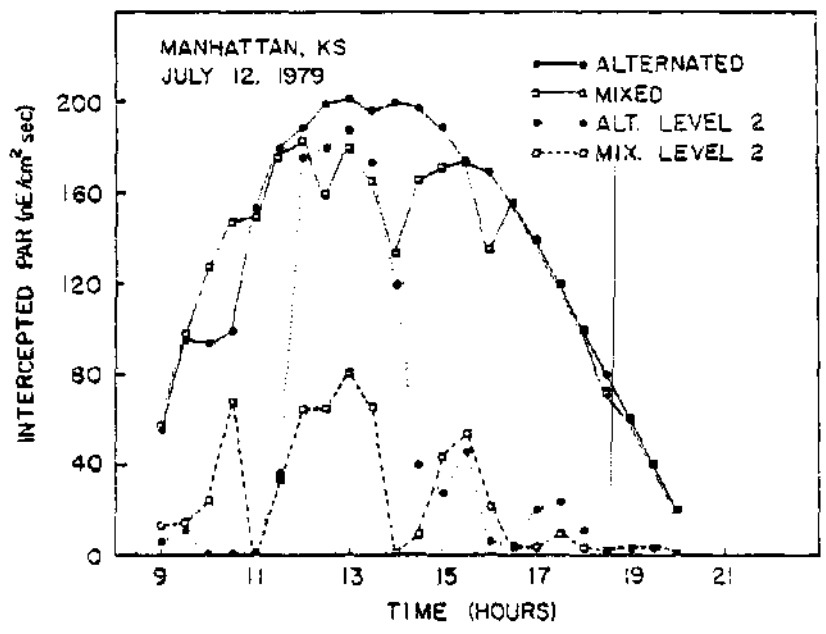


Fig. 1.4—Diurnal trends of IPAR and $IPAR_2$ in the MIX and ALT plots.

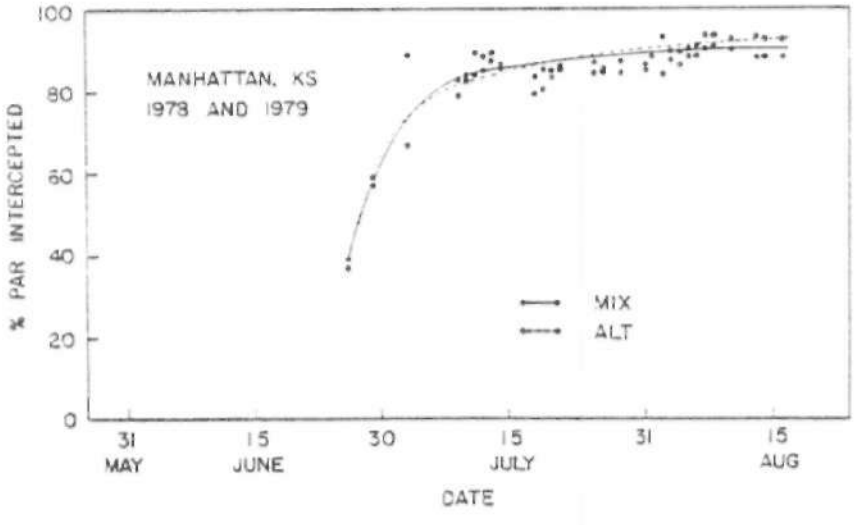


Fig. 1.5—Percent of incoming PAR intercepted in the MIX and ALT canopies.

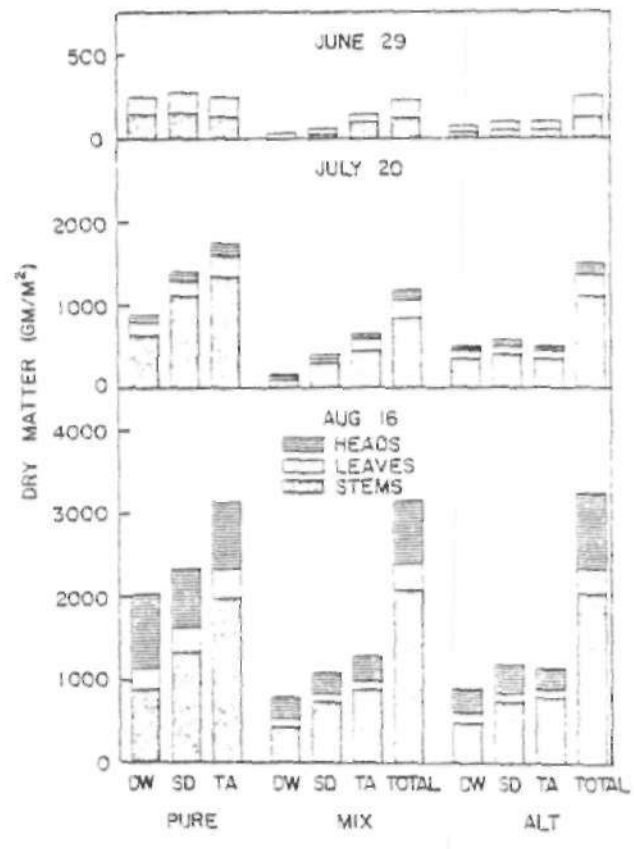


Fig. 1.6—Dry matter yields of three height isolines in pure, mixed and alternated canopies at Manhattan, Kansas, 1979.

produced more dry matter than in pure or ALT canopies. The harvest indices were 0.50, 0.41, 0.40, 0.33 and 0.30 percent for the DW, SD, MIX, ALT and TA canopies in 1978; while in 1979, these were 0.35, 0.33, 0.20, 0.20 and 0.19, respectively. The higher harvest index in the shorter (DW and SD) canopies were caused by relatively lower vegetative dry matter in these canopies compared to the TA, MIX or ALT. The higher indices in 1978 were apparently due to lower vegetative growth because of more droughty conditions in 1978 compared to 1979.

Tables 1.4 and 1.5 give the grain yield and yield components of the main treatments and the separate isolines in the MIX and ALT canopies. Presumably because of the relatively high seeding rate, TA plants produced only 0.93 heads per main plant in 1978. The 1979 season had a uniform rainfall distribution which accounted for profuse tillering and generally higher grain yield than 1978. TA plants had greater seed weight than either the SD or DW; the comparatively low seed weight of the DW plants in pure, mixed and alternated rows suggest the grains were source limited. Grain yield of the TA plots was the lowest of all treatments in both seasons. The SD plots, in contrast, had the highest grain yield in both seasons--consistent with its higher IPAR compared to either the DW or TA. The advantages in IPAR of the MIX, ALT, and TA canopies appear to favor dry matter production rather than grain yield. The shading of double dwarf plants in the MIX is reflected in grain yield. Total grain yield and seed weight of double dwarf plants in the MIX plots were considerably lower than those of corresponding plants in the pure and ALT canopies.

Table 1.4—Number of heads per main plant, seed weight, and grain yield of main plots.

Plots	1978			1979		
	#Heads/ Main Plant	1000 Seed Wt.	Grain Yield*	#Heads/ Main Plant	1000 Seed Wt.	Grain Yield*
		(gm)	(kg/ha)		(gm)	(kg/ha)
SD	1.25	34.7	7165	1.15	32.0	8027
DW	1.35	30.9	6397	1.44	27.8	7671
ALT	1.28	35.0	6779	1.37	30.1	6754
MIX	0.99	34.7	6419	1.21	31.8	6749
TA	0.93	38.6	5905	1.23	35.0	6283
$LSD_{.10}$	0.12	0.7	573	0.18	3.4	996
$LSD_{.01}$	0.18	1.1	856	0.26	5.1	1465

*Determined at 12.5% moisture content

Table 1.5—Number of heads, seed weight, and grain yield of component plants in the mixed and alternated plots.

Plots	1978			1979		
	#Heads/ Main Plant	1000 Seed Wt. (gm)	Grain Yield* (kg/ha)	#Heads/ Main Plant	1000 Seed Wt. (gm)	Grain Yield* (kg/ha)
MIXED						
DW	0.76	28.9	1065	0.76	23.6	665
SD	1.00	35.3	2209	1.25	30.7	1932
TA	1.18	40.1	3145	2.09	36.0	4152
ALTERNATED						
DW	1.25	29.3	1612	1.29	25.7	1850
SD	1.39	35.0	2417	1.26	33.5	2620
TA	1.15	40.7	2749	1.11	36.2	2285
$LSD_{.10}$	0.19	1.0	431	0.49	5.4	1129
$LSD_{.01}$	0.28	1.5	640	0.71	7.9	1653

*Determined at 12.5% moisture content

CONCLUSIONS

Plant development and LAI were similar for the isolines. Only the DW had incomplete ground cover throughout the growing season. This was reflected in significantly higher TPAR and lower IPAR relative to the other treatments. Fewer tillers and loose arrangement of leaves on TA plants caused higher TPAR and, hence, lower IPAR than in the SD canopy though the differences are statistically insignificant. IPAR in the MIX and ALT plots were similar to that of the SD. The SD plot, however, had the highest grain yield in both seasons. The lowest grain yield was obtained from the TA. High intercepted PAR in the TA, MIX, and ALT canopies favored dry matter production. Significantly lower seed weight of the DW plants suggests source limitation in pure, mixed and alternate-row stands.

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Chapter II

SOIL WATER DEPLETION AND WATER USE OF THREE HEIGHT ISOLINES OF SORGHUM

(submitted to Agronomy Journal)

SOIL WATER DEPLETION AND WATER USE OF THREE HEIGHT ISOLINES OF SORGHUM[1/]

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ABSTRACT

Dwarfing of tall sorghums provides lodging resistance and adapts the crop to mechanical harvesting. Its effect on grain yield is, however, inconsistent. To explain yield differences between height isolines, we compared profile water extraction, total water use, and water-use efficiencies (WUE) of three height isolines of sorghum. Other measurements included leaf temperature, stomatal resistance, and xylem-water potential.

The water extraction profiles of the isolines were similar except the DW plots allowed more surface evaporation because of incomplete ground cover. TA plants had the lowest xylem-water potential and highest stomatal resistance; DW plants had the reverse, while SD plants had intermediate values. The TA canopy had the highest evapotranspiration in both seasons. TA plants also had the highest WUE for dry matter but the SD plants were more efficient with respect to grain water-use efficiency. SD plants had consistently the warmest canopy temperature of the isolines during peak insolation periods. Relationship of dry matter production to normalized transpiration gave slope factor (k) of 0.173, 0.222 and 0.296 mb for the DW, SD, and TA canopies.

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INTRODUCTION

The effects of height genes in sorghum have not been fully understood. Quinby and Karper (1954) defined true height genes as those influencing only the length of internodes. But reports of significant grain yield differences between height isolines (Hadley, Freeman and Javier, 1965; Stickler and Younis, 1966; Hoshino, Uzihara and Shikata, 1978) emphasizes the need for more detailed research into other secondary effects of the height genes. Casady (1967) and Shertz (1973) found that the Dw_3 gene influenced culm diameter of the third, fourth and fifth internodes from the top of the plant, peduncle length, blade size of the third, fourth and fifth leaves from the top as well as culm height. Hoshino, et al., (1978) reported that 2-dwarf sorghum had significantly higher net assimilation rate than the shorter 3-dwarf. Pepe and Welsh (1979) evaluated the effects of the dwarfing genes on root activity of dryland wheat but found no relationship among soil water depletion, dwarfing genes and root development or activity. Other environmental studies of height isolines (Hagen and Skidmore, 1974; Skidmore and Hagen, 1978) assessed windbreak effects of mixing 2- and 3-dwarf sorghums. Sheltering by 2-dwarf plants reduced turbulent exchange, increased leaf water potential and lowered stomatal resistance of the shorter 3-dwarf plants suggesting an improved water status of the 3-dwarf plants.

Water use and water-use efficiency

Water-use efficiency is generally defined as the ratio of dry matter (Y) produced to the amount of evapotranspiration (ET). Tanner

and Sinclair (1980) differentiated between transpiration (T)-efficiency, which considers transpiration only, from ET-efficiency. Investigations of water use by agricultural plants as early as Briggs and Shantz (1914) indicated that relative water requirements (more specifically, relative transpiration) should be considered because of observed differences in transpiration (T) depending on atmospheric exposure. Gradmann (1928) and Van der Honert (1948) expressed this exposure in terms of the vapor pressure gradient from the leaf to the air. DeWit (1958), Bierhuizen and Slatyer (1965) and Tanner, et al., (1980), therefore, proposed a linear relationship between Y and T normalized with cumulative water vapor gradient:

$$Y = kT/\Delta e \qquad [1]$$

where k = crop factor

Δe = vapor gradient from the leaf to the air (e_l-e)

e_l = leaf vapor pressure and

e = vapor pressure of the air.

The factor, k, enables WUE comparison for a specified crop grown at different seasons or sites. Theoretical and experimental estimates of k for sorghum were 0.118 and 0.138 mb, respectively (Tanner, et al., 1980).

We designed experiments to compare photosynthetic light balance, water use, growth, and development of three height isolines of sorghum (Sorghum bicolor L. Moench) in pure, mixed, and alternated rows. This paper discusses the soil water extraction patterns, water-use efficiencies and leaf temperatures of the pure isoline canopies.

MATERIALS AND METHODS

The experiments were conducted at Kansas State University Ashland Agronomy Farm, Manhattan, Kansas. The soil was silty clay loam (fine-silty, mixed mesic, Pachic Haplustoll) with a maximum available water holding capacity of 13.2% by weight--about 30 cm of available water in a 150 cm soil profile (see Jaafar, Kanemasu and Powers, 1978). Nitrogen was applied at a rate of 108 kg/ha (anhydrous ammonium nitrate). The double dwarf ($dw_1dw_2Dw_3dw_4$), dwarf ($dw_1Dw_2Dw_3dw_4$) and tall ($Dw_1Dw_2Dw_3dw_4$) height isolines of White Sooner Milo were planted on 18 May, 1978 and 17 May, 1979. Their approximate heights at maturity were 90, 150 and 195 cm, respectively.

A completely randomized design was used with three treatments--the 3-dwarf (DW), 2-dwarf (SD), and 1-dwarf (TA). Limited seed supply permitted only three replications of each treatment each year. The 9 x 15 m plots were planted with 75 cm between N-S rows and 7.62 cm within rows (a density of about 175,000 plants/ha). Weekly measurements included soil water content (gravimetric and neutron probe) at 15 cm increments to 150-cm depth, leaf area and dry weight of plant parts. Evapotranspiration (ET) in 1979 was separated into evaporation (E) and transpiration (T) by a model developed by Kanemasu, Stone and Powers (1976). The model used daily inputs of temperature, vapor pressure, solar radiation and leaf area index. Water-use efficiency (WUE) of dry matter and grain yield was estimated as a ratio of dry matter or grain yield to total ET at harvest time, respectively.

Daily maximum and minimum air temperature, and relative humidity were obtained from the Kansas State University weather station. Leaf vapor pressure was estimated by

$$e_1 = 0.75(e^*_{tmax} - e^*_{tmin}) + e^*_{tmin} \quad [2]$$

where e^*_{tmax} and e^*_{tmin} represent saturated vapor pressures at maximum and minimum air temperatures, respectively (Tanner, et al., 1980). Both e^*_{tmax} and e^*_{tmin} were computed as described by Murray (1967). Air vapor pressure (e) was derived from relative humidity data at the time of maximum air temperature. The plot of e^*_{tmax}, e^*_{tmin}, e_1 and e throughout 1979 growing season is given in Figure 2.1.

Leaf temperature was measured with sets of three parallel thermocouples (wire guage 38g.) in contact with the abaxial side of three flag leaves on 20 clear days between growing point differentiation and physiological maturity in both years. Air temperature was measured on the same days with two shielded thermocouples ventilated at about 3 m/sec. Both air and leaf thermocouples were scanned every 30 minutes and the data printed out by digital recorders (Campbell CR5).

Stomatal resistance of both adaxial and abaxial surfaces on at least three flag leaves per treatment was measured with an automatic porometer (Delta-T Devices). The average leaf stomatal resistance (R_s) was calculated by

$$1/R_s = 1/R_{ad} + 1/R_{ab} \quad [3]$$

where R_{ad} and R_{ab} are the resistances of the adaxial and abaxial surfaces, respectively. Pressure chamber was used to estimate xylem-water potential, ψ_L. The stomatal resistance and xylem-water potential were measured between 1300 and 1500 CDT on 12 clear days from anthesis to physiological maturity.

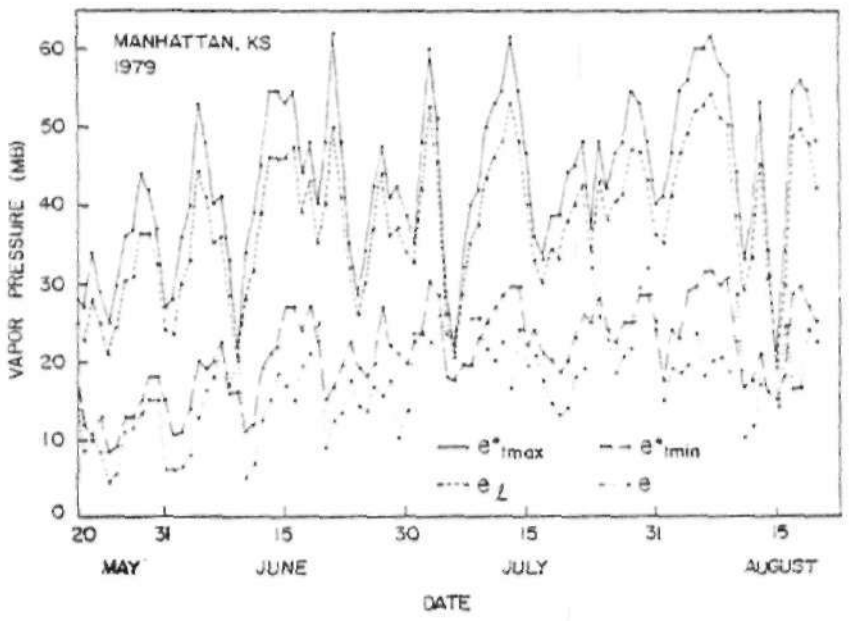


Fig. 2.1—Estimated leaf and air vapor pressures, e^*_{tmax} and e^*_{tmin} throughout 1979 growing season.

RESULTS AND DISCUSSIONS

Soil water depletion patterns of the isolines obtained from neutron probe measurements during rainless periods of 1978 and 1979 are presented in Figure 2.2 The shaded portions represent the volumetric water content extracted from the soil at the corresponding depths within the dry period. Water loss from the soil surface to about 25 cm depth combines water extraction by roots close to the surface and direct evaporation, E. If root uptake at this depth is assumed similar, then relative E was of the order DW-TA-SD from highest to lowest E. The DW plots allowed higher E because of incomplete ground cover (Owonubi and Kanemasu, 1980). It appears that the isolines extracted a small amount of water below a depth of 150 cm.

Figures 2.3 and 2.4 present the total available water depletion throughout both seasons. The growth stages were as classified by Vanderlip (1972). Rainfall was relatively evenly distributed in both seasons and the soil profiles were never depleted below 30% of maximum available water, the critical soil moisture level below which transpiration rates could be expected to decrease (see Ritchie, 1973; Sumayao, Kanemasu and Hodges, 1977). From soil-water measurements, ET was estimated as 41.9, 40.9 and 44.1 cm for the DW, SD and TA plots in 1978. ET, like potential ET, was lower in 1979, amounting to 38.0, 37.2 and 39.3 cm for the DW, SD and TA plots, respectively. Potential ET, estimated by the Priestley-Taylor equation (Priestley and Taylor, 1972), during the growing seasons was 55.4 and 51.6 cm for 1978 and 1979, respectively. The TA plots used more water than either the DW or SD in both years though the difference is small.

Model predictions of ET and T (using only 1979 data) did not differ

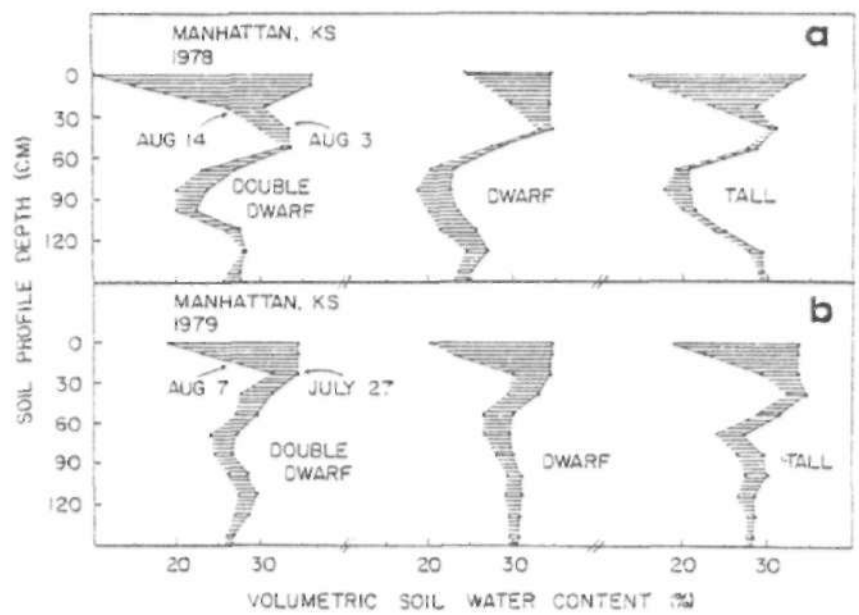


Fig. 2.2—Soil water depletion in the three isoline canopies (a) between 3 and 14 August, 1978 and (b) between 27 July and 7 August, 1979.

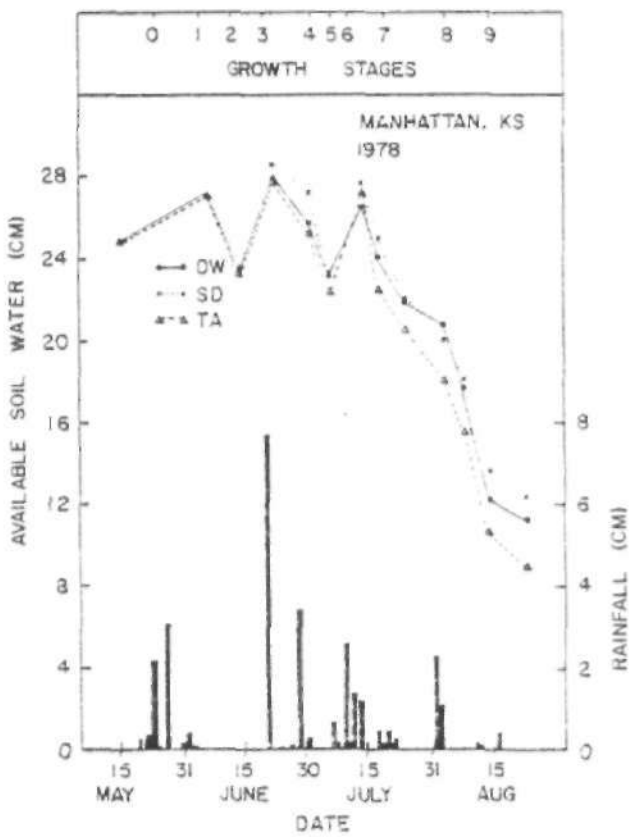


Fig. 2.3—Available soil water depletion in 1978.

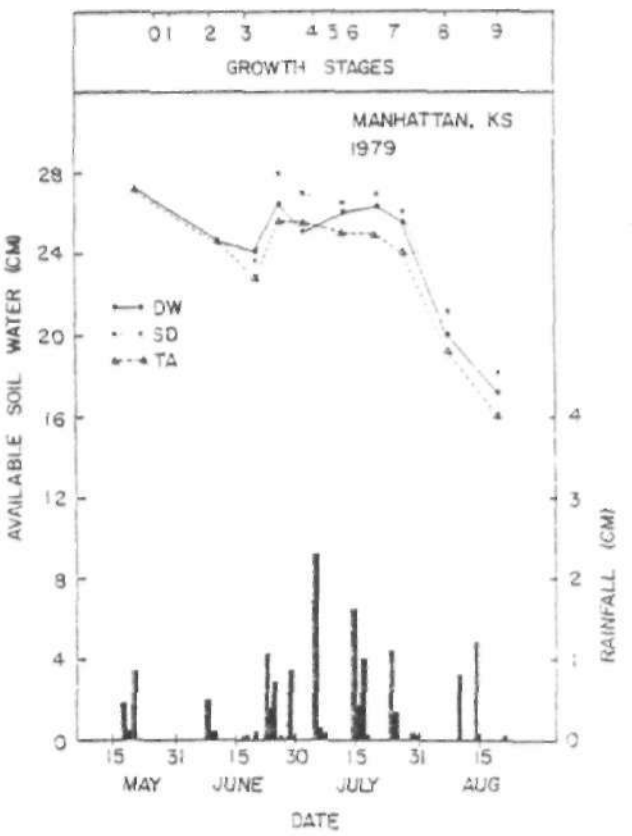


Fig. 2.4—Available soil water depletion in 1979.

between treatments. Predicted ET was 38.6, 38.4 and 38.3 cm for the DW, SD and TA plots while T was 25.5, 25.4 and 25.2 cm in the same order. The model closely predicted ET of the isolines although ET, and probably T of tall plants were underestimated relative to those of DW and SD. This is presumably because the model estimates both ET and T mainly as a function of the leaf area index with no consideration on canopy structure. The DW canopy had a slightly higher leaf area index despite a lower ground cover compared to the other isolines (see Owonubi et al., 1980).

The SD plants were consistently the warmest of the isolines especially between 1100 and 1600 CDT when insolation was near maximum (Fig. 2.5). Leaf temperature differences between the SD and the other isolines often reached 3°C. This could result from either lower T or higher heat load. Our light interception data (Owonubi et al., 1980) showed diurnal differences in light intercepted by the isolines but it is not clear if the observed differences could account for the temperature variation. An inherently warmer temperature in the SD plants might enable this line to withstand moisture stress better than either the TA or DW. Canopy temperatures appeared to be more sensitive to describing differences in T than was stomatal resistance.

Figure 2.6 shows that all the canopies had very low R_s ($\leq$ 2 sec/cm) in both seasons, indicating the plants did not experience severe water stress (see Ritchie, 1974). The ψ_L was consistently higher in DW plants, i.e., DW>SD$\geq$TA, indicating more favorable water status for the shorter isolines.

The relationship of dry matter produced by the isolines to cumulative T and normalized T are presented in Figure 2.7. T/Δe were

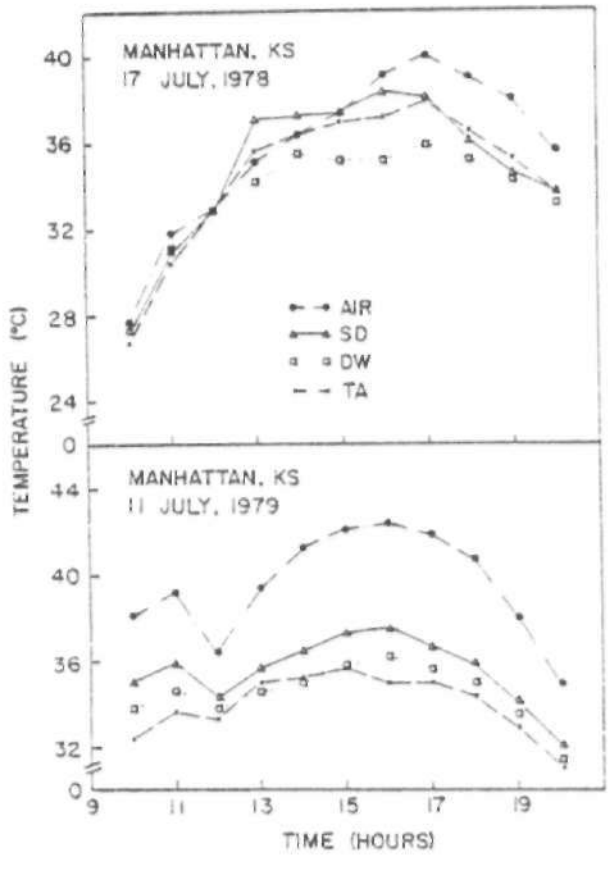


Fig. 2.5—Air and flag leaf temperatures of sorghum height isolines during 1978 and 1979 growing seasons.

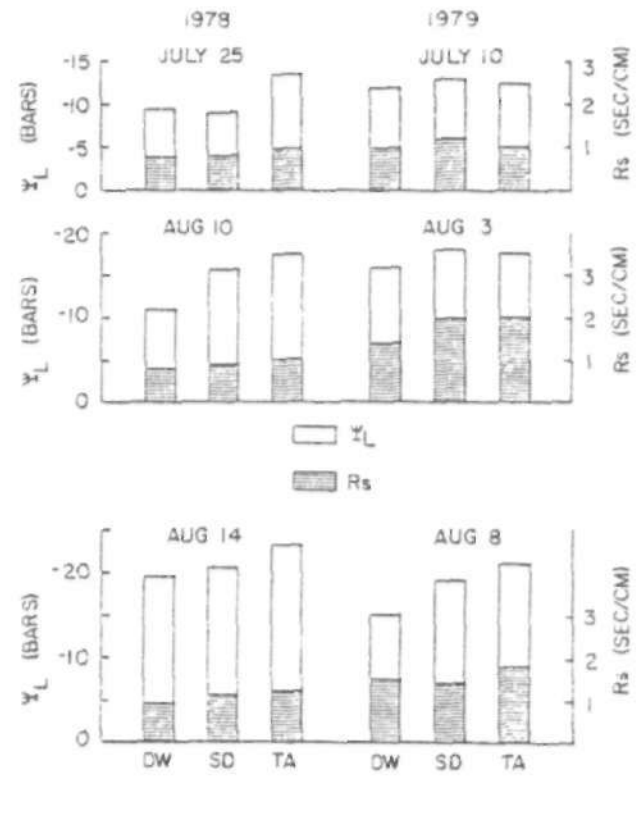


Fig. 2.6—Stomatal resistance and xylem-water potential of the three height isolines.

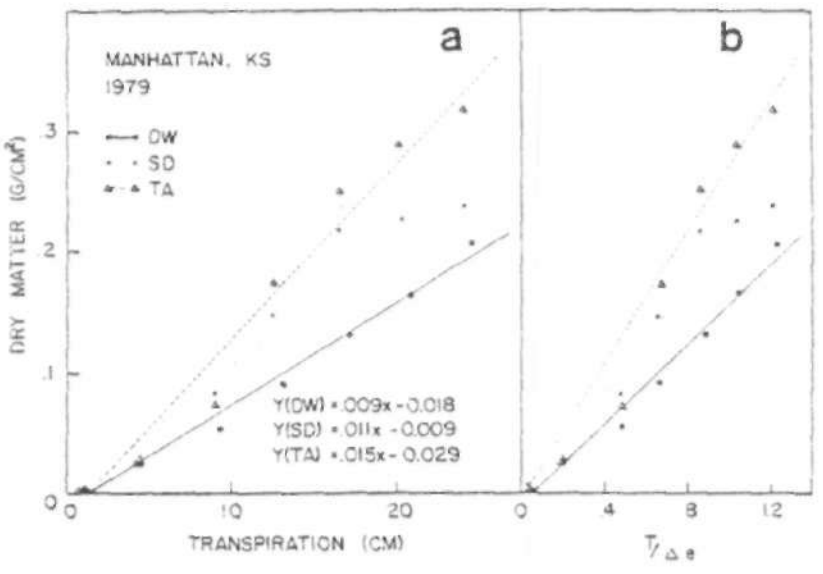


Fig. 2.7—Relationship of dry matter yield to the amount of transpiration and normalized transpiration in the isoline canopies.

calculated on a daily basis and summed over the same period as the dry matter. The slope of the lines in Figure 2.7b provided k values of 0.173, 0.222 and 0.296 mb for the DW, SD and TA plots, respectively. Our values are higher than the 0.130 mb cited by Tanner, et al., (1980). The overestimate and the genotypic differences in 'k' may be due to dry matter yield, (e_1-e), T, or the assumptions by Tanner and Sinclair (1980).

The dry matter yields were restricted to above ground organs; therefore, inclusions of roots would increase 'k' even more. The estimate of e_1 from air temperature measurements could overestimate e_1. Measurements indicate leaf temperatures below air temperature (e.g., 3 to 8°C) and could result in as much as a 100 percent overestimate in (e_1-e). Such an overestimate in e, if typical over the growing season, could lower 'k' to near the theoretical value given by Tanner and Sinclair. The magnitude of the differences in leaf temperature among isolines would not be sufficient to account for the differences in 'k'. Because model and observed ET were similar, it is difficult to perceive a large error in T. However, the more open-canopy structure of the TA canopy would be more conducive to higher transpiration than the DW canopy.

Tanner and Sinclair (1980) in their theoretical analysis assume (1) equal fluxes of carbon dioxide and water vapor, (2) a full canopy (LAI > 3) with unique relationship of sunlight to shade leaves, (3) maintenance respiration equal to the photosynthesis of shaded leaves, and (4) a hexose to biomass conversion coefficient. The major difference in dry matter production among the isolines was in the stem fraction. This would indicate that the SD and DW genotypes were sink limited,

especially during the pre-anthesis period. Therefore, the differences in 'k' among the height isolines is probably due to the inappropriateness of assumption (1). This would not necessarily be readily observed in other studies, however. The morphological differences in canopies among the isolines would contribute to their differences in 'k' values. Only a slight effect on 'k' could be realized from a biochemical analysis of the dry matter; however, the correction would bring the 'k' values closer to one another.

Water-use efficiency for dry matter and grain are given in Table 2.1. The isolines produced more dry matter per unit water transpired in direct relation to their height. TA plots were more efficient with respect to dry matter yield while SD plots produced the most grain per unit of water in both seasons. Dry matter yield was lower and ET higher in 1978 than in 1979 resulting in comparatively higher WUE for both grain and dry matter in the second season.

Table 2.1—Water-use efficiency† for dry matter (DM) and grain yield in the two growing seasons.

	1978		1979	
Plot	DM	Grain	DM	Grain
Double dwarf	3.2	1.6	6.1	2.0
Dwarf	4.3	1.8	6.8	3.3
Tall	4.9	1.4	8.7	1.6

†WUE expressed in g dry matter or grain yield/kg of water used

SUMMARY

The zone of maximum water extraction for the isolines were similar but incomplete ground cover caused more soil surface evaporation from the DW canopies. Rainfall was relatively evenly distributed in 1978 and 1979 so none of the isolines depleted available soil water below 30% of maximum. Stomatal resistance of the isolines were less than 2 sec/cm in both seasons, indicating no severe moisture stress. The xylem-water potential was of the order DW>SD≥TA indicating better water status in the DW than in other canopies. The SD canopy had higher temperature than the other isolines. The difference in T and ET between the isolines were insignificant. TA plots had the highest WUE for dry matter but the SD plants produced the most grain per unit amount of water.

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Appendix A

CLIMATIC DATA OF ASHLAND AGRONOMY FARM

DURING 1978 AND 1979 GROWING SEASONS

DATE	SR (LY/DAY)	TMAX (C)	TMIN (C)	RAIN (cm)
5/ 1/78	358.2	14.4	9.4	0.03
5/ 2/78	587.0	15.6	3.9	0.0
5/ 3/78	148.0	12.8	7.2	0.0
5/ 4/78	111.0	12.2	7.2	0.08
5/ 5/78	470.4	15.6	2.8	0.03
5/ 6/78	15.8	15.0	6.1	0.20
5/ 7/78	151.8	15.6	7.8	3.56
5/ 8/78	606.8	19.4	7.2	0.20
5/ 9/78	652.4	22.2	8.3	0.0
5/10/78	604.2	26.7	8.9	0.0
5/11/78	368.0	25.0	16.1	0.20
5/12/78	309.8	22.8	13.3	0.20
5/13/78	714.6	21.7	9.4	1.19
5/14/78	706.0	25.0	6.7	0.0
5/15/78	708.8	23.9	9.4	0.0
5/16/78	693.2	21.7	8.3	0.0
5/17/78	617.0	23.3	10.6	0.0
5/18/78	341.6	25.0	15.6	0.0
5/19/78	514.8	31.1	17.2	0.0
5/20/78	650.0	26.1	15.0	0.05
5/21/78	635.0	23.9	11.1	0.0
5/22/78	256.6	24.4	15.0	0.33
5/23/78	583.4	31.7	15.6	3.12
5/24/78	656.0	32.2	15.6	0.56

DATE	SR (LY/DAY)	TMAX (C)	TMIN (C)	RAIN (cm)
5/25/78	564.4	32.2	16.1	0.0
5/26/78	468.4	28.9	16.1	2.54
5/27/78	429.6	28.3	19.4	0.0
5/28/78	654.0	27.8	17.8	0.0
5/29/78	362.0	26.1	15.0	0.0
5/30/78	696.0	31.1	10.6	0.0
5/31/78	371.8	30.0	15.6	0.71
6/ 1/78	321.4	20.0	13.3	0.79
6/ 2/78	529.6	21.1	12.8	0.08
6/ 3/78	561.6	23.9	15.0	0.03
6/ 4/78	494.0	24.4	12.2	0.0
6/ 5/78	607.4	27.2	13.3	0.0
6/ 6/78	302.8	25.0	15.0	0.0
6/ 7/78	725.0	28.3	16.1	0.15
6/ 8/78	708.6	24.4	8.9	0.0
6/ 9/78	726.2	30.0	12.8	0.0
6/10/78	734.8	31.1	18.9	0.0
6/11/78	649.8	34.4	21.7	0.0
6/12/78	752.4	29.4	10.6	0.0
6/13/78	713.4	29.4	12.8	0.0
6/14/78	703.0	32.2	17.8	0.0
6/15/78	668.0	35.0	22.2	0.0
6/16/78	721.0	38.9	24.4	0.0
6/17/78	725.6	36.1	25.6	0.0

DATE	SR (LY/DAY)	TMAX (C)	TMIN (C)	RAIN (cm)
6/18/78	687.2	29.4	18.3	0.0
6/19/78	694.4	32.2	15.0	0.0
6/20/78	594.4	28.9	18.3	8.23
6/21/78	743.2	26.7	13.9	0.0
6/22/78	642.6	31.7	18.3	0.05
6/23/78	444.0	31.1	21.1	0.0
6/24/78	604.0	34.4	23.3	0.0
6/25/78	708.2	37.8	25.6	0.0
6/26/78	553.2	35.6	22.8	0.13
6/27/78	537.8	33.3	20.0	0.0
6/28/78	694.0	35.0	20.6	2.72
6/29/78	725.8	35.0	23.3	0.0
6/30/78	674.0	36.1	24.4	0.0
7/ 1/78	661.4	35.6	26.1	0.03
7/ 2/78	735.4	34.4	21.1	0.0
7/ 3/78	710.4	38.3	21.7	0.0
7/ 4/78	727.6	37.8	25.0	0.0
7/ 5/78	728.4	38.3	27.2	0.0
7/ 6/78	531.4	35.0	20.0	0.76
7/ 7/78	684.4	31.1	21.1	0.10
7/ 8/78	669.6	36.7	17.8	0.0
7/ 9/78	197.4	34.4	22.2	0.0
7/10/78	409.6	22.8	13.3	3.05
7/11/78	194.4	27.2	15.0	0.0

DATE	SR (LY/DAY)	TMAX (C)	TMIN (C)	RAIN (cm)
7/12/78	508.4	37.8	21.7	0.25
7/13/78	246.0	33.9	23.9	0.0
7/14/78	688.2	35.6	1d.9	1.96
7/15/78	727.8	32.8	18.3	0.0
7/16/78	585.8	34.4	18.9	0.0
7/17/78	657.4	36.7	25.0	0.0
7/18/78	603.6	35.6	22.8	0.58
7/19/78	596.2	35.0	24.4	0.20
7/20/78	181.6	32.8	22.2	0.36
7/21/78	562.0	36.1	24.4	0.41
7/22/78	383.4	31.7	20.6	0.28
7/28/78	677.0	25.6	15.6	0.0
7/24/78	710.0	31.1	14.4	0.0
7/25/78	711.6	37.2	23.3	0.0
7/26/78	704.2	34.4	25.6	0.0
7/27/78	706.2	32.8	16.1	0.0
7/28/78	698.8	37.2	19.4	0.0
7/29/78	686.8	32.2	21.1	0.0
7/30/78	503.2	28.3	18.9	0.0
7/31/78	652.8	33.9	16.7	0.0
8/ 1/78	353.8	28.9	18.3	1.50
8/ 2/78	478.6	30.6	20.6	0.30
8/ 3/78	407.6	25.6	16.1	0.0
8/ 4/78	657.2	25.0	12.2	0.0

DATE	SR (LY/DAY)	TMAX (C)	TMIN (C)	RAIN (cm)
8/ 5/78	674.4	27.8	12.2	0.0
8/ 6/78	634.8	31.1	17.2	0.0
8/ 7/78	631.6	33.3	18.3	0.0
8/ 8/78	649.8	35.0	21.1	0.0
8/ 9/78	383.0	33.3	20.6	0.0
8/10/78	540.8	30.6	19.4	0.10
8/11/78	535.8	31.7	18.9	0.05
8/12/78	629.6	38.3	18.9	0.0
8/13/78	629.0	40.0	23.3	0.0
8/14/78	562.0	37.8	26.1	0.0
8/15/78	642.0	35.0	21.7	0.69
8/16/78	643.0	36.1	13.9	0.0
8/17/78	623.8	38.9	21.7	0.10
8/18/78	606.4	37.2	26.1	0.0
8/19/78	607.8	27.8	15.6	0.0
8/20/78	615.8	32.8	13.9	0.0
8/21/78	592.0	37.2	23.3	0.0
8/22/78	516.0	37.2	25.0	0.0
8/23/78	593.8	38.3	24.4	0.0
8/24/78	582.4	38.9	26.7	0.0
8/25/78	500.8	38.3	23.9	0.0
8/26/78	381.2	37.2	20.7	0.0
8/27/78	581.6	34.4	21.7	0.38
8/28/78	428.4	30.0	20.6	0.0

DATE	SR (LY/DAY)	TMAX (C)	TMIN (C)	RAIN (cm)
5/ 1/79	498.8	23.9	6.1	0.46
5/ 2/79	81.4	18.3	10.0	0.69
5/ 3/79	297.2	10.6	5.0	0.69
5/ 4/79	684.2	18.3	5.0	0.0
5/ 5/79	648.8	22.8	6.7	0.0
5/ 6/79	637.0	29.4	13.9	0.0
5/ 7/79	575.4	27.2	16.7	0.0
5/ 8/79	472.6	29.4	18.9	0.0
5/ 9/79	284.8	27.2	20.0	0.0
5/10/79	138.0	22.2	7.2	0.79
5/11/79	691.8	17.2	2.2	1.70
5/12/79	573.6	22.2	3.3	0.0
5/13/79	663.8	23.3	7.8	0.03
5/14/79	541.8	22.8	8.3	0.58
5/15/79	625.8	23.9	11.1	0.0
5/16/79	532.4	30.0	13.9	0.0
5/17/79	644.6	28.3	18.9	0.0
5/18/79	327.4	23.9	16.7	0.23
5/19/79	210.4	22.2	13.3	0.91
5/20/79	503.4	22.8	14.4	0.86
5/21/79	668.0	22.2	10.0	0.0
5/22/79	681.6	26.1	7.8	0.0
5/23/79	552.0	23.9	11.1	0.0
5/24/79	646.8	21.1	5.0	0.0

DATE	SR (LY/DAY)	TMAX (C)	TMIN (C)	RAIN (cm)
5/25/79	675.8	23.9	5.6	0.0
5/26/79	626.8	27.2	11.1	0.0
5/27/79	713.8	27.8	11.1	0.03
5/28/79	680.2	30.6	13.3	0.0
5/29/79	618.0	30.0	16.1	0.0
5/30/79	404.6	27.8	16.1	0.0
5/31/79	570.4	22.2	12.8	0.0
6/ 1/79	455.6	22.8	7.8	0.0
6/ 2/79	671.4	27.2	8.3	0.0
6/ 3/79	702.0	28.9	11.7	0.0
6/ 4/79	561.4	33.9	17.2	0.0
6/ 5/79	598.4	32.2	16.7	0.0
6/ 6/79	395.0	28.9	17.2	0.0
6/ 7/79	462.0	29.4	19.4	0.0
6/ 8/79	209.4	25.6	13.9	1.04
6/ 9/79	124.0	18.9	13.9	0.25
6/10/79	737.0	26.1	8.9	0.20
6/11/79	732.4	28.3	10.0	0.0
6/12/79	706.2	31.1	16.7	0.0
6/13/79	712.4	34.4	18.3	0.0
6/14/79	723.2	34.4	18.9	0.0
6/15/79	644.6	33.9	22.2	0.0
6/16/79	622.8	34.4	22.2	0.05
6/17/79	485.6	30.6	20.6	0.10

DATE	SR (LY/DAY)	TMAX (C)	TMIN (C)	RAIN (cm)
6/18/79	601.2	32.2	22.2	0.10
6/19/79	317.8	28.9	19.4	0.0
6/20/79	736.2	32.2	13.3	0.18
6/21/79	702.2	36.7	14.4	0.0
6/22/79	622.2	32.2	17.2	2.08
6/23/79	450.2	26.7	18.9	0.74
6/24/79	325.0	23.3	16.7	1.40
6/25/79	448.8	26.1	16.1	0.0
6/26/79	574.4	30.0	17.2	0.05
6/27/79	513.8	32.8	22.2	0.0
6/28/79	622.2	29.4	18.9	1.65
6/29/79	720.4	30.0	18.3	0.0
6/30/79	439.6	28.3	17.2	0.0
7/ 1/79	226.8	26.7	19.4	0.0
7/ 2/79	467.4	32.2	20.6	0.0
7/ 3/79	650.4	36.1	24.4	0.0
7/ 4/79	614.6	33.3	23.3	0.0
7/ 5/79	147.8	23.3	16.1	4.60
7/ 6/79	120.0	18.9	15.6	0.30
7/ 7/79	274.6	25.0	17.2	0.13
7/ 8/79	374.2	28.9	17.2	0.0
7/ 9/79	593.2	30.0	20.0	0.0
7/10/79	583.4	32.8	21.1	0.0
7/11/79	671.6	33.9	22.2	0.0

DATE	SR (LY/DAY)	TMAX (C)	TMIN (C)	RAIN (cm)
6/18/79	601.2	32.2	22.2	0.10
6/19/79	317.8	28.9	19.4	0.0
6/20/79	736.2	32.2	13.3	0.18
6/21/79	702.2	36.7	14.4	0.0
6/22/79	622.2	32.2	17.2	2.08
6/23/79	450.2	26.7	18.9	0.74
6/24/79	325.0	23.3	16.7	1.40
6/25/79	448.8	26.1	16.1	0.0
6/26/79	574.4	30.0	17.2	0.05
6/27/79	513.8	32.8	22.2	0.0
6/28/79	622.2	29.4	18.9	1.65
6/29/79	720.4	30.0	18.3	0.0
6/30/79	439.6	28.3	17.2	0.0
7/ 1/79	226.8	26.7	19.4	0.0
7/ 2/79	467.4	32.2	20.6	0.0
7/ 3/79	650.4	36.1	24.4	0.0
7/ 4/79	614.6	33.3	23.3	0.0
7/ 5/79	147.8	23.3	16.1	4.60
7/ 6/79	120.0	18.9	15.6	0.30
7/ 7/79	274.6	25.0	17.2	0.13
7/ 8/79	374.2	28.9	17.2	0.0
7/ 9/79	593.2	30.0	20.0	0.0
7/10/79	583.4	32.8	21.1	0.0
7/11/79	671.6	33.9	22.2	0.0

DATE	SR (LY/DAY)	TMAX (C)	TMIN (C)	RAIN (cm)
7/12/79	648.4	34.4	23.3	0.0
7/13/79	679.4	36.7	23.9	0.0
7/14/79	660.8	34.4	23.9	0.0
7/15/79	395.6	31.7	18.9	3.10
7/16/79	402.4	27.2	20.6	0.86
7/17/79	371.0	25.6	18.3	2.03
7/18/79	525.8	28.3	17.8	0.05
7/19/79	618.4	28.3	16.1	0.0
7/20/79	594.4	30.6	17.8	0.0
7/21/79	547.8	31.1	20.0	0.0
7/22/79	503.4	32.2	21.7	0.0
7/23/79	109.0	28.3	21.1	0.0
7/24/79	548.6	32.2	22.8	2.13
7/25/79	580.6	30.0	20.6	0.71
7/26/79	529.8	31.7	19.4	0.0
7/27/79	488.8	32.2	21.1	0.0
7/28/79	534.8	34.4	21.7	0.0
7/29/79	340.0	33.9	23.3	0.0
7/30/79	265.8	32.2	23.3	0.13
7/31/79	284.6	28.9	21.1	0.05
8/ 1/79	552.6	29.4	15.6	0.0
8/ 2/79	418.8	31.7	20.6	0.0
8/ 3/79	641.8	34.4	20.0	0.0
8/ 4/79	638.0	35.0	23.3	0.0

DATE	SR (LY/DAY)	TMAX (C)	TMIN (C)	RAIN (cm)
8/ 5/79	639.4	36.1	23.9	0.0
8/ 6/79	630.8	36.1	25.0	0.0
8/ 7/79	636.2	36.7	25.0	0.0
8/ 8/79	614.0	35.6	23.9	0.0
8/ 9/79	611.0	35.0	24.4	0.0
8/10/79	117.0	30.6	19.4	0.0
8/11/79	646.4	25.6	14.4	1.57
8/12/79	634.0	28.3	15.0	0.0
8/13/79	601.0	33.9	18.3	0.0
8/14/79	60.4	26.1	13.9	0.0
8/15/79	190.0	17.8	12.8	2.39
8/16/79	247.0	26.1	15.6	0.0
8/17/79	594.2	34.4	23.3	0.0
8/18/79	562.0	35.0	23.9	0.0
8/19/79	605.0	34.4	22.2	0.0
8/20/79	527.4	32.2	21.1	0.05
8/21/79	498.8	30.6	19.4	0.20
8/22/79	577.0	32.2	19.4	0.0
8/23/79	575.6	28.3	16.7	0.0
8/24/79	438.2	30.6	13.9	0.0
8/25/79	458.4	28.9	17.8	0.0
8/26/79	465.6	27.2	17.2	3.17
8/27/79	286.8	26.1	16.1	0.0
8/28/79	543.0	33.9	18.3	0.0

DATE	SR (LY/DAY)	TMAX (C)	TMIN (C)	RAIN (cm)
8/29/79	510.4	32.2	18.9	0.03
8/30/79	543.4	35.0	22.2	0.0
8/31/79	537.0	32.8	24.4	0.0

EFFECT OF PLANT HEIGHT ON LIGHT INTERCEPTION, WATER USE AND YIELD OF GRAIN SORGHUM IN PURE AND MIXED CANOPIES

by

JOSEPH JIMOH OWONUBI

B.Sc., Ahmadu Bello University, 1972

M.S., Kansas State University, 1974

AN ABSTRACT OF A DOCTOR'S DISSERTATION

submitted in partial fulfillment of the

requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Agronomy

KANSAS STATE UNIVERSITY
Manhattan, Kansas
1980

ABSTRACT

Advantages of short over tall sorghum genotypes include resistance to lodging and adaptation to mechanical harvesting. Grain yield comparison of sorghum height types are, however, inconsistent. Experiments were designed to relate sorghum height to growth and development in pure and mixed canopies in the summer of 1978 and 1979. The treatments were: the 1-dwarf, 2-dwarf, 3-dwarf, a 33% by weight mixed-intercrop and alternating rows of the height isolines. Water-use efficiency (WUE), photosynthetic light (PAR) interception, flag leaf temperatures, stomatal resistance, xylem-water potential, dry matter accumulation and grain yield of the height isolines in the pure, mixed and alternated rows were determined.

The plant population of approximately 175,000 plants/ha, gave leaf area indices greater than 3-7 from half-bloom through grain filling. Only the 3-dwarf plots had incomplete ground cover which allowed significantly higher PAR transmission than either the 1- or 2-dwarf canopies. Fewer tillers and open arrangement of leaves on the tall 1-dwarf plants allowed higher PAR transmission and, therefore, lower interception compared to the 2-dwarf canopy though these differences were not statistically significant. Intercepted PAR in the mixed and alternated rows were similar to that in 1- or 2-dwarf plots.

The water extraction profiles of the pure isolines were similar except the 3-dwarf plots allowed more surface evaporation because of incomplete ground cover. Tall plants had the lowest xylem-water potential and highest stomatal resistance, 3-dwarf plants had the reverse while 2-dwarf plants were intermediate. The tall canopy had the highest evapotranspiration in both seasons. The 2-dwarf plants had

consistently the warmest canopy temperature of the isolines during peak insolation periods.

Differences in dry matter of the isolines were mainly in the stem fraction rather than leaves or heads. The tall plants produced about the same total dry matter as the mixed and alternated plots. Relationship of dry matter production to transpiration normalized with water vapor pressure gave 3lope factor (k) of 0.173, 0,222 and 0.296 mb for the 3-, 2- and 1-dwarf canopies. Tall plants had the highest WUE for dry matter but the 2-dwarf plants were more efficient with respect to grain water-use efficiency. The 2-dwarf produced the most grain in both seasons. Tall plants yielded more grain in the mixed than in either pure or alternated canopies. The 3hort 3-dwarf plants in the mixed plots were shaded and, therefore, yielded the lowest in dry matter and grain.

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND   DW

MAXIMUM AVAILABLE WATER (MM)..... 335.0000

THETA SUB V (15 BAR)..... 0.1300

THETA INITIAL IN 5 FT. PROFILE (MM)..... 448.0000

THETA SUB 5 CM. LAYER..... 0.3000

U (MM)..... 10.0000

ALPHA (P-T)..... 1.2800

FALLRT..... 0.3500

SOIL CONSTANT (MM DAY TO -1/2)..... 3.5000

X SUB 5 (INIT.WATER CONTENT IN 5 CM. LAYER,WT). 0.1700

FIELD CAPACITY..... 524.9998

BMTS MULTIPLIER..... 1.4000

THE INITIAL LAYER VALUES USED ARE 0.30, 0.30, 0.30, 0.30, 0.30

THE MAXIMUM LAYER VALUES USED ARE 0.35, 0.35, 0.35, 0.35, 0.35

THE MINIMUM LAYER VALUES USED ARE 0.13, 0.13, 0.13, 0.13, 0.13

THE LATITUDE USED ..... 39. 8.

THE INPUT FORMAT USED ..... (F6.1,2F5.2,F5.2,2)X,2F5.2)

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND OW

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPD MM/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	BATS	GDD
5	17	28.3	18.9	1.00	0.0	432.0	263.0	0.0	0.0	287.00	4.421	3.454	0.0	0.0	3.454	525.00	1.00	0.0	24.5
5	18	22.8	15.7	1.00	0.0	327.0	186.9	0.0	0.0	523.20	2.900	2.266	0.0	0.0	2.266	525.00	1.00	0.0	42.0
5	19	19.4	13.3	1.00	0.0	210.0	102.1	0.0	0.0	462.30	1.488	1.163	0.0	0.0	1.163	525.00	1.00	0.0	53.5
5	20	22.8	14.4	1.00	0.0	503.0	314.5	0.0	0.0	360.70	4.831	3.774	0.0	0.0	3.774	525.00	1.00	0.0	65.0
5	21	22.2	10.0	1.00	0.0	668.0	434.1	0.0	0.0	203.20	6.483	5.064	0.0	0.0	5.064	525.00	1.00	0.0	80.0
5	22	26.1	7.8	1.00	0.0	682.0	444.2	0.0	0.0	259.10	6.927	5.412	0.0	0.0	5.412	525.00	1.00	0.0	94.5
5	23	23.3	11.1	1.00	0.0	552.0	350.0	0.0	0.0	198.10	5.336	4.169	0.0	0.0	4.169	525.00	1.00	0.0	107.5
5	24	21.1	5.0	1.00	0.0	647.0	418.8	0.0	0.0	109.20	6.006	4.692	0.0	0.0	4.692	525.00	1.00	0.0	117.5
5	25	23.9	5.6	1.00	0.0	676.0	439.9	0.0	0.0	142.20	6.587	5.146	0.0	0.0	5.146	525.00	1.00	0.0	130.0
5	26	27.2	11.1	1.00	0.0	627.0	404.3	0.0	0.0	276.90	6.490	5.070	0.0	0.0	5.070	525.00	1.00	0.0	146.5
5	27	27.8	11.1	0.99	0.01	714.0	467.4	0.02	0.01	297.20	7.556	5.856	0.067	0.0	5.924	525.00	1.01	0.0	163.5
5	28	30.6	13.3	0.99	0.02	680.0	442.8	0.03	0.01	340.40	7.477	5.772	0.100	0.0	5.872	525.00	1.01	0.0	184.5
5	29	30.9	16.1	0.98	0.00	618.0	397.8	0.05	0.02	375.90	6.748	5.168	0.150	0.0	5.317	525.00	1.00	0.0	208.0
5	30	27.8	16.1	0.97	0.00	405.0	243.4	0.07	0.02	383.50	4.018	3.053	0.124	0.0	3.177	525.00	1.00	0.0	229.5
5	31	22.2	12.8	0.96	0.00	570.0	363.0	0.09	0.03	149.90	5.493	4.140	0.217	0.0	4.358	525.00	1.00	0.0	248.0
TOTALS						4368.79	82.760	64.199	0.658	0.0	64.858								

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND OK

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	TB/VPG MM/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	EMTS	GDD
6	1	22.8	7.8	0.96	0.08	456.0	280.4	0.10	0.03	154.90	4.177	3.136	0.183	0.0	3.319	525.00	1.00	0.0	254.5
6	2	27.2	8.3	0.95	0.05	672.0	437.0	0.12	0.04	167.60	6.930	5.162	0.364	0.0	5.526	525.00	1.00	0.0	270.0
6	3	28.9	11.7	0.95	0.08	702.0	458.7	0.14	0.05	195.60	7.537	5.569	0.460	0.0	6.029	525.00	1.00	0.0	288.5
6	4	33.9	17.2	0.94	0.09	561.0	356.5	0.16	0.05	322.60	6.362	4.663	0.442	0.039	5.144	525.00	1.00	0.0	313.0
6	5	32.2	16.7	0.93	0.17	598.0	383.3	0.17	0.06	419.10	6.692	4.886	0.493	0.0	5.378	525.00	1.00	0.0	337.0
6	6	28.9	17.2	0.93	0.00	394.0	235.5	0.19	0.06	459.70	3.958	2.867	0.324	0.0	3.191	525.00	1.00	0.0	360.5
6	7	29.4	19.4	0.92	0.00	462.0	284.7	0.21	0.07	574.00	4.862	3.494	0.439	0.0	3.932	525.00	1.00	0.0	386.5
6	8	25.6	13.9	0.91	0.00	209.0	101.4	0.23	0.08	424.20	1.612	1.149	0.159	0.0	1.308	525.00	1.00	0.0	404.0
6	9	18.9	13.9	0.91	0.00	124.0	39.8	0.24	0.08	525.80	0.577	0.409	0.059	0.0	0.469	525.00	1.00	0.0	415.5
6	10	26.1	8.9	0.90	0.14	677.0	440.6	0.26	0.09	124.50	6.904	4.864	0.764	0.0	5.627	525.00	1.00	0.0	430.0
6	11	28.3	10.0	0.89	0.12	732.0	480.4	0.28	0.09	175.30	7.785	5.440	0.924	0.0	6.364	525.00	1.00	0.0	446.5
6	12	31.1	16.7	0.89	1.45	706.0	461.6	0.30	0.10	317.50	7.952	5.514	1.007	0.0	6.521	525.00	1.00	0.0	470.5
6	13	34.4	18.3	0.88	0.31	712.0	465.9	0.31	0.10	388.60	8.405	5.805	1.098	0.158	7.060	525.00	1.00	0.0	496.0
6	14	34.4	18.9	0.88	0.60	723.0	473.9	0.33	0.11	475.00	8.568	5.870	1.186	0.171	7.227	525.00	1.00	0.0	522.0
6	15	33.9	22.2	0.87	0.00	645.0	417.4	0.35	0.12	426.70	7.596	5.163	1.111	0.099	6.373	525.00	1.00	0.0	551.0
6	16	34.4	22.2	0.86	0.00	621.0	400.0	0.37	0.12	378.50	7.327	4.940	1.129	0.163	6.231	525.00	1.00	0.0	580.0
6	17	30.6	20.6	0.86	0.00	486.0	302.1	0.38	0.13	492.80	5.252	3.527	0.829	0.0	4.356	525.00	1.00	0.0	607.5
6	18	32.2	22.2	0.85	0.00	601.0	385.5	0.40	0.13	528.30	6.879	4.583	1.139	0.0	5.722	525.00	1.00	0.0	636.5
6	19	28.9	19.4	0.79	0.00	318.0	180.4	0.59	0.20	645.20	3.059	1.890	0.720	0.0	2.610	525.00	1.00	0.0	662.0
6	20	32.2	13.3	0.73	0.27	736.0	483.3	0.78	0.26	223.50	8.327	4.769	2.500	0.0	7.269	525.00	1.00	0.0	683.0
6	21	36.7	14.4	0.68	0.24	702.0	458.7	0.97	0.32	325.10	8.366	4.443	3.014	1.106	8.564	525.00	1.00	0.0	705.0
6	22	32.2	17.2	0.63	1.70	622.0	400.7	1.16	0.39	340.40	7.011	3.452	2.916	0.0	6.368	525.00	1.00	0.0	729.5
6	23	26.7	19.4	0.58	0.00	450.0	276.0	1.35	0.45	454.70	4.557	2.080	2.131	0.0	4.211	525.00	1.00	0.0	753.0
6	24	23.3	16.7	0.54	0.00	325.0	185.4	1.55	0.52	365.80	2.899	1.222	1.501	0.0	2.724	525.00	1.00	0.0	771.0
6	25	26.1	16.1	0.50	0.00	449.0	275.3	1.74	0.58	345.40	4.451	1.740	2.502	0.0	4.242	525.00	1.00	0.0	791.0
6	26	30.0	17.2	0.46	0.00	575.0	366.6	1.93	0.64	426.70	6.247	2.264	3.768	0.0	6.032	525.00	1.00	0.0	815.5
6	27	32.8	22.2	0.43	0.00	514.0	322.4	2.12	0.71	398.80	5.792	1.946	3.713	0.0	5.659	525.00	1.00	0.0	844.5
6	28	29.4	18.9	0.40	0.00	622.0	400.7	2.31	0.77	442.00	6.827	2.127	4.618	0.0	6.744	525.00	1.00	0.0	870.0
6	29	30.0	18.3	0.37	0.00	720.0	471.7	2.50	0.83	238.80	8.073	2.332	5.741	0.0	8.073	525.00	1.00	0.0	895.5
6	30	28.3	17.2	0.36	0.00	440.0	268.8	2.59	0.86	348.00	4.488	1.251	3.237	0.0	4.488	525.00	1.00	0.0	918.4
TOTALS										*******	179.471	106.556	48.470	1.736	156.762				

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND OW

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPG MM/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	BMTS	GDD
7	1	26.7	19.4	0.34	0.00	227.0	114.4	2.68	0.89	624.80	1.889	0.508	1.381	0.0	1.889	525.00	1.00	0.0	941.9
7	2	32.2	20.6	0.33	0.00	467.0	288.4	2.78	0.93	599.40	5.112	1.321	3.791	0.0	5.112	525.00	1.00	0.0	969.4
7	3	36.1	24.4	0.32	0.00	650.0	421.0	2.87	0.96	571.50	7.925	1.978	5.957	1.853	9.788	525.00	1.00	0.0	1000.4
7	4	33.3	23.3	0.31	0.00	615.0	395.6	2.96	0.99	665.50	7.184	1.728	5.456	0.180	7.364	525.00	1.00	0.0	1030.4
7	5	23.3	15.1	0.31	0.0	148.0	-6.9	3.05	1.00	581.70	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	1047.9
7	6	18.9	15.6	0.31	0.0	120.0	-30.4	3.15	1.00	525.80	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	1060.9
7	7	25.0	17.2	0.28	0.00	275.0	99.3	3.24	1.00	490.20	1.591	0.342	1.249	0.0	1.591	525.00	1.00	0.0	1080.9
7	8	28.9	17.2	0.27	0.00	374.0	182.2	3.33	1.00	655.30	3.062	0.636	2.427	0.0	3.062	525.00	1.00	0.0	1104.4
7	9	30.0	20.0	0.26	0.00	593.0	365.4	3.42	1.00	645.20	6.296	1.261	5.035	0.0	6.296	525.00	1.00	0.0	1131.4
7	10	32.8	21.1	0.25	0.00	583.0	357.1	3.52	1.00	551.20	6.386	1.229	5.157	0.0	6.386	525.00	1.00	0.0	1159.4
7	11	33.9	22.2	0.24	0.00	672.0	431.5	3.61	1.00	500.40	7.854	1.458	6.395	0.569	8.423	525.00	1.00	0.0	1188.4
7	12	34.4	23.3	0.23	0.00	648.0	411.5	3.70	1.00	569.00	7.570	1.356	6.214	0.895	8.465	525.00	1.00	0.0	1218.4
7	13	36.7	23.9	0.22	0.00	679.0	437.4	3.85	1.00	414.00	8.282	1.398	6.884	2.526	10.808	525.00	1.00	0.0	1248.9
7	14	34.4	23.9	0.20	0.00	661.0	422.3	4.00	1.00	609.60	7.787	1.238	6.549	0.943	8.730	525.00	1.00	0.0	1279.4
7	15	31.7	18.9	0.19	0.00	396.0	200.6	4.15	1.00	485.10	3.510	0.526	2.984	0.0	3.510	525.00	1.00	0.0	1305.4
7	16	27.2	20.6	0.18	0.00	402.0	205.6	4.30	1.00	520.70	3.433	0.484	2.949	0.0	3.433	525.00	1.00	0.0	1330.4
7	17	25.6	18.3	0.17	0.00	371.0	179.7	4.45	1.00	426.70	2.911	0.387	2.524	0.0	2.911	525.00	1.00	0.0	1351.9
7	18	28.3	17.8	0.16	0.00	526.0	309.4	4.60	1.00	365.80	5.177	0.648	4.529	0.0	5.177	525.00	1.00	0.0	1375.4
7	19	28.3	16.1	0.15	0.00	619.0	387.2	4.75	1.00	332.70	6.435	0.759	5.676	0.0	6.435	525.00	1.00	0.0	1397.4
7	20	30.6	17.8	0.14	0.00	595.0	367.1	4.90	1.00	358.10	6.311	0.701	5.610	0.0	6.311	525.00	1.00	0.0	1422.4
7	21	31.1	20.0	0.14	0.00	548.0	327.8	5.03	1.00	454.70	5.722	0.604	5.118	0.0	5.722	525.00	1.00	0.0	1449.4
7	22	32.2	21.7	0.13	0.00	504.0	291.0	5.16	1.00	487.70	5.181	0.519	4.662	0.0	5.181	525.00	1.00	0.0	1477.9
7	23	27.8	21.1	0.13	0.0	109.0	-39.6	5.29	1.00	812.80	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	1503.9
7	24	32.2	22.8	0.12	0.00	549.0	328.6	5.42	1.00	655.30	5.877	0.531	5.346	0.0	5.877	525.00	1.00	0.0	1533.4
7	25	30.0	20.6	0.11	0.00	581.0	355.4	5.55	1.00	574.00	6.137	0.527	5.610	0.0	6.137	525.00	1.00	0.0	1560.9
7	26	31.7	19.4	0.10	0.00	530.0	312.7	5.68	1.00	467.40	5.484	0.447	5.037	0.0	5.484	525.00	1.00	0.0	1587.4
7	27	32.2	21.1	0.10	0.00	489.0	278.4	5.81	1.00	520.70	4.946	0.383	4.564	0.0	4.946	525.00	1.00	0.0	1615.4
7	28	34.4	21.1	0.09	0.00	535.0	316.9	5.94	1.00	543.60	5.780	0.425	5.355	0.771	6.551	525.00	1.00	0.0	1643.4
7	29	33.9	23.3	0.09	0.00	340.0	153.7	6.07	1.00	751.80	2.810	0.196	2.614	0.233	3.043	525.00	1.00	0.0	1673.4
7	30	32.2	23.3	0.08	0.00	266.0	91.8	6.20	1.00	820.40	1.645	0.109	1.536	0.0	1.645	525.00	1.00	0.0	1703.4
7	31	28.9	21.1	0.09	0.00	285.0	107.7	5.99	1.00	609.60	1.839	0.132	1.707	0.0	1.839	525.00	1.00	0.0	1730.4
TOTALS										*******	144.146	21.831	122.315	7.970	152.116				

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND OW

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPG MM/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	BMIS	GDD
8	1	29.4	15.6	0.10	0.00	553.0	332.0	5.77	1.00	386.10	5.580	0.439	5.142	0.0	5.580	525.00	1.00	0.0	1762.9
8	2	31.7	20.6	0.11	0.00	419.0	219.8	5.56	1.00	475.00	3.872	0.331	3.541	0.0	3.872	525.00	1.00	0.0	1780.4
8	3	34.4	20.0	0.12	0.00	642.0	406.4	5.34	1.00	467.40	7.380	0.688	6.692	0.964	8.344	525.00	1.00	0.0	1807.4
8	4	35.0	23.3	0.13	0.00	638.0	403.1	5.13	1.00	497.80	7.465	0.757	6.708	1.342	8.807	525.00	1.00	0.0	1837.4
8	5	36.1	23.9	0.14	0.00	639.0	403.9	4.91	1.00	591.80	7.597	0.841	6.756	2.101	9.698	525.00	1.00	0.0	1867.9
8	6	36.1	25.0	0.15	0.00	631.0	397.2	4.70	1.00	459.70	7.504	0.903	6.601	2.053	9.557	525.00	1.00	0.0	1899.4
8	7	36.7	25.0	0.16	0.00	636.0	401.4	4.57	1.00	505.50	7.634	0.967	6.667	2.447	10.081	525.00	1.00	0.0	1930.9
8	8	35.6	23.9	0.17	0.00	614.0	383.0	4.44	1.00	515.60	7.156	0.955	6.201	1.588	8.744	525.00	1.00	0.0	1961.4
8	9	35.0	24.4	0.18	0.00	611.0	380.5	4.31	1.00	469.90	7.078	0.995	6.083	1.217	8.295	525.00	1.00	0.0	1992.4
8	10	30.6	19.4	0.18	0.0	117.0	-32.9	4.18	1.00	721.40	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	2018.9
8	11	25.6	14.4	0.20	0.00	646.0	409.8	4.05	1.00	251.50	6.531	1.018	5.513	0.0	6.531	525.00	1.00	0.0	2036.9
8	12	28.3	15.0	0.21	0.00	634.0	399.8	3.92	1.00	297.20	6.613	1.086	5.528	0.0	6.613	525.00	1.00	0.0	2057.9
8	13	33.9	18.3	0.22	2.17	601.0	372.1	3.79	1.00	439.40	6.670	1.153	5.517	0.491	7.161	525.00	1.00	0.0	2083.4
8	14	26.1	13.9	0.22	0.0	60.0	-80.6	3.66	1.00	784.90	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	2101.4
8	15	17.8	12.8	0.25	0.00	190.0	28.2	3.53	1.00	355.60	0.400	0.077	0.323	0.0	0.400	525.00	1.00	0.0	2110.9
8	16	26.1	15.6	0.26	0.00	247.0	75.9	3.40	1.00	617.20	1.224	0.247	0.977	0.0	1.224	525.00	1.00	0.0	2130.4
8	17	34.4	23.3	0.36	0.00	594.0	380.4	2.55	0.85	414.00	6.999	1.982	5.017	0.722	7.721	525.00	1.00	0.0	2160.4
8	18	35.0	23.9	0.51	0.00	562.0	357.2	1.70	0.57	414.00	6.630	2.633	3.667	0.733	7.034	525.00	1.00	0.0	2190.9
8	19	34.4	22.2	0.71	0.00	605.0	388.4	0.85	0.40	482.60	7.114	3.963	2.297	0.331	6.591	525.00	1.00	0.0	2219.9
8	20	32.2	21.1	1.00	0.0	527.0	331.9	0.0	0.40	444.50	5.896	4.606	0.0	0.0	4.606	525.00	1.00	0.0	2247.9
TOTALS										9591.07	109.346	23.641	83.231	13.988	120.860				

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND OR

MONTH	POT. EVAP	SOIL EVAP	TRAN EVAP	A EVAP	TOTAL EVAP	RAIN (MM)	RATIO T/EO	TRAN EVAP(2)	TOT. EVAP(2)	RATIO T3/EO(2)	RATIO ET/EO(2)	RUNOFF	DRAINAGE	TVP
5	82.76	64.20	0.66	0.0	64.86	******	0.11	0.66	64.86	0.11	11.75	3679.02	431.75	0.03
6	179.47	106.56	48.47	1.74	156.76	******	8.35	50.21	156.76	8.35	26.14	5771.93	1179.87	5.20
7	144.15	21.83	122.31	7.97	152.12	******	24.97	130.28	152.12	24.97	29.09	*******	1186.75	0.30
8	109.35	23.64	83.23	13.99	120.86	******	15.62	97.22	120.86	15.62	19.52	8716.46	770.97	2.17
TOT.	515.72	216.23	254.67	23.69	494.60	*******	49.05	278.37	494.60	49.05	86.50	*******	3569.34	7.39

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND SD

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPG MM/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	BMTS	GDD
5	17	28.3	18.9	1.00	0.0	432.0	263.0	0.0	0.0	287.00	4.421	3.454	0.0	0.0	3.454	525.00	1.00	0.0	24.5
5	18	22.8	16.7	1.00	0.0	327.0	186.9	0.0	0.0	523.20	2.900	2.266	0.0	0.0	2.266	525.00	1.00	0.0	42.0
5	19	19.4	13.3	1.00	0.0	210.0	102.1	0.0	0.0	462.30	1.488	1.163	0.0	0.0	1.163	525.00	1.00	0.0	53.5
5	20	22.8	14.4	1.00	0.0	503.0	314.5	0.0	0.0	360.70	4.831	3.774	0.0	0.0	3.774	525.00	1.00	0.0	69.0
5	21	22.2	10.0	1.00	0.0	668.0	434.1	0.0	0.0	203.20	6.483	5.064	0.0	0.0	5.064	525.00	1.00	0.0	80.0
5	22	26.1	7.8	1.00	0.0	682.0	444.2	0.0	0.0	259.10	6.927	5.412	0.0	0.0	5.412	525.00	1.00	0.0	94.5
5	23	23.3	11.1	1.00	0.0	552.0	350.0	0.0	0.0	198.10	5.336	4.169	0.0	0.0	4.169	525.00	1.00	0.0	107.5
5	24	21.1	5.0	1.00	0.0	647.0	418.8	0.0	0.0	109.20	6.006	4.692	0.0	0.0	4.692	525.00	1.00	0.0	117.5
5	25	23.9	5.6	1.00	0.0	676.0	439.9	0.0	0.0	142.20	6.587	5.146	0.0	0.0	5.146	525.00	1.00	0.0	130.0
5	26	27.2	11.1	1.00	0.0	627.0	404.3	0.0	0.0	276.90	6.490	5.070	0.0	0.0	5.070	525.00	1.00	0.0	146.5
5	27	27.8	11.1	1.00	0.01	714.0	467.4	0.01	0.00	297.20	7.556	5.880	0.034	0.0	5.913	525.00	1.00	0.0	163.5
5	28	30.6	13.3	0.99	0.02	680.0	442.8	0.03	0.01	340.40	7.477	5.772	0.100	0.0	5.872	525.00	1.00	0.0	184.5
5	29	30.0	16.1	0.98	0.00	618.0	397.8	0.04	0.01	375.90	6.748	5.188	0.120	0.0	5.308	525.00	1.00	0.0	208.0
5	30	27.8	16.1	0.98	0.00	405.0	243.4	0.05	0.02	383.50	4.018	3.078	0.089	0.0	3.167	525.00	1.00	0.0	229.5
5	31	22.2	12.8	0.97	0.00	570.0	363.0	0.07	0.02	149.90	5.493	4.173	0.170	0.0	4.343	525.00	1.00	0.0	243.0
TOTALS						4368.79	82.760	64.301	0.512	0.0	64.813								

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND SD

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPG MN/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	BMTS	GDD
6	1	22.8	7.8	0.97	0.06	456.0	280.4	0.08	0.03	154.90	4.177	3.161	0.147	0.0	3.308	525.00	1.00	0.0	254.5
6	2	27.2	8.3	0.96	0.03	672.0	437.0	0.09	0.03	167.60	6.930	5.224	0.274	0.0	5.498	525.00	1.00	0.0	270.0
6	3	28.9	11.7	0.96	0.06	702.0	458.7	0.10	0.03	195.60	7.537	5.659	0.331	0.0	5.989	525.00	1.00	0.0	288.5
6	4	33.9	17.2	0.95	0.07	561.0	356.5	0.12	0.04	322.60	6.362	4.738	0.334	0.030	5.102	525.00	1.00	0.0	313.0
6	5	32.2	16.7	0.95	0.13	598.0	383.3	0.13	0.04	419.10	6.692	4.984	0.380	0.0	5.344	525.00	1.00	0.0	337.0
6	6	28.9	17.2	0.95	0.00	394.0	235.5	0.14	0.05	459.70	3.958	2.925	0.241	0.0	3.166	525.00	1.00	0.0	360.5
6	7	29.4	19.4	0.94	0.00	462.0	284.7	0.16	0.05	574.00	4.862	3.564	0.337	0.0	3.901	525.00	1.00	0.0	386.5
6	8	25.6	13.9	0.93	0.00	209.0	101.4	0.17	0.06	424.20	1.612	1.177	0.119	0.0	1.296	525.00	1.00	0.0	404.0
6	9	18.9	13.9	0.93	0.00	124.0	39.8	0.18	0.06	525.80	0.577	0.419	0.045	0.0	0.464	525.00	1.00	0.0	415.5
6	10	26.1	8.9	0.92	0.11	677.0	440.6	0.20	0.07	124.50	6.904	4.981	0.594	0.0	5.575	525.00	1.00	0.0	433.0
6	11	28.3	10.0	0.92	0.09	732.0	480.4	0.21	0.07	175.30	7.785	5.594	0.702	0.0	6.296	525.00	1.00	0.0	446.5
6	12	31.1	16.7	0.92	1.08	706.0	461.6	0.22	0.07	317.50	7.952	5.692	0.750	0.0	6.442	525.00	1.00	0.0	470.5
6	13	34.4	18.3	0.91	0.24	712.0	465.9	0.23	0.08	388.60	8.405	5.992	0.827	0.119	6.939	525.00	1.00	0.0	496.1
6	14	34.4	18.9	0.91	0.39	723.0	473.9	0.25	0.08	475.00	8.568	6.060	0.913	0.131	7.104	525.00	1.00	0.0	522.0
6	15	33.9	22.2	0.90	0.00	645.0	417.4	0.26	0.09	426.70	7.596	5.351	0.840	0.075	6.266	525.00	1.00	0.0	551.0
6	16	34.4	22.2	0.90	0.00	621.0	400.0	0.27	0.09	378.50	7.327	5.141	0.840	0.121	6.102	525.00	1.00	0.0	580.0
6	17	30.6	21.6	0.89	0.00	486.0	302.1	0.29	0.10	492.80	5.252	3.656	0.644	0.0	4.300	525.00	1.00	0.0	607.5
6	18	32.2	22.2	0.89	0.00	601.0	385.5	0.30	0.10	528.30	6.879	4.769	0.871	0.0	5.640	525.00	1.00	0.0	636.5
6	19	28.9	19.4	0.81	0.00	318.0	180.4	0.52	0.17	645.20	3.059	1.943	0.643	0.0	2.587	525.00	1.00	0.0	662.0
6	20	32.2	13.3	0.74	0.26	736.0	483.3	0.74	0.25	223.50	8.327	4.846	2.390	0.0	7.235	525.00	1.00	0.0	683.0
6	21	36.7	14.4	0.69	0.23	702.0	458.7	0.95	0.32	325.10	8.366	4.478	2.963	1.088	8.529	525.00	1.00	0.0	705.0
6	22	32.2	17.2	0.63	1.71	622.0	400.7	1.17	0.39	340.40	7.011	3.438	2.936	0.0	6.374	525.00	1.00	0.0	729.5
6	23	26.7	19.4	0.58	0.00	450.0	276.0	1.39	0.46	454.70	4.557	2.047	2.178	0.0	4.226	525.00	1.00	0.0	753.0
6	24	23.3	16.7	0.53	0.00	325.0	185.4	1.61	0.54	365.80	2.899	1.193	1.543	0.0	2.736	525.00	1.00	0.0	771.0
6	25	26.1	16.1	0.48	0.00	449.0	275.3	1.83	0.61	345.40	4.451	1.678	2.590	0.0	4.269	525.00	1.00	0.0	791.0
6	26	30.0	17.2	0.44	0.00	575.0	366.6	2.05	0.68	426.70	6.247	2.158	3.920	0.0	6.078	525.00	1.00	0.0	815.5
6	27	32.8	22.2	0.41	0.00	514.0	322.4	2.26	0.75	398.80	5.792	1.841	3.865	0.0	5.706	525.00	1.00	0.0	844.5
6	28	29.4	18.9	0.37	0.00	622.0	400.7	2.48	0.83	442.00	6.827	1.988	4.818	0.0	6.806	525.00	1.00	0.0	870.0
6	29	30.0	18.3	0.34	0.00	720.0	471.7	2.70	0.90	238.80	8.073	2.153	5.920	0.0	8.073	525.00	1.00	0.0	895.5
6	30	28.3	17.2	0.33	0.00	440.0	268.8	2.77	0.92	348.00	4.488	1.164	3.324	0.0	4.488	525.00	1.00	0.0	918.4
TOTALS										******	179.471	107.996	46.280	1.564	155.839				

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND SD

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPG MM/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	RMIS	GDD
7	1	26.7	19.4	0.32	0.00	227.0	114.4	2.84	0.95	624.80	1.689	0.477	1.412	0.0	1.889	525.00	1.00	0.0	941.9
7	2	32.2	20.6	0.31	0.00	467.0	288.4	2.91	0.97	599.40	5.112	1.254	3.858	0.0	5.112	525.00	1.00	0.0	969.4
7	3	36.1	24.4	0.31	0.00	650.0	421.0	2.98	0.99	571.50	7.935	1.893	6.042	1.879	9.814	525.00	1.00	0.0	1000.4
7	4	33.3	23.3	0.30	0.00	615.0	383.9	3.05	1.00	665.50	6.970	1.617	5.353	0.177	7.147	525.00	1.00	0.0	1030.4
7	5	23.3	16.1	0.30	0.0	148.0	-6.9	3.12	1.00	581.70	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	1047.9
7	6	18.9	15.6	0.30	0.0	120.0	-30.4	3.18	1.00	525.80	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	1060.9
7	7	25.0	17.2	0.27	0.00	275.0	99.3	3.25	1.00	490.20	1.591	0.341	1.250	0.0	1.591	525.00	1.00	0.0	1080.9
7	8	28.9	17.2	0.27	0.00	374.0	182.2	3.32	1.00	655.30	3.062	0.638	2.424	0.0	3.062	525.00	1.00	0.0	1104.4
7	9	30.0	20.0	0.26	0.00	593.0	365.4	3.39	1.00	645.20	6.296	1.276	5.020	0.0	6.296	525.00	1.00	0.0	1131.4
7	10	32.8	21.1	0.25	0.00	583.0	357.1	3.46	1.00	551.20	6.386	1.259	5.127	0.0	6.386	525.00	1.00	0.0	1155.4
7	11	33.9	22.2	0.25	0.00	672.0	431.5	3.53	1.00	500.40	7.854	1.506	6.348	0.565	8.419	525.00	1.00	0.0	1188.4
7	12	34.4	23.3	0.24	0.00	648.0	411.5	3.60	1.00	569.00	7.570	1.411	6.159	0.887	8.457	525.00	1.00	0.0	1218.4
7	13	36.7	23.9	0.23	0.00	679.0	437.4	3.68	1.00	414.00	8.282	1.496	6.786	2.490	10.772	525.00	1.00	0.0	1248.9
7	14	34.4	23.9	0.22	0.00	661.0	422.3	3.75	1.00	609.60	7.787	1.368	6.420	0.924	8.712	525.00	1.00	0.0	1279.4
7	15	31.7	18.9	0.22	0.00	396.0	200.6	3.82	1.00	485.10	3.510	0.599	2.910	0.0	3.510	525.00	1.00	0.0	1295.4
7	16	27.2	20.6	0.21	0.00	402.0	205.6	3.90	1.00	520.70	3.433	0.568	2.865	0.0	3.433	525.00	1.00	0.0	1330.4
7	17	25.6	18.3	0.21	0.00	371.0	179.7	3.98	1.00	426.70	2.911	0.467	2.445	0.0	2.911	525.00	1.00	0.0	1351.9
7	18	28.3	17.8	0.20	0.00	526.0	309.4	4.05	1.00	365.80	5.177	0.807	4.370	0.0	5.177	525.00	1.00	0.0	1375.4
7	19	28.3	16.1	0.19	0.00	619.0	387.2	4.13	1.00	332.70	6.435	0.972	5.464	0.0	6.435	525.00	1.00	0.0	1397.4
7	20	30.6	17.8	0.19	0.00	595.0	367.1	4.20	1.00	358.10	6.311	0.927	5.384	0.0	6.311	525.00	1.00	0.0	1422.4
7	21	31.1	20.0	0.18	0.00	548.0	327.8	4.31	1.00	454.70	5.722	0.804	4.918	0.0	5.722	525.00	1.00	0.0	1445.4
7	22	32.2	21.7	0.17	0.00	504.0	291.0	4.42	1.00	467.70	5.181	0.697	4.484	0.0	5.181	525.00	1.00	0.0	1477.9
7	23	27.8	21.1	0.17	0.0	109.0	-39.6	4.53	1.00	812.80	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	1503.9
7	24	32.2	22.8	0.16	0.00	549.0	328.6	4.64	1.00	655.30	5.877	0.724	5.153	0.0	5.877	525.00	1.00	0.0	1533.4
7	25	30.0	20.6	0.15	0.00	581.0	355.4	4.75	1.00	574.00	6.137	0.724	5.413	0.0	6.137	525.00	1.00	0.0	1560.9
7	26	31.7	19.4	0.14	0.00	530.0	312.7	4.86	1.00	467.40	5.484	0.619	4.864	0.0	5.484	525.00	1.00	0.0	1587.4
7	27	32.2	21.1	0.14	0.00	489.0	278.4	4.97	1.00	520.70	4.946	0.535	4.412	0.0	4.946	525.00	1.00	0.0	1615.4
7	28	34.4	21.1	0.13	0.00	535.0	316.9	5.08	1.00	543.60	5.780	0.598	5.182	0.746	6.526	525.00	1.00	0.0	1643.4
7	29	33.9	23.3	0.13	0.00	340.0	153.7	5.19	1.00	751.80	2.810	0.278	2.532	0.225	3.035	525.00	1.00	0.0	1673.4
7	30	32.2	23.3	0.12	0.00	266.0	91.8	5.30	1.00	820.40	1.645	0.156	1.489	0.0	1.645	525.00	1.00	0.0	1703.4
7	31	28.9	21.1	0.12	0.00	285.0	107.7	5.29	1.00	609.60	1.839	0.175	1.664	0.0	1.839	525.00	1.00	0.0	1730.4
TOTALS										******	143.932	24.186	119.747	7.894	151.826				

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND SD

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPG MM/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	BMTS	GDD
8	1	29.4	15.6	0.12	0.00	553.0	332.0	5.27	1.00	386.10	5.580	0.535	5.045	0.0	5.580	525.00	1.00	0.0	1752.9
8	2	31.7	20.6	0.12	0.00	419.0	219.8	5.26	1.00	475.00	3.872	0.373	3.499	0.0	3.872	525.00	1.00	0.0	1780.4
8	3	34.4	20.0	0.12	0.00	642.0	406.4	5.24	1.00	467.40	7.380	0.716	6.664	0.960	8.340	525.00	1.00	0.0	1807.4
8	4	35.0	23.3	0.12	0.00	638.0	403.1	5.23	1.00	497.80	7.465	0.728	6.738	1.348	8.813	525.00	1.00	0.0	1837.4
8	5	36.1	23.9	0.13	0.00	639.0	403.9	5.21	1.00	591.80	7.597	0.746	6.851	2.131	9.727	525.00	1.00	0.0	1867.9
8	6	36.1	25.0	0.13	0.00	631.0	397.2	5.20	1.00	459.70	7.504	0.740	6.764	2.104	9.608	525.00	1.00	0.0	1899.4
8	7	36.7	25.0	0.13	0.00	636.0	401.4	5.15	1.00	505.50	7.634	0.768	6.866	2.520	10.154	525.00	1.00	0.0	1930.9
8	8	35.6	23.9	0.13	0.00	614.0	383.0	5.10	1.00	515.60	7.156	0.734	6.422	1.644	8.801	525.00	1.00	0.0	1961.4
8	9	35.0	24.4	0.13	0.00	611.0	380.5	5.05	1.00	469.90	7.078	0.741	6.337	1.267	8.345	525.00	1.00	0.0	1992.4
8	10	30.6	19.4	0.13	0.0	117.0	-32.9	5.00	1.00	721.40	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	2018.9
8	11	25.6	14.4	0.14	0.00	646.0	409.8	4.95	1.00	251.50	6.531	0.712	5.820	0.0	6.531	525.00	1.00	0.0	2036.9
8	12	28.3	15.0	0.14	0.00	634.0	399.8	4.90	1.00	297.20	6.613	0.735	5.879	0.0	6.613	525.00	1.00	0.0	2057.9
8	13	33.9	18.3	0.15	2.32	601.0	372.1	4.85	1.00	439.40	6.670	0.756	5.914	0.526	7.196	525.00	1.00	0.0	2083.4
8	14	26.1	13.9	0.15	0.0	60.0	-80.6	4.80	1.00	784.90	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	2101.4
8	15	17.8	12.8	0.15	0.00	190.0	28.2	4.75	1.00	355.60	0.400	0.047	0.353	0.0	0.400	525.00	1.00	0.0	2110.9
8	16	26.1	15.6	0.15	0.00	247.0	75.9	4.70	1.00	617.20	1.224	0.147	1.077	0.0	1.224	525.00	1.00	0.0	2130.4
8	17	34.4	23.3	0.25	0.00	594.0	366.3	3.52	1.00	414.00	6.739	1.297	5.442	0.784	7.522	525.00	1.00	0.0	2160.4
8	18	35.0	23.9	0.39	0.00	562.0	357.2	2.35	0.78	414.00	6.630	2.033	4.532	0.906	7.471	525.00	1.00	0.0	2190.9
8	19	34.4	22.2	0.63	0.00	605.0	388.4	1.18	0.40	482.60	7.114	3.475	3.000	0.432	6.907	525.00	1.00	0.0	2219.9
8	20	32.2	21.1	1.00	0.0	527.0	331.9	0.0	0.40	444.50	5.896	4.606	0.0	0.0	4.606	525.00	1.00	0.0	2247.9
TOTALS										9591.07	109.086	19.890	87.200	14.621	121.711				

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND SD

MONTH	POT. EVAP	SOIL EVAP	TRAN EVAP	A EVAP	TOTAL EVAP	RAIN (MM)	RATIO T/EO	TRAN EVAP(2)	TOT. EVAP(2)	RATIO T3/EO(2)	RATIO ET/EO(2)	RUNOFF	DRAINAGE	IVP
5	82.76	64.30	0.51	0.0	64.81	******	0.09	0.51	64.81	0.09	11.75	3678.97	431.83	3.72
6	179.47	108.00	46.28	1.56	155.84	******	7.99	47.84	155.84	7.99	26.00	9770.47	1182.34	4.46
7	143.93	24.19	119.75	7.89	151.83	******	24.47	127.64	151.83	24.47	29.08	*******	1187.28	0.00
8	109.09	19.89	87.20	14.62	121.71	******	16.45	101.82	121.71	16.45	19.68	8716.94	768.73	2.32
TOT.	515.25	216.37	253.74	24.08	494.19	*******	49.00	277.82	494.19	49.30	86.51	*******	3570.19	6.80

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND TA

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPG MM/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	BMTS	GDD
5	17	28.3	18.9	1.00	0.0	432.0	263.0	0.0	0.0	287.00	4.421	3.454	0.0	0.0	3.454	525.00	1.00	0.0	24.5
5	18	22.8	16.7	1.00	0.0	327.0	186.9	0.0	0.0	523.20	2.900	2.266	0.0	0.0	2.266	525.00	1.00	0.0	42.0
5	19	19.4	13.3	1.00	0.0	210.0	102.1	0.0	0.0	462.30	1.488	1.163	0.0	0.0	1.163	525.00	1.00	0.0	53.5
5	20	22.8	14.4	1.00	0.0	503.0	314.5	0.0	0.0	360.70	4.831	3.774	0.0	0.0	3.774	525.00	1.00	0.0	69.5
5	21	22.2	10.0	1.00	0.0	668.0	434.1	0.0	0.0	203.20	6.483	5.064	0.0	0.0	5.064	525.00	1.00	0.0	80.0
5	22	26.1	7.8	1.00	0.0	662.0	444.2	0.0	0.0	259.10	6.927	5.412	0.0	0.0	5.412	525.00	1.00	0.0	94.5
5	23	23.3	11.1	1.00	0.0	552.0	350.0	0.0	0.0	198.10	5.336	4.169	0.0	0.0	4.169	525.00	1.00	0.0	107.5
5	24	21.1	5.0	1.00	0.0	647.0	418.8	0.0	0.0	109.20	6.006	4.692	0.0	0.0	4.692	525.00	1.00	0.0	117.5
5	25	23.9	5.6	1.00	0.0	676.0	439.9	0.0	0.0	142.20	6.587	5.146	0.0	0.0	5.146	525.00	1.00	0.0	130.0
5	26	27.2	11.1	1.00	0.0	627.0	404.3	0.0	0.0	276.90	6.490	5.070	0.0	0.0	5.070	525.00	1.00	0.0	146.5
5	27	27.8	11.1	1.00	0.01	714.0	467.4	0.01	0.00	297.20	7.556	5.880	0.034	0.0	5.913	525.00	1.00	0.0	163.5
5	28	30.6	13.3	0.99	0.02	680.0	442.8	0.03	0.01	340.40	7.477	5.772	0.100	0.0	5.872	525.00	1.00	0.0	184.5
5	29	30.0	16.1	0.98	0.00	618.0	397.8	0.04	0.01	375.90	6.748	5.188	0.120	0.0	5.308	525.00	1.00	0.0	208.0
5	30	27.8	16.1	0.98	0.00	405.0	243.4	0.05	0.02	383.50	4.018	3.078	0.089	0.0	3.167	525.00	1.00	0.0	229.5
5	31	22.2	12.8	0.97	0.00	570.0	363.0	0.07	0.02	149.90	5.493	4.173	0.170	0.0	4.343	525.00	1.00	0.0	243.0
TOTALS						4368.79	82.760	64.301	0.512	0.0	64.813								

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND TA

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPG MM/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	BMTS	GDD
6	1	22.8	7.8	0.97	0.06	456.0	280.4	0.08	0.03	154.90	4.177	3.161	0.147	0.0	3.308	525.00	1.00	0.0	254.5
6	2	27.2	8.3	0.96	0.03	672.0	437.0	0.09	0.03	167.60	6.930	5.224	0.274	0.0	5.498	525.00	1.00	0.0	270.0
6	3	28.9	11.7	0.96	0.06	702.0	458.7	0.10	0.03	195.60	7.537	5.659	0.331	0.0	5.989	525.00	1.00	0.0	288.5
6	4	33.9	17.2	0.95	0.07	561.0	356.5	0.12	0.04	322.60	6.362	4.738	0.334	0.030	5.102	525.00	1.00	0.0	313.0
6	5	32.2	16.7	0.95	0.13	598.0	383.3	0.13	0.04	419.10	6.692	4.964	0.380	0.0	5.344	525.00	1.00	0.0	337.0
6	6	28.9	17.2	0.95	0.00	394.0	235.5	0.14	0.05	459.70	3.958	2.925	0.241	0.0	3.166	525.00	1.00	0.0	360.5
6	7	29.4	19.4	0.94	0.00	462.0	284.7	0.16	0.05	574.00	4.862	3.564	0.337	0.0	3.901	525.00	1.00	0.0	386.5
6	8	25.6	13.9	0.93	0.00	209.0	101.4	0.17	0.06	424.20	1.612	1.177	0.119	0.0	1.296	525.00	1.00	0.0	404.0
6	9	18.9	13.9	0.93	0.00	124.0	39.8	0.18	0.06	525.80	0.577	0.419	0.045	0.0	0.464	525.00	1.00	0.0	415.5
6	10	26.1	8.9	0.92	0.11	677.0	440.6	0.20	0.07	124.50	6.904	4.981	0.594	0.0	5.575	525.00	1.00	0.0	430.0
6	11	28.3	10.0	0.92	0.09	732.0	480.4	0.21	0.07	175.30	7.785	5.594	0.702	0.0	6.296	525.00	1.00	0.0	446.5
6	12	31.1	15.7	0.92	1.08	706.0	461.6	0.22	0.07	317.50	7.952	5.692	0.750	0.0	6.442	525.00	1.00	0.0	470.5
6	13	34.4	18.3	0.91	0.24	712.0	465.9	0.23	0.08	388.60	8.405	5.992	0.827	0.119	6.939	525.00	1.00	0.0	496.0
6	14	34.4	18.9	0.91	0.39	723.0	473.9	0.25	0.08	475.00	8.568	6.060	0.913	0.131	7.104	525.00	1.00	0.0	522.0
6	15	33.9	22.2	0.90	0.00	645.0	417.4	0.26	0.09	426.70	7.596	5.351	0.840	0.075	6.266	525.00	1.00	0.0	551.0
6	16	34.4	22.2	0.90	0.00	621.0	400.0	0.27	0.09	378.50	7.327	5.141	0.840	0.121	6.102	525.00	1.00	0.0	580.0
6	17	30.6	23.6	0.89	0.00	486.0	302.1	0.29	0.10	492.80	5.252	3.656	0.644	0.0	4.300	525.00	1.00	0.0	607.5
6	18	32.2	22.2	0.89	0.00	601.0	385.5	0.30	0.10	528.30	6.879	4.769	0.871	0.0	5.640	525.00	1.00	0.0	636.5
6	19	28.9	19.4	0.82	0.00	318.0	180.4	0.51	0.17	645.20	3.059	1.951	0.632	0.0	2.583	525.00	1.00	0.0	662.0
6	20	32.2	13.3	0.75	0.25	736.0	483.3	0.72	0.24	223.50	8.327	4.884	2.334	0.0	7.218	525.00	1.00	0.0	683.0
6	21	36.7	14.4	0.69	0.23	702.0	458.7	0.93	0.31	325.10	8.366	4.514	2.912	1.069	8.494	525.00	1.00	0.0	705.0
6	22	32.2	17.2	0.64	1.67	622.0	400.7	1.14	0.38	340.40	7.011	3.479	2.877	0.0	6.356	525.00	1.00	0.0	729.5
6	23	26.7	19.4	0.58	0.00	450.0	276.0	1.35	0.45	454.70	4.557	2.080	2.131	0.0	4.211	525.00	1.00	0.0	753.0
6	24	23.3	16.7	0.54	0.00	325.0	185.4	1.55	0.52	365.80	2.899	1.222	1.501	0.0	2.724	525.00	1.00	0.0	771.0
6	25	26.1	16.1	0.50	0.00	449.0	275.3	1.76	0.59	345.40	4.451	1.726	2.522	0.0	4.248	525.00	1.00	0.0	791.0
6	26	30.0	17.2	0.46	0.00	575.0	366.6	1.97	0.66	426.70	6.247	2.228	3.819	0.0	6.047	525.00	1.00	0.0	815.5
6	27	32.8	22.2	0.42	0.00	514.0	322.4	2.18	0.73	398.80	5.782	1.900	3.779	0.0	5.680	525.00	1.00	0.0	844.5
6	28	29.4	18.9	0.39	0.00	622.0	400.7	2.39	0.80	442.00	6.827	2.060	4.714	0.0	6.774	525.00	1.00	0.0	870.0
6	29	30.0	18.3	0.36	0.00	720.0	471.7	2.60	0.87	238.80	8.373	2.241	5.832	0.0	8.073	525.00	1.00	0.0	895.5
6	30	28.3	17.2	0.34	0.00	440.0	268.8	2.72	0.91	348.00	4.488	1.188	3.300	0.0	4.488	525.00	1.00	0.0	918.4
TOTALS										*******	179.471	108.541	45.543	1.545	155.629				

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND TA

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPG MM/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	BMTS	GDD
7	1	26.7	19.4	0.32	0.00	227.0	114.4	2.85	0.95	624.80	1.889	0.475	1.414	0.0	1.889	525.00	1.00	0.0	941.9
7	2	32.2	20.6	0.31	0.00	467.0	288.4	2.97	0.99	599.40	5.112	1.225	3.887	0.0	5.112	525.00	1.00	0.0	969.4
7	3	36.1	24.4	0.29	0.00	650.0	413.1	3.09	1.00	571.50	7.787	1.779	6.008	1.869	9.656	525.00	1.00	0.0	1000.4
7	4	33.3	23.3	0.28	0.00	615.0	383.9	3.22	1.00	665.50	6.970	1.512	5.458	0.180	7.150	525.00	1.00	0.0	1030.4
7	5	23.3	16.1	0.28	0.0	148.0	-6.9	3.34	1.00	581.70	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	1047.9
7	6	18.9	15.6	0.28	0.0	120.0	-30.4	3.46	1.00	525.80	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	1060.9
7	7	25.0	17.2	0.24	0.00	275.0	99.3	3.58	1.00	490.20	1.591	0.299	1.292	0.0	1.591	525.00	1.00	0.0	1080.9
7	8	28.9	17.2	0.23	0.00	374.0	182.2	3.71	1.00	655.30	3.062	0.547	2.516	0.0	3.062	525.00	1.00	0.0	1104.4
7	9	30.0	20.0	0.22	0.00	593.0	365.4	3.83	1.00	645.20	6.296	1.071	5.225	0.0	6.296	525.00	1.00	0.0	1131.4
7	10	32.8	21.1	0.21	0.00	583.0	357.1	3.95	1.00	551.20	6.386	1.036	5.350	0.0	6.386	525.00	1.00	0.0	1159.4
7	11	33.9	22.2	0.20	0.00	672.0	431.5	4.08	1.00	500.40	7.854	1.210	6.644	0.591	8.445	525.00	1.00	0.0	1188.4
7	12	34.4	23.3	0.19	0.00	648.0	411.5	4.20	1.00	569.00	7.570	1.112	6.459	0.930	8.500	525.00	1.00	0.0	1218.4
7	13	36.7	23.9	0.19	0.00	679.0	437.4	4.23	1.00	414.00	8.282	1.202	7.080	2.598	10.880	525.00	1.00	0.0	1248.9
7	14	34.4	23.9	0.18	0.00	661.0	422.3	4.25	1.00	609.60	7.787	1.121	6.666	0.960	8.747	525.00	1.00	0.0	1279.4
7	15	31.7	18.9	0.18	0.00	396.0	200.6	4.27	1.00	485.10	3.510	0.501	3.009	0.0	3.510	525.00	1.00	0.0	1305.4
7	16	27.2	20.6	0.18	0.00	402.0	205.6	4.30	1.00	520.70	3.433	0.484	2.949	0.0	3.433	525.00	1.00	0.0	1330.4
7	17	25.6	18.3	0.18	0.00	371.0	179.7	4.32	1.00	426.70	2.911	0.408	2.504	0.0	2.911	525.00	1.00	0.0	1351.9
7	18	28.3	17.8	0.18	0.00	526.0	309.4	4.35	1.00	365.80	5.177	0.716	4.461	0.0	5.177	525.00	1.00	0.0	1375.4
7	19	28.3	16.1	0.17	0.00	619.0	387.2	4.38	1.00	332.70	6.435	0.880	5.556	0.0	6.435	525.00	1.00	0.0	1397.4
7	20	30.6	17.8	0.17	0.00	595.0	367.1	4.40	1.00	358.10	6.311	0.856	5.455	0.0	6.311	525.00	1.00	0.0	1422.4
7	21	31.1	20.0	0.17	0.00	548.0	327.8	4.39	1.00	454.70	5.722	0.779	4.943	0.0	5.722	525.00	1.00	0.0	1449.4
7	22	32.2	21.7	0.17	0.00	504.0	291.0	4.38	1.00	467.70	5.181	0.708	4.473	0.0	5.181	525.00	1.00	0.0	1477.9
7	23	27.8	21.1	0.17	0.0	109.0	-39.6	4.37	1.00	812.80	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	1503.9
7	24	32.2	22.8	0.18	0.00	549.0	328.6	4.36	1.00	655.30	5.877	0.810	5.067	0.0	5.877	525.00	1.00	0.0	1533.4
7	25	30.0	20.6	0.18	0.00	581.0	355.4	4.35	1.00	574.00	6.137	0.849	5.288	0.0	6.137	525.00	1.00	0.0	1560.9
7	26	31.7	19.4	0.18	0.00	530.0	312.7	4.34	1.00	467.40	5.484	0.762	4.722	0.0	5.484	525.00	1.00	0.0	1587.4
7	27	32.2	21.1	0.18	0.00	489.0	278.4	4.33	1.00	520.70	4.946	0.690	4.257	0.0	4.946	525.00	1.00	0.0	1615.4
7	28	34.4	21.1	0.18	0.00	535.0	316.9	4.32	1.00	543.60	5.780	0.809	4.971	0.716	6.495	525.00	1.00	0.0	1643.4
7	29	33.9	23.3	0.18	0.00	340.0	153.7	4.31	1.00	751.80	2.810	0.395	2.415	0.215	3.025	525.00	1.00	0.0	1673.4
7	30	32.2	23.3	0.18	0.00	266.0	91.8	4.30	1.00	820.40	1.645	0.232	1.413	0.0	1.645	525.00	1.00	0.0	1703.4
7	31	28.9	21.1	0.17	0.00	285.0	107.7	4.40	1.00	609.60	1.839	0.249	1.590	0.0	1.839	525.00	1.00	0.0	1730.4
TOTALS										*******	143.784	22.712	121.071	8.059	151.843				

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND TA

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPG MM/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	BMTS	GDD
8	1	29.4	15.6	0.17	0.00	553.0	332.0	4.50	1.00	386.10	5.580	0.727	4.853	0.0	5.560	525.00	1.00	0.0	1752.9
8	2	31.7	20.6	0.16	0.00	419.0	219.8	4.60	1.00	475.00	3.872	0.485	3.387	0.0	3.872	525.00	1.00	0.0	1780.4
8	3	34.4	20.0	0.15	0.00	642.0	406.4	4.70	1.00	467.40	7.380	0.888	6.492	0.935	8.315	525.00	1.00	0.0	1807.4
8	4	35.0	23.3	0.15	0.00	636.0	403.1	4.80	1.00	497.80	7.465	0.863	6.602	1.320	8.786	525.00	1.00	0.0	1837.4
8	5	36.1	23.9	0.14	0.00	639.0	403.9	4.90	1.00	591.80	7.597	0.844	6.753	2.100	9.697	525.00	1.00	0.0	1867.9
8	6	36.1	25.0	0.14	0.00	631.0	397.2	5.00	1.00	459.70	7.504	0.801	6.703	2.085	9.589	525.00	1.00	0.0	1899.4
8	7	36.7	25.0	0.14	0.00	636.0	401.4	4.93	1.00	505.50	7.634	0.838	6.796	2.494	10.128	525.00	1.00	0.0	1930.9
8	8	35.6	23.9	0.14	0.00	614.0	383.0	4.86	1.00	515.60	7.156	0.808	6.348	1.625	8.782	525.00	1.00	0.0	1961.4
8	9	35.0	24.4	0.15	0.00	611.0	380.5	4.79	1.00	469.90	7.078	0.822	6.256	1.251	8.329	525.00	1.00	0.0	1992.4
8	10	30.6	19.4	0.15	0.0	117.0	-32.9	4.72	1.00	721.40	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	2018.9
8	11	25.6	14.4	0.16	0.00	646.0	409.8	4.65	1.00	251.50	6.531	0.802	5.730	0.0	6.531	525.00	1.00	0.0	2036.9
8	12	28.3	15.0	0.16	0.00	634.0	399.8	4.58	1.00	297.20	6.613	0.835	5.779	0.0	6.613	525.00	1.00	0.0	2057.9
8	13	33.9	18.3	0.17	2.28	601.0	372.1	4.51	1.00	439.40	6.670	0.866	5.804	0.517	7.186	525.00	1.00	0.0	2083.4
8	14	26.1	13.9	0.17	0.0	60.0	-80.6	4.44	1.00	784.90	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	2101.4
8	15	17.8	12.8	0.18	0.00	190.0	28.2	4.37	1.00	355.60	0.400	0.055	0.345	0.0	0.400	525.00	1.00	0.0	2110.9
8	16	26.1	15.6	0.18	0.00	247.0	75.9	4.30	1.00	617.20	1.224	0.173	1.052	0.0	1.224	525.00	1.00	0.0	2130.4
8	17	34.4	23.3	0.28	0.00	594.0	366.3	3.22	1.00	414.00	6.739	1.461	5.277	0.760	7.499	525.00	1.00	0.0	2160.4
8	18	35.0	23.9	0.42	0.00	562.0	357.2	2.15	0.72	414.00	6.630	2.201	4.289	0.858	7.348	525.00	1.00	0.0	2190.9
8	19	34.4	22.2	0.65	0.00	605.0	388.4	1.07	0.40	482.60	7.114	3.631	2.776	0.400	6.806	525.00	1.00	0.0	2219.9
8	20	32.2	21.1	1.00	0.0	527.0	331.9	0.0	0.40	444.50	5.896	4.606	0.0	0.0	4.606	525.00	1.00	0.0	2247.9
TOTALS										9591.07	109.086	21.707	85.241	14.344	121.292				

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND TA

MONTH	POT. EVAP	SOIL EVAP	TRAN EVAP	A EVAP	TOTAL EVAP	RAIN (MM)	RATIO T/EO	TRAN EVAP(2)	TOT. EVAP(2)	RATIO T3/EO(2)	RATIO ET/EO(2)	RUNOFF	DRAINAGE	TVP
5	82.76	64.30	0.51	0.0	64.81	******	0.09	0.51	64.81	0.09	11.75	3678.97	431.83	0.02
6	179.47	108.54	45.54	1.54	155.63	******	7.86	47.09	155.63	7.86	25.96	5770.25	1182.81	4.41
7	143.78	22.71	121.07	8.06	151.84	******	24.66	129.13	151.84	24.66	29.10	*******	1186.85	0.00
8	109.09	21.71	85.24	14.34	121.29	******	16.08	99.59	121.29	16.08	19.62	8716.37	769.49	2.28
TOT.	515.10	217.26	252.37	23.95	493.58	*******	48.68	276.32	493.58	48.68	86.43	*******	3570.98	6.72

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND MIX

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPG MM/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	DMTS	GDD
5	17	28.3	18.9	1.00	0.0	432.0	263.0	0.0	0.0	287.00	4.421	3.454	0.0	0.0	3.454	525.00	1.00	0.0	24.5
5	18	22.8	16.7	1.00	0.0	327.0	186.9	0.0	0.0	523.20	2.900	2.266	0.0	0.0	2.266	525.00	1.00	0.0	42.0
5	19	19.4	13.3	1.00	0.0	210.0	102.1	0.0	0.0	462.30	1.488	1.163	0.0	0.0	1.163	525.00	1.00	0.0	53.5
5	20	22.8	14.4	1.00	0.0	503.0	314.5	0.0	0.0	360.70	4.831	3.774	0.0	0.0	3.774	525.00	1.00	0.0	69.0
5	21	22.2	10.0	1.00	0.0	668.0	434.1	0.0	0.0	203.20	6.483	5.064	0.0	0.0	5.064	525.00	1.00	0.0	80.0
5	22	26.1	7.8	1.00	0.0	682.0	444.2	0.0	0.0	259.10	6.927	5.412	0.0	0.0	5.412	525.00	1.00	0.0	94.5
5	23	23.3	11.1	1.00	0.0	552.0	350.0	0.0	0.0	198.10	5.336	4.169	0.0	0.0	4.169	525.00	1.00	0.0	107.5
5	24	21.1	5.0	1.00	0.0	647.0	418.8	0.0	0.0	109.20	6.006	4.692	0.0	0.0	4.692	525.00	1.00	0.0	117.5
5	25	23.9	5.6	1.00	0.0	676.0	439.9	0.0	0.0	142.20	6.587	5.146	0.0	0.0	5.146	525.00	1.00	0.0	130.0
5	26	27.2	11.1	1.00	0.0	627.0	404.3	0.0	0.0	276.90	6.490	5.070	0.0	0.0	5.070	525.00	1.00	0.0	146.5
5	27	27.8	11.1	1.00	0.01	714.0	467.4	0.01	0.00	297.20	7.556	5.880	0.034	0.0	5.913	525.00	1.00	0.0	163.5
5	28	30.6	13.3	0.99	0.02	680.0	442.8	0.03	0.01	340.40	7.477	5.772	0.100	0.0	5.872	525.00	1.00	0.0	184.5
5	29	30.0	16.1	0.98	0.00	618.0	397.8	0.04	0.01	375.90	6.748	5.188	0.120	0.0	5.308	525.00	1.00	0.0	208.0
5	30	27.8	16.1	0.98	0.00	405.0	243.4	0.05	0.02	383.50	4.018	3.078	0.089	0.0	3.167	525.00	1.00	0.0	229.5
5	31	22.2	12.8	0.97	0.00	570.0	363.0	0.07	0.02	149.90	5.493	4.173	0.170	0.0	4.343	525.00	1.00	0.0	243.0
TOTALS						4368.79	82.760	64.301	0.512	0.0	64.813								

MODEL ET-80.0 ... 1979 JUE'S SORGHUM PLANTED 5/17/79 ASHLAND MIX

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPG MM/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	BMTS	GDD
6	1	22.8	7.8	0.97	0.06	456.0	280.4	0.08	0.03	154.90	4.177	3.161	0.147	0.0	3.308	525.00	1.00	0.0	254.5
6	2	27.2	8.3	0.96	0.03	672.0	437.0	0.09	0.03	167.60	6.930	5.224	0.274	0.0	5.498	525.00	1.00	0.0	270.0
6	3	28.9	11.7	0.96	0.06	702.0	458.7	0.10	0.03	195.60	7.537	5.659	0.331	0.0	5.989	525.00	1.00	0.0	288.5
6	4	33.9	17.2	0.95	0.07	561.0	356.5	0.12	0.04	322.60	6.362	4.738	0.334	0.030	5.102	525.00	1.00	0.0	313.0
6	5	32.2	16.7	0.95	0.13	598.0	383.3	0.13	0.04	419.10	6.652	4.964	0.380	0.0	5.344	525.00	1.00	0.0	337.0
6	6	28.9	17.2	0.95	0.00	394.0	235.5	0.14	0.05	459.70	3.958	2.925	0.241	0.0	3.166	525.00	1.00	0.0	360.5
6	7	29.4	19.4	0.94	0.00	462.0	284.7	0.16	0.05	574.00	4.862	3.564	0.337	0.0	3.901	525.00	1.00	0.0	386.5
6	8	25.6	13.9	0.93	0.00	209.0	101.4	0.17	0.06	424.20	1.612	1.177	0.119	0.0	1.296	525.00	1.00	0.0	404.0
6	9	18.9	13.9	0.93	0.00	124.0	39.8	0.18	0.06	525.80	0.577	0.419	0.045	0.0	0.464	525.00	1.00	0.0	415.5
6	10	26.1	8.9	0.92	0.11	677.0	440.6	0.20	0.07	124.50	6.904	4.981	0.594	0.0	5.575	525.00	1.00	0.0	430.0
6	11	28.3	10.0	0.92	0.09	732.0	480.4	0.21	0.07	175.30	7.785	5.594	0.702	0.0	6.296	525.00	1.00	0.0	446.5
6	12	31.1	16.7	0.92	1.08	706.0	461.6	0.22	0.07	317.50	7.952	5.692	0.750	0.0	6.442	525.00	1.00	0.0	470.5
6	13	34.4	18.3	0.91	0.24	712.0	465.9	0.23	0.08	388.60	8.405	5.992	0.627	0.119	6.939	525.00	1.00	0.0	496.0
6	14	34.4	18.9	0.91	0.39	723.0	473.9	0.25	0.08	475.00	8.568	6.060	0.913	0.131	7.104	525.00	1.00	0.0	522.0
6	15	33.9	22.2	0.90	0.00	645.0	417.4	0.26	0.09	426.70	7.596	5.351	0.840	0.075	6.266	525.00	1.00	0.0	551.0
6	16	34.4	22.2	0.90	0.00	621.0	400.0	0.27	0.09	378.50	7.327	5.141	0.840	0.121	6.102	525.00	1.00	0.0	580.0
6	17	30.6	20.6	0.89	0.00	486.0	302.1	0.29	0.10	492.80	5.252	3.656	0.644	0.0	4.300	525.00	1.00	0.0	607.5
6	18	32.2	22.2	0.89	0.00	601.0	385.5	0.30	0.10	528.30	6.879	4.769	0.871	0.0	5.640	525.00	1.00	0.0	636.5
6	19	28.9	19.4	0.85	0.00	318.0	180.4	0.40	0.13	645.20	3.059	2.038	0.507	0.0	2.545	525.00	1.00	0.0	662.0
6	20	32.2	13.3	0.82	0.18	736.0	483.3	0.50	0.17	223.50	8.327	5.331	1.690	0.0	7.022	525.00	1.00	0.0	683.0
6	21	36.7	14.4	0.79	0.16	702.0	458.7	0.60	0.20	325.10	8.366	5.148	1.999	0.734	7.881	525.00	1.00	0.0	705.0
6	22	32.2	17.2	0.76	1.12	622.0	400.7	0.70	0.23	340.40	7.011	4.145	1.918	0.0	6.063	525.00	1.00	0.0	729.5
6	23	26.7	19.4	0.73	0.00	450.0	276.0	0.80	0.27	454.70	4.557	2.589	1.398	0.0	3.987	525.00	1.00	0.0	753.0
6	24	23.3	16.7	0.70	0.00	325.0	185.4	0.90	0.30	365.80	2.899	1.583	0.982	0.0	2.565	525.00	1.00	0.0	771.0
6	25	26.1	16.1	0.67	0.00	449.0	275.3	1.00	0.33	345.40	4.451	2.335	1.644	0.0	3.979	525.00	1.00	0.0	791.0
6	26	30.0	17.2	0.65	0.00	575.0	366.6	1.10	0.37	426.70	6.247	3.150	2.492	0.0	5.642	525.00	1.00	0.0	815.5
6	27	32.8	22.2	0.62	0.00	514.0	322.4	1.20	0.40	398.80	5.792	2.807	2.474	0.0	5.281	525.00	1.00	0.0	844.5
6	28	29.4	18.9	0.60	0.00	622.0	400.7	1.30	0.43	442.00	6.827	3.179	3.102	0.0	6.281	525.00	1.00	0.0	870.0
6	29	30.0	18.3	0.57	0.00	720.0	471.7	1.40	0.47	238.80	8.073	3.613	3.880	0.0	7.493	525.00	1.00	0.0	895.5
6	30	28.3	17.2	0.53	0.00	440.0	268.8	1.58	0.53	348.00	4.488	1.869	2.357	0.0	4.226	525.00	1.00	0.0	918.4
TOTALS										*******	179.471	116.856	33.632	1.210	151.698				

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND NIX

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPG MM/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	BMTS	GDD
7	1	26.7	19.4	0.50	0.00	227.0	114.4	1.75	0.58	624.80	1.889	0.735	1.066	0.0	1.801	525.00	1.00	0.0	941.9
7	2	32.2	20.6	0.46	0.00	467.0	288.4	1.93	0.64	599.40	5.112	1.853	3.083	0.0	4.936	525.00	1.00	0.0	969.4
7	3	36.1	24.4	0.43	0.00	650.0	421.0	2.11	0.70	571.50	7.935	2.677	5.072	1.578	9.327	525.00	1.00	0.0	1030.4
7	4	33.3	23.3	0.40	0.00	615.0	395.6	2.28	0.76	665.50	7.184	2.265	4.821	0.159	7.245	525.00	1.00	0.0	1080.4
7	5	23.3	16.1	0.38	0.00	146.0	57.2	2.46	0.82	581.70	0.891	0.262	0.626	0.0	0.888	525.00	1.00	0.0	1097.9
7	6	18.9	15.6	0.35	0.00	120.0	36.9	2.64	0.88	525.80	0.539	0.147	0.392	0.0	0.539	525.00	1.00	0.0	1109.9
7	7	25.0	17.2	0.33	0.00	275.0	149.2	2.82	0.94	490.20	2.389	0.608	1.782	0.0	2.389	525.00	1.00	0.0	1080.9
7	8	28.9	17.2	0.30	0.00	374.0	221.0	2.99	1.00	655.30	3.714	0.883	2.832	0.0	3.714	525.00	1.00	0.0	1104.4
7	9	30.0	20.0	0.28	0.00	593.0	365.4	3.17	1.00	645.20	6.296	1.393	4.903	0.0	6.296	525.00	1.00	0.0	1131.4
7	10	32.8	21.1	0.26	0.00	583.0	357.1	3.35	1.00	551.20	6.386	1.315	5.071	0.0	6.386	525.00	1.00	0.0	1159.4
7	11	33.9	22.2	0.25	0.00	672.0	431.5	3.52	1.00	500.40	7.854	1.512	6.342	0.564	8.418	525.00	1.00	0.0	1188.4
7	12	34.4	23.3	0.23	0.00	648.0	411.5	3.70	1.00	569.00	7.570	1.356	6.214	0.895	8.465	525.00	1.00	0.0	1218.4
7	13	36.7	23.9	0.22	0.00	679.0	437.4	3.76	1.00	414.00	8.282	1.449	6.833	2.508	10.789	525.00	1.00	0.0	1248.9
7	14	34.4	23.9	0.22	0.00	661.0	422.3	3.82	1.00	609.60	7.787	1.330	6.457	0.930	8.717	525.00	1.00	0.0	1279.4
7	15	31.7	18.9	0.21	0.00	396.0	200.6	3.89	1.00	485.10	3.510	0.583	2.927	0.0	3.510	525.00	1.00	0.0	1305.4
7	16	27.2	20.6	0.21	0.00	402.0	205.6	3.95	1.00	520.70	3.433	0.557	2.876	0.0	3.433	525.00	1.00	0.0	1330.4
7	17	25.6	18.3	0.20	0.00	371.0	179.7	4.01	1.00	426.70	2.911	0.461	2.450	0.0	2.911	525.00	1.00	0.0	1351.9
7	18	28.3	17.8	0.20	0.00	526.0	309.4	4.07	1.00	365.80	5.177	0.801	4.376	0.0	5.177	525.00	1.00	0.0	1375.4
7	19	28.3	16.1	0.19	0.00	619.0	387.2	4.14	1.00	332.70	6.435	0.968	5.467	0.0	6.435	525.00	1.00	0.0	1397.4
7	20	30.6	17.8	0.19	0.00	595.0	367.1	4.20	1.00	358.10	6.311	0.927	5.384	0.0	6.311	525.00	1.00	0.0	1422.4
7	21	31.1	20.0	0.18	0.00	548.0	327.8	4.35	1.00	454.70	5.722	0.792	4.931	0.0	5.722	525.00	1.00	0.0	1449.4
7	22	32.2	21.7	0.17	0.00	504.0	291.0	4.50	1.00	487.70	5.181	0.675	4.506	0.0	5.181	525.00	1.00	0.0	1477.9
7	23	27.8	21.1	0.17	0.0	109.0	-39.6	4.65	1.00	812.80	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	1503.9
7	24	32.2	22.8	0.15	0.00	549.0	328.6	4.80	1.00	655.30	5.877	0.680	5.197	0.0	5.877	525.00	1.00	0.0	1533.4
7	25	30.0	20.6	0.14	0.00	581.0	355.4	4.95	1.00	574.00	6.137	0.669	5.468	0.0	6.137	525.00	1.00	0.0	1560.9
7	26	31.7	19.4	0.13	0.00	530.0	312.7	5.10	1.00	467.40	5.484	0.563	4.921	0.0	5.484	525.00	1.00	0.0	1587.4
7	27	32.2	21.1	0.12	0.00	489.0	278.4	5.25	1.00	520.70	4.946	0.478	4.468	0.0	4.946	525.00	1.00	0.0	1615.4
7	28	34.4	21.1	0.12	0.00	535.0	316.9	5.40	1.00	543.60	5.780	0.526	5.253	0.756	6.536	525.00	1.00	0.0	1643.4
7	29	33.9	23.3	0.11	0.00	340.0	153.7	5.55	1.00	751.80	2.810	0.241	2.569	0.229	3.039	525.00	1.00	0.0	1673.4
7	30	32.2	23.3	0.10	0.00	266.0	91.8	5.70	1.00	820.40	1.645	0.133	1.512	0.0	1.645	525.00	1.00	0.0	1703.4
7	31	28.9	21.1	0.11	0.00	285.0	107.7	5.59	1.00	609.60	1.839	0.155	1.684	0.0	1.839	525.00	1.00	0.0	1730.4
TOTALS										*******	147.027	26.991	119.484	7.618	154.094				

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND MIX

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPG MM/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	BMIS	GDD
8	1	29.4	15.6	0.11	0.00	553.0	332.0	5.47	1.00	386.10	5.580	0.494	5.086	0.0	5.580	525.00	1.00	0.0	1752.9
8	2	31.7	20.6	0.12	0.00	419.0	219.8	5.36	1.00	475.00	3.872	0.358	3.514	0.0	3.872	525.00	1.00	0.0	1780.4
8	3	34.4	20.0	0.12	0.00	642.0	406.4	5.24	1.00	467.40	7.380	0.716	6.664	0.960	8.340	525.00	1.00	0.0	1807.4
8	4	35.0	23.3	0.13	0.00	638.0	403.1	5.13	1.00	497.80	7.465	0.757	6.708	1.342	8.807	525.00	1.00	0.0	1837.4
8	5	36.1	23.9	0.14	0.00	639.0	403.9	5.01	1.00	591.80	7.597	0.808	6.789	2.111	9.708	525.00	1.00	0.0	1867.9
8	6	36.1	25.0	0.14	0.00	631.0	397.2	4.90	1.00	459.70	7.504	0.834	6.670	2.074	9.578	525.00	1.00	0.0	1899.4
8	7	36.7	25.0	0.14	0.00	636.0	401.4	4.88	1.00	505.50	7.634	0.855	6.779	2.488	10.122	525.00	1.00	0.0	1930.9
8	8	35.6	23.9	0.14	0.00	614.0	383.0	4.86	1.00	515.60	7.156	0.808	6.348	1.625	8.782	525.00	1.00	0.0	1961.4
8	9	35.0	24.4	0.15	0.00	611.0	380.5	4.84	1.00	469.90	7.078	0.806	6.272	1.254	8.332	525.00	1.00	0.0	1992.4
8	10	30.6	19.4	0.15	0.0	117.0	-32.9	4.82	1.00	721.40	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	2018.9
8	11	25.6	14.4	0.15	0.00	646.0	409.8	4.80	1.00	251.50	6.531	0.755	5.776	0.0	6.531	525.00	1.00	0.0	2036.9
8	12	28.3	15.0	0.15	0.00	634.0	399.8	4.78	1.00	297.20	6.613	0.771	5.843	0.0	6.613	525.00	1.00	0.0	2057.9
8	13	33.9	18.3	0.15	2.31	601.0	372.1	4.76	1.00	439.40	6.670	0.784	5.886	0.524	7.194	525.00	1.00	0.0	2083.4
8	14	26.1	13.9	0.15	0.0	60.0	-80.6	4.74	1.00	784.50	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	2101.4
8	15	17.8	12.8	0.15	0.00	190.0	28.2	4.72	1.00	355.60	0.400	0.048	0.352	0.0	0.400	525.00	1.00	0.0	2110.9
8	16	26.1	15.6	0.15	0.00	247.0	75.9	4.70	1.00	617.20	1.224	0.147	1.077	0.0	1.224	525.00	1.00	0.0	2130.4
8	17	34.4	23.3	0.25	0.10	594.0	366.3	3.52	1.00	414.00	6.739	1.297	5.442	0.784	7.522	525.00	1.00	0.0	2160.4
8	18	35.0	23.9	0.39	0.00	562.0	357.2	2.35	0.78	414.00	6.630	2.033	4.532	0.906	7.471	525.00	1.00	0.0	2190.9
8	19	34.4	22.2	0.63	0.00	605.0	388.4	1.18	0.40	482.60	7.114	3.475	3.000	0.432	6.907	525.00	1.00	0.0	2219.9
8	20	32.2	21.1	1.00	0.0	527.0	331.9	0.0	0.40	444.50	5.896	4.606	0.0	0.0	4.606	525.00	1.00	0.0	2247.9
TOTALS										5591.07	105.086	20.353	86.737	14.500	121.591				

MODEL FT-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND MIX

MONTH	POT. EVAP	SOIL EVAP	TRAN EVAP	A EVAP	TOTAL EVAP	RAIN (MM)	RATIO T/EO	TRAN EVAP(2)	TOT. EVAP(2)	RATIO T3/EO(2)	RATIO ET/EO(2)	RUNOFF	DRAINAGE	TVP
5	82.76	64.30	0.51	0.0	64.81	******	0.09	0.51	64.81	0.09	11.75	3678.97	431.83	0.02
6	179.47	116.86	33.63	1.21	151.70	******	5.79	34.84	151.70	5.79	25.31	9768.41	1188.09	3.72
7	147.03	26.99	119.48	7.62	154.09	******	25.34	127.10	154.09	25.34	30.92	*******	1185.94	0.00
8	109.09	20.35	86.74	14.50	121.59	******	16.37	101.24	121.59	16.37	19.67	8716.80	768.98	2.31
TOT.	518.34	228.50	240.37	23.33	492.19	*******	47.60	263.69	492.19	47.60	87.65	*******	3574.84	6.05

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND ALT

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPG MM/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	BMTS	GDD
5	17	28.3	18.9	1.00	0.0	432.0	263.0	0.0	0.0	287.00	4.421	3.454	0.0	0.0	3.454	525.00	1.00	0.0	24.5
5	18	22.8	16.7	1.00	0.0	327.0	186.9	0.0	0.0	523.20	2.900	2.266	0.0	0.0	2.266	525.00	1.00	0.0	42.0
5	19	19.4	13.3	1.00	0.0	210.0	102.1	0.0	0.0	462.30	1.488	1.163	0.0	0.0	1.163	525.00	1.00	0.0	53.5
5	20	22.8	14.4	1.00	0.0	503.0	314.5	0.0	0.0	360.70	4.831	3.774	0.0	0.0	3.774	525.00	1.00	0.0	69.0
5	21	22.2	10.0	1.00	0.0	668.0	434.1	0.0	0.0	203.20	6.483	5.064	0.0	0.0	5.064	525.00	1.00	0.0	80.0
5	22	26.1	7.8	1.00	0.0	682.0	444.2	0.0	0.0	259.10	6.927	5.412	0.0	0.0	5.412	525.00	1.00	0.0	94.5
5	23	23.3	11.1	1.00	0.0	552.0	350.0	0.0	0.0	198.10	5.336	4.169	0.0	0.0	4.169	525.00	1.00	0.0	107.5
5	24	21.1	5.0	1.00	0.0	647.0	418.8	0.0	0.0	109.20	6.006	4.692	0.0	0.0	4.692	525.00	1.00	0.0	117.5
5	25	23.9	5.6	1.00	0.0	676.0	439.9	0.0	0.0	142.20	6.587	5.146	0.0	0.0	5.146	525.00	1.00	0.0	130.0
5	26	27.2	11.1	1.00	0.0	627.0	404.3	0.0	0.0	276.90	6.490	5.070	0.0	0.0	5.070	525.00	1.00	0.0	146.5
5	27	27.8	11.1	0.99	0.01	714.0	467.4	0.02	0.01	297.20	7.556	5.856	0.067	0.0	5.924	525.00	1.00	0.0	163.5
5	28	30.6	13.3	0.98	0.02	680.0	442.8	0.04	0.01	340.40	7.477	5.749	0.133	0.0	5.882	525.00	1.00	0.0	184.5
5	29	30.0	16.1	0.97	0.00	618.0	397.8	0.07	0.02	375.90	6.746	5.127	0.209	0.0	5.335	525.00	1.00	0.0	208.0
5	30	27.8	16.1	0.96	0.00	405.0	243.4	0.09	0.03	383.50	4.018	3.029	0.159	0.0	3.188	525.00	1.00	0.0	229.5
5	31	22.2	12.8	0.96	0.00	570.0	363.0	0.11	0.04	149.90	5.493	4.107	0.265	0.0	4.372	525.00	1.00	0.0	243.0
TOTALS						4368.79	82.760	64.078	0.833	0.0	64.911								

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND ALT

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPG MM/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	BMTS	GDD
6	1	22.8	7.8	0.95	0.10	456.0	280.4	0.13	0.04	154.90	4.177	3.099	0.237	0.0	3.336	525.00	1.00	0.0	254.5
6	2	27.2	8.3	0.94	0.06	672.0	437.0	0.15	0.05	167.60	6.930	5.101	0.452	0.0	5.553	525.00	1.00	0.0	270.0
6	3	28.9	11.7	0.93	0.10	702.0	458.7	0.17	0.06	195.60	7.537	5.503	0.555	0.0	6.058	525.00	1.00	0.0	288.5
6	4	33.9	17.2	0.92	0.11	561.0	356.5	0.20	0.07	322.60	6.362	4.590	0.548	0.049	5.186	525.00	1.00	0.0	313.0
6	5	32.2	16.7	0.92	0.22	598.0	383.3	0.22	0.07	419.10	6.692	4.790	0.631	0.0	5.421	525.00	1.00	0.0	337.0
6	6	28.9	17.2	0.91	0.00	394.0	235.5	0.24	0.08	459.70	3.958	2.811	0.406	0.0	3.216	525.00	1.00	0.0	360.5
6	7	29.4	19.4	0.90	0.00	462.0	284.7	0.26	0.09	574.00	4.862	3.425	0.538	0.0	3.963	525.00	1.00	0.0	386.5
6	8	25.6	13.9	0.89	0.00	209.0	101.4	0.28	0.09	424.20	1.612	1.126	0.191	0.0	1.318	525.00	1.00	0.0	404.0
6	9	18.9	13.9	0.89	0.00	124.0	39.8	0.30	0.10	525.80	0.577	0.400	0.073	0.0	0.473	525.00	1.00	0.0	415.5
6	10	26.1	8.9	0.88	0.18	677.0	440.6	0.33	0.11	124.50	6.904	4.730	0.956	0.0	5.686	525.00	1.00	0.0	430.0
6	11	28.3	10.0	0.87	0.15	732.0	480.4	0.35	0.12	175.30	7.785	5.291	1.139	0.0	6.430	525.00	1.00	0.0	446.5
6	12	31.1	16.7	0.86	1.76	706.0	461.6	0.37	0.12	317.50	7.952	5.362	1.225	0.0	6.587	525.00	1.00	0.0	470.5
6	13	34.4	18.3	0.86	0.39	712.0	465.9	0.39	0.13	388.60	8.405	5.623	1.360	0.196	7.178	525.00	1.00	0.0	496.0
6	14	34.4	18.9	0.85	0.62	723.0	473.9	0.41	0.14	475.00	8.568	5.686	1.451	0.209	7.346	525.00	1.00	0.0	522.0
6	15	33.9	22.2	0.84	0.00	645.0	417.4	0.43	0.14	426.70	7.596	5.001	1.344	0.120	6.465	525.00	1.00	0.0	551.0
6	16	34.4	22.2	0.83	0.00	621.0	400.0	0.46	0.15	378.50	7.327	4.766	1.379	0.199	6.344	525.00	1.00	0.0	580.0
6	17	30.6	20.6	0.83	0.00	486.0	302.1	0.48	0.16	492.80	5.252	3.390	1.027	0.0	4.417	525.00	1.00	0.0	607.5
6	18	32.2	22.2	0.82	0.00	601.0	385.5	0.50	0.17	528.30	6.879	4.404	1.396	0.0	5.801	525.00	1.00	0.0	636.5
6	19	28.9	19.4	0.77	0.00	318.0	180.4	0.66	0.22	645.20	3.059	1.838	0.795	0.0	2.633	525.00	1.00	0.0	662.0
6	20	32.2	13.3	0.72	0.28	736.0	483.3	0.83	0.28	223.50	8.327	4.675	2.635	0.0	7.310	525.00	1.00	0.0	683.0
6	21	36.7	14.4	0.67	0.24	702.0	458.7	0.99	0.33	325.10	8.366	4.408	3.065	1.125	8.598	525.00	1.00	0.0	705.0
6	22	32.2	17.2	0.63	1.69	622.0	400.7	1.15	0.38	340.40	7.011	3.466	2.897	0.0	6.362	525.00	1.00	0.0	729.5
6	23	26.7	19.4	0.59	0.00	450.0	276.0	1.32	0.44	454.70	4.557	2.105	2.095	0.0	4.200	525.00	1.00	0.0	753.0
6	24	23.3	16.7	0.55	0.00	325.0	185.4	1.48	0.49	355.80	2.899	1.257	1.452	0.0	2.708	525.00	1.00	0.0	771.0
6	25	26.1	16.1	0.52	0.00	449.0	275.3	1.65	0.55	345.40	4.451	1.803	2.411	0.0	4.214	525.00	1.00	0.0	791.0
6	26	30.0	17.2	0.49	0.00	575.0	366.6	1.81	0.60	426.70	6.247	2.375	3.608	0.0	5.983	525.00	1.00	0.0	815.5
6	27	32.8	22.2	0.46	0.00	514.0	322.4	1.97	0.66	398.80	5.792	2.066	3.541	0.0	5.607	525.00	1.00	0.0	844.5
6	28	29.4	18.9	0.43	0.00	622.0	400.7	2.14	0.71	442.00	6.827	2.276	4.403	0.0	6.679	525.00	1.00	0.0	870.0
6	29	30.0	18.3	0.40	0.00	720.0	471.7	2.30	0.77	238.80	8.073	2.525	5.446	0.0	7.971	525.00	1.00	0.0	895.5
6	30	28.3	17.2	0.38	0.00	440.0	268.8	2.46	0.82	348.00	4.488	1.317	3.152	0.0	4.469	525.00	1.00	0.0	918.4
TOTALS										*******	179.471	105.206	50.408	1.897	157.510				

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND ALT

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPG MM/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	BMTS	GDD
7	1	26.7	19.4	0.35	0.00	227.0	114.4	2.62	0.87	624.80	1.889	0.520	1.369	0.0	1.889	525.00	1.00	0.0	941.9
7	2	32.2	20.6	0.33	0.00	467.0	288.4	2.78	0.93	599.40	5.112	1.321	3.791	0.0	5.112	525.00	1.00	0.0	969.4
7	3	36.1	24.4	0.31	0.00	650.0	421.0	2.95	0.98	571.50	7.935	1.916	6.019	1.872	9.807	525.00	1.00	0.0	1010.4
7	4	33.3	23.3	0.29	0.00	615.0	383.9	3.11	1.00	665.50	6.970	1.579	5.391	0.176	7.148	525.00	1.00	0.0	1030.4
7	5	23.3	16.1	0.29	0.0	148.0	-6.9	3.27	1.00	581.70	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	1047.9
7	6	18.9	15.6	0.29	0.0	120.0	-30.4	3.43	1.00	525.80	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	1060.9
7	7	25.0	17.2	0.24	0.00	275.0	99.3	3.59	1.00	490.20	1.591	0.298	1.293	0.0	1.591	525.00	1.00	0.0	1080.9
7	8	28.9	17.2	0.22	0.00	374.0	182.2	3.75	1.00	655.30	3.062	0.538	2.525	0.0	3.062	525.00	1.00	0.0	1104.4
7	9	30.0	20.0	0.21	0.00	593.0	365.4	3.92	1.00	645.20	6.296	1.033	5.262	0.0	6.296	525.00	1.00	0.0	1131.4
7	10	32.8	21.1	0.20	0.00	583.0	357.1	4.08	1.00	551.20	6.386	0.984	5.402	0.0	6.386	525.00	1.00	0.0	1159.4
7	11	33.9	22.2	0.18	0.00	672.0	431.5	4.24	1.00	500.40	7.854	1.135	6.719	0.598	8.452	525.00	1.00	0.0	1188.4
7	12	34.4	23.3	0.17	0.00	648.0	411.5	4.40	1.00	569.00	7.570	1.026	6.544	0.942	8.512	525.00	1.00	0.0	1218.4
7	13	36.7	23.9	0.17	0.00	679.0	437.4	4.48	1.00	414.00	8.282	1.088	7.194	2.640	10.922	525.00	1.00	0.0	1248.9
7	14	34.4	23.9	0.16	0.00	661.0	422.3	4.55	1.00	609.60	7.787	0.995	6.793	0.978	8.765	525.00	1.00	0.0	1279.4
7	15	31.7	18.9	0.16	0.00	396.0	200.6	4.63	1.00	485.10	3.510	0.434	3.075	0.0	3.510	525.00	1.00	0.0	1305.4
7	16	27.2	20.6	0.15	0.00	402.0	205.6	4.70	1.00	520.70	3.433	0.413	3.020	0.0	3.433	525.00	1.00	0.0	1330.4
7	17	25.6	18.3	0.15	0.00	371.0	179.7	4.78	1.00	426.70	2.911	0.339	2.572	0.0	2.911	525.00	1.00	0.0	1351.9
7	18	28.3	17.8	0.15	0.00	526.0	309.4	4.85	1.00	365.80	5.177	0.587	4.590	0.0	5.177	525.00	1.00	0.0	1375.4
7	19	28.3	16.1	0.14	0.00	619.0	387.2	4.93	1.00	332.70	6.435	0.707	5.728	0.0	6.435	525.00	1.00	0.0	1397.4
7	20	30.6	17.8	0.14	0.00	595.0	367.1	5.00	1.00	358.10	6.311	0.674	5.637	0.0	6.311	525.00	1.00	0.0	1422.4
7	21	31.1	20.0	0.14	0.00	548.0	327.8	4.97	1.00	454.70	5.722	0.618	5.104	0.0	5.722	525.00	1.00	0.0	1449.4
7	22	32.2	21.7	0.14	0.00	504.0	291.0	4.94	1.00	487.70	5.181	0.567	4.614	0.0	5.181	525.00	1.00	0.0	1477.9
7	23	27.8	21.1	0.14	0.0	109.0	-39.6	4.91	1.00	812.80	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	1503.9
7	24	32.2	22.8	0.14	0.00	549.0	328.6	4.88	1.00	655.30	5.877	0.658	5.219	0.0	5.877	525.00	1.00	0.0	1533.4
7	25	30.0	20.6	0.15	0.00	581.0	355.4	4.85	1.00	574.00	6.137	0.696	5.441	0.0	6.137	525.00	1.00	0.0	1560.9
7	26	31.7	19.4	0.15	0.00	530.0	312.7	4.82	1.00	467.40	5.484	0.629	4.855	0.0	5.484	525.00	1.00	0.0	1587.4
7	27	32.2	21.1	0.15	0.00	489.0	278.4	4.79	1.00	520.70	4.946	0.574	4.372	0.0	4.946	525.00	1.00	0.0	1615.4
7	28	34.4	21.1	0.15	0.00	535.0	316.9	4.76	1.00	543.60	5.780	0.679	5.101	0.734	6.514	525.00	1.00	0.0	1643.4
7	29	33.9	23.3	0.15	0.00	340.0	153.7	4.73	1.00	751.80	2.810	0.334	2.476	0.220	3.030	525.00	1.00	0.0	1673.4
7	30	32.2	23.3	0.15	0.00	266.0	91.8	4.70	1.00	820.40	1.645	0.198	1.447	0.0	1.645	525.00	1.00	0.0	1703.4
7	31	28.9	21.1	0.15	0.00	285.0	107.7	4.74	1.00	609.60	1.839	0.218	1.621	0.0	1.839	525.00	1.00	0.0	1730.4
TOTALS										*******	143.932	20.759	123.173	8.163	152.095				

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND ALT

MO	DAY	MAX TEMP (C)	MIN TEMP (C)	TAU	T3/VPG MN/MB	SOLAR RAD (LYS)	NET RAD (LYS)	LEAF AREA	COVER	RAIN (MM)	POT. EVAP (MM)	SOIL EVAP (MM)	TRAN EVAP (MM)	A EVAP (MM)	TOTAL EVAP (MM)	THETA (MM)	KS	BMTS	GDD
8	1	29.4	15.6	0.15	0.00	553.0	332.0	4.79	1.00	386.10	5.580	0.648	4.932	0.0	5.580	525.00	1.00	0.0	1752.9
8	2	31.7	20.6	0.15	0.00	419.0	219.8	4.83	1.00	475.00	3.872	0.442	3.430	0.0	3.872	525.00	1.00	0.0	1780.4
8	3	34.4	20.0	0.14	0.00	642.0	406.4	4.87	1.00	467.40	7.380	0.830	6.550	0.943	8.324	525.00	1.00	0.0	1807.4
8	4	35.0	23.3	0.14	0.00	638.0	403.1	4.91	1.00	497.80	7.465	0.826	6.639	1.328	8.793	525.00	1.00	0.0	1837.4
8	5	36.1	23.9	0.14	0.00	639.0	403.9	4.96	1.00	591.80	7.597	0.824	6.773	2.106	9.703	525.00	1.00	0.0	1867.9
8	6	36.1	25.0	0.14	0.00	631.0	397.2	5.00	1.00	459.70	7.504	0.801	6.703	2.085	9.589	525.00	1.00	0.0	1899.4
8	7	36.7	25.0	0.14	0.00	636.0	401.4	4.98	1.00	505.50	7.634	0.822	6.812	2.500	10.134	525.00	1.00	0.0	1930.9
8	8	35.6	23.9	0.14	0.00	614.0	383.0	4.96	1.00	515.60	7.156	0.777	6.380	1.633	8.790	525.00	1.00	0.0	1961.4
8	9	35.0	24.4	0.14	0.00	611.0	380.5	4.94	1.00	469.90	7.078	0.774	6.304	1.261	8.339	525.00	1.00	0.0	1992.4
8	10	30.6	19.4	0.14	0.0	117.0	-32.9	4.92	1.00	721.40	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	2018.9
8	11	25.6	14.4	0.14	0.00	646.0	409.8	4.90	1.00	251.50	6.531	0.726	5.806	0.0	6.531	525.00	1.00	0.0	2036.9
8	12	28.3	15.0	0.14	0.00	634.0	399.8	4.88	1.00	297.20	6.613	0.741	5.873	0.0	6.613	525.00	1.00	0.0	2057.9
8	13	33.9	18.3	0.14	2.32	601.0	372.1	4.86	1.00	439.40	6.670	0.753	5.917	0.527	7.196	525.00	1.00	0.0	2083.4
8	14	26.1	13.9	0.14	0.0	60.0	-80.6	4.84	1.00	784.90	0.0	0.0	0.0	0.0	0.0	525.00	1.00	0.0	2101.4
8	15	17.8	12.8	0.15	0.00	190.0	28.2	4.82	1.00	355.60	0.400	0.046	0.354	0.0	0.400	525.00	1.00	0.0	2110.9
8	16	26.1	15.6	0.15	0.00	247.0	75.9	4.80	1.00	617.20	1.224	0.142	1.083	0.0	1.224	525.00	1.00	0.0	2130.4
8	17	34.4	23.3	0.24	0.00	594.0	366.3	3.60	1.00	414.00	6.739	1.256	5.482	0.789	7.528	525.00	1.00	0.0	2160.4
8	18	35.0	23.9	0.38	0.00	562.0	357.2	2.40	0.80	414.00	6.630	1.993	4.589	0.918	7.500	525.00	1.00	0.0	2190.9
8	19	34.4	22.2	0.62	0.00	605.0	388.4	1.20	0.40	482.60	7.114	3.448	3.039	0.438	6.924	525.00	1.00	0.0	2215.9
8	20	32.2	21.1	1.00	0.0	527.0	331.9	0.0	0.40	444.50	5.896	4.606	0.0	0.0	4.606	525.00	1.00	0.0	2247.9
TOTALS										9591.07	109.086	20.455	86.665	14.527	121.648				

MODEL ET-80.0 ... 1979 JOE'S SORGHUM PLANTED 5/17/79 ASHLAND ALT

MONTH	POT. EVAP	SOIL EVAP	TRAN EVAP	A EVAP	TOTAL EVAP	RAIN (MM)	RATIO T/EO	TRAN EVAP(2)	TOT. EVAP(2)	RATIO T3/EO(2)	RATIO ET/EO(2)	RUNOFF	DRAINAGE	TVP
5	82.76	64.08	0.83	0.0	64.91	******	0.15	0.83	64.91	0.15	11.76	3679.08	431.67	1.94
6	179.47	105.21	50.41	1.90	157.51	******	8.67	52.30	157.51	8.67	26.25	9773.30	1177.56	5.89
7	143.93	20.76	123.17	8.16	152.10	******	25.05	131.34	152.10	25.05	29.11	*******	1186.62	0.00
8	109.00	20.46	86.67	14.53	121.65	******	16.36	101.19	121.65	16.36	19.68	8716.78	768.90	2.32
TOT.	515.25	210.50	261.08	24.59	496.16	*******	50.23	285.67	496.16	50.23	86.80	*******	3564.75	8.25