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Responses of Guar to Supplemental Irrigation in Heavy Clay Soils of Abu Naama

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Abstract: *A field study from 1999 through 2001 was carried out to investigate three water regimes effects on the performance and yield of guar [Cyamopsis tetragonoloba (L.)Taubert], using a randomized complete block design with four replications.*
The water regime treatments studied were; fully-irrigated, one supplemental irrigation and rain-fed.
In the research reported here, most of the parameters namely; plant height,number of pods per plant; biomass and grain yield is presented. Consistent significant differences between the fully-irrigated and rain-fed treatment (P = 0.05) was noted, in which rain-fed exhibited low results as compared to fully-irrigated. However, one supplemental gave variable effect on the parameters mentioned earlier. Nevertheless, weight per seed and harvest index showed no response to the three water regimes.
When the data of the three seasons were subjected to combined analyses, it was observed that the yield reductions in one supplemental irrigation and rain-fed from fully-irrigated were 18% and 42% respectively. The three seasons differed significantly (P = 0.01) with regard to all the parameters of the plant studied, except the harvest index. The differential response of grain yield of guar in each of the three seasons and combined data analyses to the three water regimes, follow similar trends as in biomass or total dry matter at harvest. Consequently, the biomass can be regarded as an indicator of guar crop yield. On the other hand differences in guar yield can be attributed entirely, to number of pods per plant.
Finally this study, clearly suggest that it is necessary to provide one to three irrigations to guar crop depending on the growing environmental conditions of the seasons.

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I. Introduction

Guar [*Cyamopsis tetragonoloba* (L.) Taubert] is a leguminous and drought-tolerant crop. However, it responds well to irrigation. Guar requires 400 – 500 mm annual rainfall and it also grows best in areas with annual rainfall of 900 mm.

The importance of guar stems from the fact that it provides guar gum, used for example in the following: (1) Mining industry (2) Paper manufacturing (3) Cosmetics, hand lotions and creams (4) Bread baking (5) Cold drinks industry. The bi-product with high protein is used as animal feed. Furthermore, guar should be grown in rotation with other crops because it is beneficial to the succeeding crop (James, 1983).

Guar is recently gaining importance in Sudan, and that is supported by the fact that it has entered industrialization. Although information about guar is available elsewhere, here in the southern part of centralrain lands, data are meager. However, Farah (1983) reported that in order to achieve high yields in rain-grown sorghum in Abu Naama area, supplementary irrigation is needed during one or more of its growth periods. Hence research work is needed to fully comprehend the effects of supplemental irrigation during summer (Kharif) on the yield of guar. Consequently, the objective of this study was to determine the effects of supplemental irrigation on performance and yield of guar.

II. Materials And Methods

The experiments were conducted at Abu Naama research station in the years; 1999, 2000, 2001. Three water regimes namely; rain-fed, one supplemental irrigation and fully-irrigated were studied.

The treatment designated as fully-irrigated was irrigated during periods without rains or if there were visual symptoms of water stress. In the season 1999-2000, the fully-irrigated and one supplemental irrigation received irrigation water 66 days after planting (DAP), in the second season 2000-2001, fully-irrigated and 0ne supplemental irrigation treatments received first irrigation 83 DAP, whereas fully-irrigated one received second and third irrigations 94 and 102 DAP respectively. However, irrigation schedules in the season 2001-2002 were as follows: fully-irrigated and single supplemental irrigations received irrigation 69 DAPS, and fully-irrigated received two extra-irrigations 80 and 91 DAP.

The experimental design was a randomized complete block design with four replications. Plots consisted of four 8m long rows of guar plants and the rows were 0.75 m apart.

Planting was carried out in the last week of July in season 1999-2000, whereas in seasons 2000-2001 and 2001-2002 planting was done in the third week of July. Plants were thinned to one plant per hill. The crop was weeded as required.

At harvest, the two middle rows each 7m- long were harvested. Data on plant height, number of pods per plant, biomass, harvest index (HI), weight per seed and seed yield were recorded. The data were subjected to statistical analysis for separate seasons and combined analysis for the three seasons was also performed.

III. Results And Discussions

Analysis of variance of plant height in each of the three seasons (1999-2000, 2000-2001, 2001-2002), in table 1 showed that there was a persistent significant difference between fully-irrigated and rain-fed treatments (P = 0.05). In contrast, one supplemental irrigation treatment variably influences the plant height from one season to another. However, combined analyses of the three seasons indicated that fully-irrigated had taller plants than rain-fed and differ significantly (P = 0.01). On the other hand one supplemental irrigation treatment was intermediate in its effect on plant height of guar.

In year 2001 the guar crop had a highly significantly taller plants than in years 1999 and 2000 (P = 0.01). This might be due to the fact that the summer of 2001 might have presented quite different growing conditions with regard to rainfall.

Table1: Effects of water regimeson guar plant height during 1999- 2002 seasons

Water regimes	Plant height (cm)			Treatment mean
	Season			
	1999-2000	2000-2001	2001-2002	
Fully-irrigated	88.5	95.7	109.19	97.8
Single supplemental irrigation	91.5	87.05	101.44	93.33
Rain-fed	70.25	77.95	97.62	81.94
Season mean	83.42	86.9	102.75	91.02
S.E ± (treatment)	5.14	7.15	3.26	3.09
S.E ± (season)		3.09		
S.E ± (season x treatment)		5.36		

The water regimes had no effects on number of pods per plant (P = 0.05) in the year 1999 (Table2). However, in the years 2000 and 2001, fully-irrigated regime had significantly more pods per plant than rain-fed treatment (P = 0.05). Single supplemental irrigation was intermediate in its effect on number of pods per plant in year 2000, however in year 2001 it had similar effect of fully-irrigated on number of pods per plant (Table2).

Table2: Effects of three water regimes during years 1999 through 2002, on guarnumber of pods per plant

Water regimes	Number of pods per plant			Treatment mean
	Season			
	1999-2000	2000-2001	2001-2002	
Fully-irrigated	54	64	96	71
Single supplemental irrigation	46	54	92	64
Rain-fed	54	44	80	59
Season mean	51	54	90	65
S.E. ± (Treatment)	4.05	4.5	4.92	1.84
S.E. ± (Season)		1.84		
S.E. ± (Season x Treatment)		3.19		

A highly significant difference was observed between water regime treatments (P = 0.01) when the data was subjected to combined analysis of the three seasons, fully-irrigated treatment significantly increased the number of pods per plant compared to single supplemental irrigation and rain-fed treatment (P = 0.01). The trend in number of pods per plant was similar to that in plant height regarding the effects of the three seasons, where in year 2001, the number of pods per plant was significantly more than in years 1999 and 2000 (P = 0.01), due to the fact that the rainfall in year 2001 was good. The overall number of pods per plant was 71, 64 and 59 pods per plant for fully-irrigated, single irrigation and rain-fed treatment respectively.

The data of biomass presented in Table 3, demonstrates that the biomass in fully-irrigated and single irrigation have increased significantly than in rain-fed treatment (P = 0.05), in year 1999 and 2001. Comparatively, the data of biomass in year 2000, regarding fully-irrigated and one supplemental irrigation showed a highly significant difference compared to rain-fed (P = 0.01). The biomass weight ranged from 229 464 gm^{-2} for period of the three seasons.

Table 3: Effects of three water regimes on guar biomass during year 1999 through 2002

Water regimes	Biomass (gm^{-2})			Treatment mean
	Season			
	1999-2000	2000-2001	2001-2002	
Fully-irrigated	463	396	564	474
Singlesupplemental irrigation	464	347	504	439
Rain-fed	354	229	413	332
Season mean	428	324	494	415
S.E. ± (Treatment)	36	28	37	16
S.E. ± (Season)		15.81		
S.E. ± (Season x Treatment)		27.38		

In all, fully-irrigated and single supplemental irrigation regimes produced more dry matter in above ground parts of the plant than rain-fed treatment. The combined data analyses of biomass showed a similar trend as that observed in the three seasons, where fully-irrigated and one supplemental irrigation treatments produced more photosynthetic matter than rain-fed treatment (P = 0.01). The magnitudes of reduction of biomass weight in the rain-fed treatment in comparison to fully-irrigated were: 24%, 42%, and 27% for the years 1999, 2000 and 2001 respectively.

A highly significant difference was noted between the seasons (P = 0.01). In year 2001 we had more dry matter produced by guar crop in the above ground parts than in 1999 and 2000. On the other hand, the biomass in 1999 was also more than in year 2000.

In Table 4, significant differences were not observed in years 1999 and 2000 between water regimes with respect to weight per seed (P = 0.05), while in year 2001, there were significant differences between the treatments (P = 0.05), in which the rain-fed treatment plants accumulated more dry matter in the seeds than fully-irrigated treatment (P = 0.05), and one supplemental irrigation was intermediate in its response. This suggest that the plants in rain-fed treatment translocate the available dry matter to the seed while the fully-irrigated partition the available dry matter between seed and other plant parts.

Overall, analyses of the three seasons exhibited no significant differences between the water regimes (P = 0.05). I n year 2000 the guar crop had heavier seed weight than in years 1999 and 2001. On the other hand weight was significantly heavier in year 2001 than in year 1999 (P = 0.05).

Table 4: Effects of three water regimes on guar crop weight per seed during 1999 through 2002 seasons

Water regimes	Weight per seed (mg)			Treatment mean
	season			
	1999-2000	2000-2001	2001-2002	
Fully-irrigated	35.53	38.65	36.58	36.92
Single supplemental irrigation	34.15	40.85	37.50	37.50
Rain-fed	32.05	40.20	38.73	36.99
Season mean	33.91	39.90	37.60	37.12
S.E. ± (treatment)	0.99	1.34	0.74	0.52
S.E. ± (season)		0.52		
S.E. ± (seasonxtreatment)		0.89		

The data of harvest index presented in Table 5 revealed that all the treatments studied indicated no significant differences between them. Similarly, when the data was combined and analyzed, no significant differences among the water regimes were noted, as well as between the three seasons effects (P = 0.05).

Table 5: Effects of three water regimes on harvest index of guar during 1999 through 2002 seasons

Water regimes	Harvest index (HI)			Treatment mean
	Season			
	1999-2000	2000-2001	2001-2002	
Fully-irrigated	0.15	0.16	0.27	0.19
Single supplemental irrigation	0.14	0.15	0.16	0.15
Rain-fed	0.14	0.16	0.12	0.14
Season mean	0.14	0.16	0.18	0.16
S.E. ± (treatment	0.01	0.02	0.06	0.02
S.E. ± (season)		0.02		
S.E ± (season x treatment		0.03		

The yield results of the first season in Table 6, indicated that the fully-irrigated and single supplemental irrigation treatments significantly increased the yield of guar compared to rain-fed treatment (P = 0.05).Yields of 653, 663 and 472 $kgha^{-1}$ were obtained from fully-irrigated, single supplemental irrigation and rain-fed treatments respectively. In the second and third seasons, the fully-irrigated consistently out-yielded the rain-fed treatment, but single irrigation treatment was intermediate in its effect on guar yield (P = 0.05). Yields obtained in order of fully-irrigated, one supplemental irrigation and rain-fed treatments were 640, 515 and 350 kgha^{-1} in year 2000, whereas in year 2001, the yields were 1112, 804 and 585 kgha^{-1} respectively.

Table 6: Effect of three water regimes on guar yield during 1999 through 2002 seasons

Water regime	Yield (kg ha^{-1})			Treatment mean
	Season			
	1999-2000	2000-2001	2001-2002	
Fully-irrigated	653	640	1112	802
Single supplemental irrigation	663	515	804	661
% change	(+2)	(-20)	(-28)	(-18)
Rain-fed	472	350	585	469
% change	(- 28)	(- 45)	(- 47)	(- 42)
Season	596	502	834	644
S.E. ± (treatment)	53.32	79.95	159.47	72.63
S.E ± (season)		72.63		
S.E ± (season x treatment)		125.8		

% Represent percentage increase or decrease from the fully-irrigated treatment.

Combined data of the three seasons indicated that fully-irrigated and single supplemental irrigation treatments significantly increased the grain yield of guar compared to rain-fed treatment (P = 0.01). In the third season we obtained high yields than in the second season, while the first season had an intermediate yields (P = 0.01).

Guar crop grown under various water regimes showed a reduction in yields of 28, 45 and 47 percent under rain-fed conditions compared to fully-irrigated in years; 1999, 2000 and 2001 respectively. The small yield reduction of 28% in the year 1999 for rain-fed treatment may be attributed to the fact that fully-irrigated and single supplemental irrigation had received only single irrigation during the season. The fully-irrigated and single irrigation treatment in1999 season presented a growing condition which was not different from the rain-fed treatment. Overall reduction of yield for the three seasons regarding single irrigation and rain-fed treatments were 18% and 42% respectively.

The insignificant differences among the treatments with respect to harvest index during the period of the three seasons suggest that the dry matter was almost equally translocated and/or remobilized to the seeds. Hence, the weight per seed generally showed insignificant difference between treatments, consequently it didn’t contribute to yield differences.

The main contributing parameter to grain yield differences in this study seemed to be number of pods per plant. This is in agreement with results found by Khidir and Osman (1970), in their study with sesame crop, indicating thatnumber of pods per plant is essential for improvement of yield in sesame. In contrast, biomass data which showed that more dry matter were accumulated in fully-irrigated and single irrigation can be considered as an indicator of high grain yield in comparison with rain-fed.

When we carried out regression analysis of biomass and grain yield of guar, we found a positive correlation between total biomass at maturity and grain yield of guar (r^2 = 0.9635). This is in agreement with results found in a different study (Black, 1982).

The prediction equation relating grain yield (Y) to total biomass at maturity (X), is Y = -276.78 + 2.218X. However, this predictionequation is applicable only within the range of the data used in regression analysis.

IV. Conclusion

(1) Although guar is considered as drought-tolerant crop, this study revealed that it responded well to supplemental irrigation with regard to most parameters studied.
(2) The data of this study indicated that the weight per seed and harvest index were less sensitive to water regimes.
(3) Throughout the study there were consistent significant differences between fully-irrigated and rain-fed treatments regarding the grain yield of guar. In which the rain-fed had lower yields than fully-irrigated. Reduction in yield ranged from 28% to 47%. However, single irrigation had variable effect on guar yield.
(4) It is evident from the data that the contributing factor for grain yield differences in this study seemed to be number of pods per plant.
(5) The results of biomass and yield appear to be in agreement with a study on wheat by Black (1982), where he indicated that total dry matter production, or straw production at maturity gave a very reliable means of

grain yield prediction. As such we can suggest that biomass or total dry matter production of guar at maturity can be used as an indicator of grain yield of guar.

(6) It is generally accepted that the marked between the 3-seasons results of all parameters excluding harvest index can be attributed partly to variation in the amount and distribution of rainfall.

(7) Depending on the environmental conditions of the season, we strongly recommend one to three supplemental irrigations for guar crop.

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References

[1]. Black, A.L. (1982). Long-term N.P fertilizer and climate influences on Morphology and yield components of spring wheat. Agron. J. 74: 651-656.

[2]. Farah, S.M. (1983). Effects of supplementary irrigation on rain-grown Sorghum (*Sorghum bicolor*) in Sudan J. Agr. Sci., Camb. 100: 323-327.

[3]. James, A.D. (1983). Handbook of legumes of world economic Importance 2nd. Edition, Plenum Press, New York and London

[4]. Khidir, M.O. and Osman, H.G (1970). Correlation studies of some Agronomic characters in sesame, Expl. Agric. 6: 27-31.

[5]. Little, T.A., and Hills, F.J. (1978). Agriculture experimentation designAnd analysis.

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