DIFFERENTIALLY IRRIGATED SORGHUM AND MILLET ON THE YUMA MESA

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Summary

The identification of more drought tolerance in sorghum and millet is an important goal for arid land agriculture. A sprinkler irrigation gradient system was used to investigate responses of sorghum and millet to moisture stress on the Yuma Mesa. This location has ideal temperatures, rainfall and sandy soil conditions to allow for evaluating effects of moisture stress. Total water application through the sprinkler system graded from 695 mm at the line source to 0 mm at the edge of the plot. Several entries, including registered hybrids, experimental material and standard varieties, were able to develop viable panicles through the complete range of water application while many other were able to develop fully only in areas of high water application. The sprinkler irrigation gradient system has proved to be an effective tool for identification of drought tolerant sorghum and millet.

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Investigations of drought resistant crops are increasing dramatically in both irrigated and rainfed semi-arid areas of the world. Grain sorghum and millet, well known for their capabilities to withstand substantial periods of moisture stress, are ideally suited to these environments. Although sorghum and millet are generally considered drought resistant, there is a vast range of responses to limited water as evidenced by the diverse climatic conditions under which they are cultivated. The identification of cultivars with inherent drought resisting mechanisms requires breeders from many parts of the world to assemble germplasm in a locality which is assured of both severe stress and adequate moisture conditions. The irrigated Yuma Mesa fulfills these criteria exceptionally well.

Over 300 grain sorghum entries were grown on the Yuma Mesa in 1979 as reported in the 1980 Forage and Grain Report for Arizona and during the summer of 1980, a sprinkler irrigation gradient system was again used to identify drought resistant germplasm from another 280 sorghum and 20 millet entries. The March 17 planting was similar to the previous year but a cooling trend (Figure 1) prevented rapid initial growth. The cool weather continued through the first part of the growing season which resulted in delay of other developmental steps. There were 66 days with temperatures in excess of or equal to 40°C and the peak period occurred during July when mean maximum and minimum temperatures were 42°C and 24°C, respectively. Evaporation during July averaged 11.3 mm/day while total evaporation during the period of March through August was 1689 mm as compared to only 18 mm total rainfall for the same period. Severe environmental conditions coupled with a soil with an available water holding capacity of 3.6% on a volumetric basis presented an ideal area to investigate variable responses to moisture stress.

Single row sorghum and millet entries were planted perpendicular to a line source sprinkler irrigation gradient system which was designed to give uniform application at the same distance along the line source but decreasing application with increased distance from the line source (Figure 2). The water application gradient was imposed after 6 flood irrigations to insure adequate early growth under the sandy soil conditions (91% sand). Total application through the system along the line source was 695 mm, somewhat higher than 1979, and decreased to 0 mm at the edge of the plot (Figure 2). The difference between ambient and leaf temperature was measured with a Licor 1600 leaf porometer and 26 selected entries was correlated with distance from the line source with $r = 0.82$ (Figure 2), as evaporative cooling was prevented due to increased stomatal resistance under moisture stress conditions.

Panicle development was compared to RS610 145 days after planting and ranked on a basis of 0 to 5 with 5 being superior. Rankings were made in areas of high, medium and low water application perpendicular to the line source (Figure 3). Days to 50% anthesis was recorded and appeared to be somewhat delayed. At the same time panicle ranking was conducted, the distance from line source to last viable inflorescence of each entry was measured to give a better indication of development under a water application gradient (Figure 3). Entries which were able to produce viable heads under conditions of severe moisture stress and ranked 3 or better were considered drought resistant. Unfortunately, severe bird damage prevented grain harvest and yield comparisons.

Comparisons can be made between known resistant varieties such as RS610 and experimental entries such as 1028-19. Superior potential parents for future hybrids can be identified. Different hybrids with either CK60 or Redlan as the male sterile were included to investigate parental contributions to drought resistance. When CK60 and Redlan were crossed with SC500-6-1, SC118, TAM Blk 25 and (TX412 x TX 414), progeny with CK60 parentage consistently produced viable heads to a greater distance than those of Redlan parentage (Figure 3). They also flowered earlier, averaging 18 days sooner and had somewhat better rankings as compared to RS610.

The sprinkler irrigation is an ideal tool for separating large numbers of crop entries. It is being used in Yuma to identify drought resistant sorghum and millets so breeders and growers will have a better basis for choosing varieties for areas prone to periods of moisture stress. Because of its capabilities, the system has been expanded and over 500 entries are being investigated during 1981.

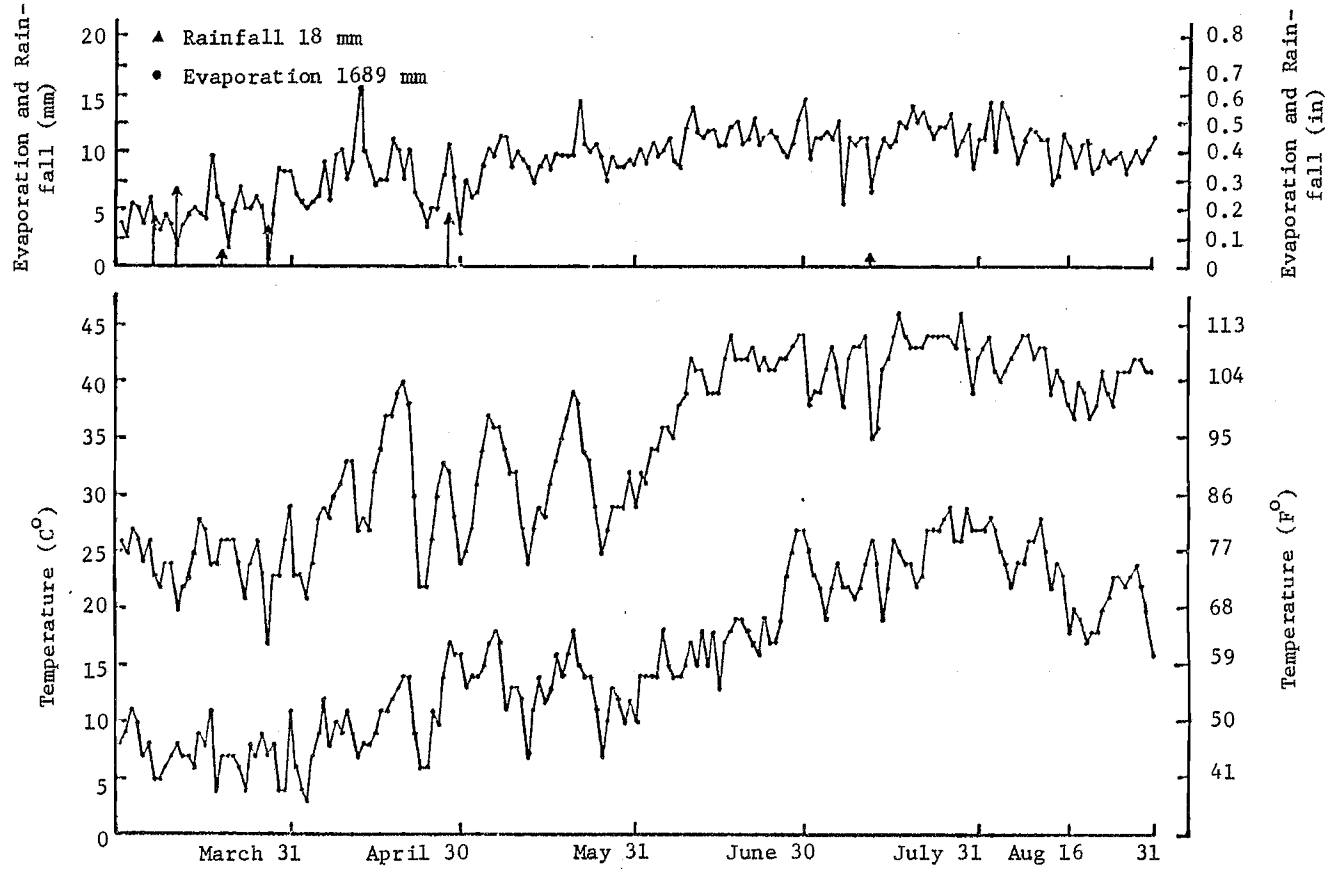

Figure 1. Meterological data for Yuma Mesa, Agricultural Experiment Station, Yuma, Arizona from March through August 1980.

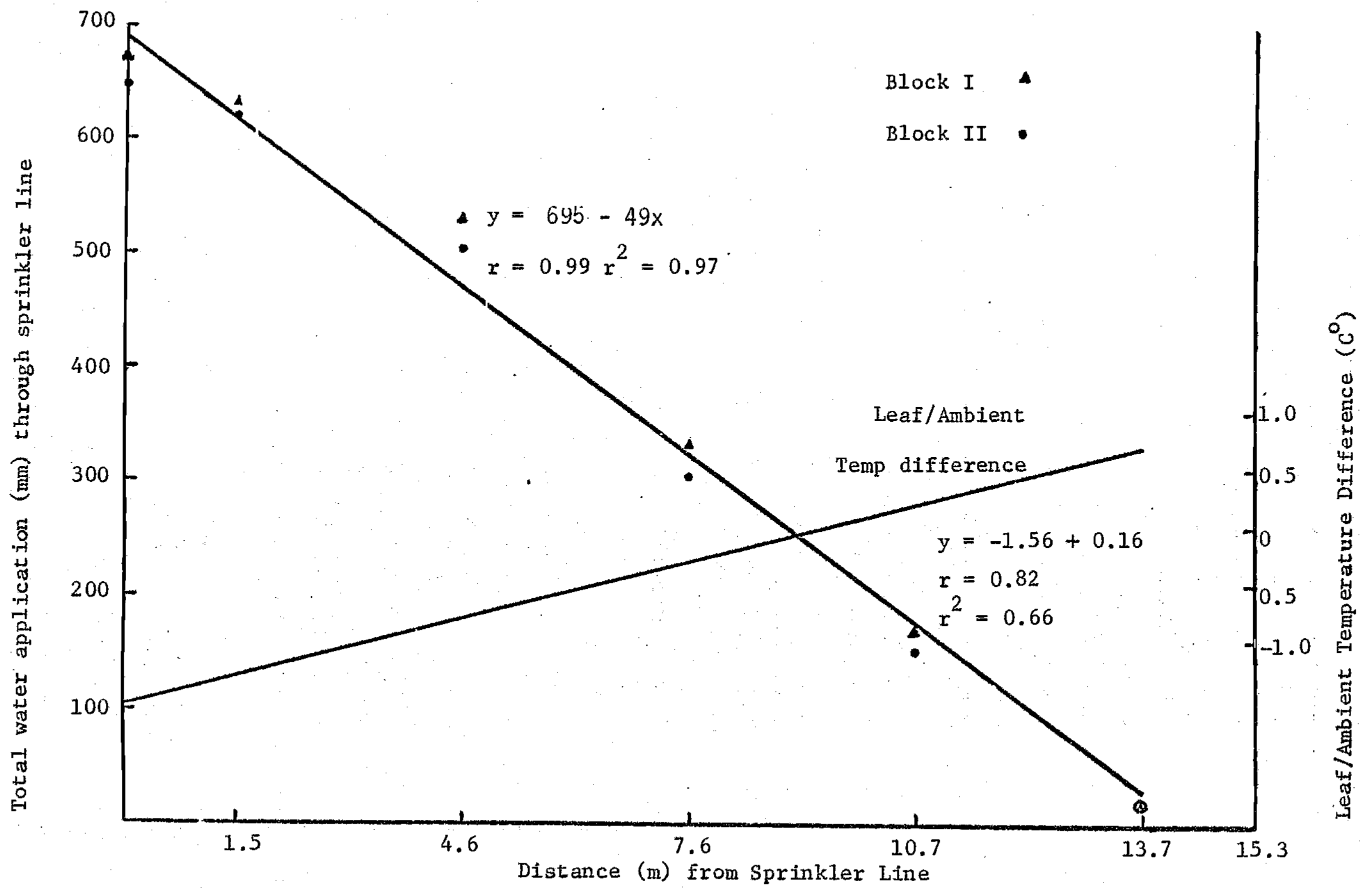

Figure 2. Regression lines of total water application through the sprinkler irrigation gradient system of mean of all catch can sites for two blocks combined at distances of 0.0, 1.5, 4.6, 7.6, 10.7 and 13.7 m from the line source.

145 Day Ranking H	M	L*	Days to Anthesis	Distance (m) from Sprinkler Line after 145 days (0 3 6 9 12 15)	Distance (m)
4	4	3	102	RS 610	15.3
4	4	0	93	TX 7000	12.2
4	4	3	87	Yellow XB92	15.3
2	2	0	95	BTX 378	9.5
4	4	3	85	DKC 42Y	15.3
4	4	0	101	ATX 399 x TX 2737	8.5
4	3	3	81	1979 D31-1-F	15.3
2	2	0	95	1044-42	8.8
3	3	3	85	MX83 X 156	15.3
0	0	0	115	1028-19	0.9
3	3	0	101	ATX 623 x Rio	10.1
2	2	0	101	79 CV 3106	8.5
4	4	0	102	A35 X TX 7000	9.5
3	3	2	81	CK 60 X SC 500-6-1	15.3
3	3	0	101	Red L X SC 500-6-1	8.8
3	3	2	88	CK 60 X SC 118	15.3
3	3	0	112	Red L X SC 118	6.4
2	2	2	81	CK 60 X TAM Blk 25	15.3
2	2	0	93	Red L X TAM Blk 25	11.9
3	3	3	86	Red L X (TX 412 X TX 414)	15.3
2	2	0	98	Red L X (TX 412 X TX 414)	10.4
4	4	4	81	78-2059/78-7101 Pearl Millet	15.3
4	4	4	81	78-2059/79-4104 Pearl Millet	15.3
4	4	4	81	78-2157/78-7101 Pearl Millet	15.3
4	4	4	81	78-2157/79-4104 Pearl Millet	15.3
4	4	4	81	78-2157/78-7024 Pearl Millet	15.3

*Water Application H = High, M = Medium, L = Low

Figure 3. 145 day ranking of panicle development on a 0-5 system with 5 representing excellent development; rankings were taken in the region of high, medium and low water application in each row. Days to Anthesis is the number of days after the March 17, 1980 planting to 50% bloom in the region of high water application for each entry. Distance from Sprinkler Line after 145 days is a graphic representation of the distance (m) from the line source to the last viable head of each entry on the north side of the sprinkler line. The name of each entry appears above the representing line and the numerical value for the graphic representation appears in the last column.