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Off-Season Production Potential of Two Sesame Cultivars Under Irrigation

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Abstract: *A one season (2001 – 2002) study was conducted at Kenaf Sudanese and Arab Company in Abu Naama. Two sesame varieties (Sesamum orientale L.); Promo and Khidir were used together with four irrigation intervals (5, 10, 15 and 20 days), in a factorial design completely randomized in four replications, to evaluate the influence of irrigation intervals on sesame crop.*

The data revealed that irrigation intervals had no influence on the plant height and weight per seed of the two sesame varieties, however, variety khidir tended to produce heavier seed than promo, but it didn't contribute to yield difference between the two cultivars.

Data of number of capsules per plant exhibited that irrigation intervals influenced the two varieties differentially. Variety promo had more capsules

Per plant than variety Khidir, and light frequent irrigation influence the sesame crop to produce more capsules than light and longer irrigation intervals.

Seed yield produced per unit of irrigation water applied (water use efficiency; 0.201, 0.294, 0.415 and 0.616 kg m^{-3}) increased as days between irrigation increased from 5 through 20 days. The water use efficiency of the two cultivars differed significantly ($p = 0.01$) when averaged across irrigation intervals, in which

Promo and Khidir had 0.52 and 0.243 kgm^{-3} respectively, which was indicative of their respective yields.

It is evident that variety Promo performed better than variety Khidir with yields of 545 and 349 kg ha^{-1}, respectively, as influenced by irrigation intervals. Also we found better performance of the two varieties under light and more frequent irrigation. Differences in yield of two sesame varieties were due to differences in number of capsules per plant.

Economic evaluation exhibited that light and more frequent irrigation of 5 days interval was profitable giving highest net benefits with high marginal return.

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I. Introduction

Sesame (*Sesamum orientale* L.) is an important oil crop in Sudan for local consumption and export (Khidir and Osman, 1970). Moreover, Sudan ranks third in world production after India and China.

Generally, in most areas of Sudan, sesame is grown under rain-fed conditions with rainfall of 400 – 800 mm. However, the rainfall in most of these areas, especially in central rain-land is characterized by uncertainty, intermittent and uneven distribution within the season, and it varied from one year to another and this is reflected in variable yields of sesame crop.

In reviewing the research work carried out on sesame under irrigation, Ageeb (1969) reported that Abu Naama with its unpredictable rainfall pattern may require a few supplementary irrigations to obtain a good yield of sesame crop. However, Farah in 1972 indicated that single and frequent irrigation gave almost similar yields of 1112 and 1029 kg ha^{-1}, respectively, but both were significantly different from rain-fed treatment which gave yield of 614 kg ha^{-1}. Later Osman (1980), reported that sesame crop can be grown successfully in winter, with its yield double or treble as compared with sesame yield grown under rain-fed conditions. Loggale (2000) in a study of sesame found a highly significant difference between fully-irrigated and rain-fed treatment with yields of 643 447 kg ha^{-1}, respectively.

All these results indicated a necessity to grow sesame crop under irrigation or supplemental irrigation. Nevertheless, there is little published data on winter-grown sesame. Hence, the objectives of this study were to determine:

1. Potential production of sesame crop in winter.
2. The appropriate irrigation interval which gives reasonablyhigh yield.
3. If it is economical to grow sesame in winter under irrigation.
4. If two sesame varieties responded differently to frequency of irrigation.

II. Materials And Methods

The study was carried out in season 2001 – 2002 at Kenaf Sudanese and Arab Company in Abu Naama. The experimental design was a randomized complete block design with a factorial arrangements of two sesame cultivars (Khidir and Promo), and four frequency of irrigation (5, 10, 15, and 20 days), replicated four times.

The schedules of irrigation for irrigation intervals, in days after planting (DAP) and number of irrigations for the two cultivars are shown in Table 1 We used a cylindrical tube with a diameter of 0.1016 m (4 inches) for providing irrigation water to the plots. The discharge of the tube is 6.6 m^{-3} of irrigation water per hour. Time to irrigate each plot (3.2 x 6 m) was five minutes, thus each plot received equal amount of water per irrigation, amounting to 0.55 m^{-3} of water which was considered as light irrigation. The cost of one cubic meter of irrigation water in Kenaf Project was 2.2 Sudanese Dinars.

Table1: Number of days between irrigation, number of irrigation and schedule of irrigation of two sesame varieties

Treatment		Number Of irrigation	Schedule of irrigation in days after planting (DAP)
Variety	Days between irrigation		
Khidir	5	10	40, 46, 52, 58, 64, 70, 76, 82,88, 94
	10	6	45, 56, 67, 78, 89, 100
	15	4	50, 66, 82, 98
	20	3	55, 74, 95
Promo	5	9	40, 46, 52, 58, 64, 70, 76, 82, 88
	10	5	45, 56, 67, 78, 89
	15	3	50, 66, 82
	20	2	55, 74

Planting of the experiment was carried out on 18th December 2001, in four rows for each plot, and the rows were 0.75 m apart. During seedling or vegetative growth stage of sesame, we experienced cold weather which slowed down the development growth a little bit. Weeding was carried out whenever necessary. When variety Promo was harvested on March 21st, 2001, variety Khidir was green; therefore its harvest was delayed until 9th of April, giving a twenty days difference from Promo with regard to days to maturity.

In the study the following parameters were measured: seed yield ($kgha^{-1}$), number of pods per plant, weight per seed (mg) and plant height (cm). The data were analyzed using analyses of variance, and statistical comparisons of means were made with least significance difference (Little and Hills, 1978). Also the data were subjected to economic evaluation.

III. Results And Discussions

The results of plant height and weight per seed, presented in Table 2 and Table 3, respectively, indicated that neither frequency of irrigation nor the two varieties; Khidir and Promo showed a significant difference between either of the two at P= 0.05. The plant height of Khidir cultivar ranged from 78 to 84 cm, while plant height of Promo cultivar ranged from 73 to 77 cm for the four frequency of irrigation. On the other hand, weight per seed for Khidir ranged from 3.83 to 4.23 mg. And variety Promo weight per seed ranged from 3.29 to 3.87 mg for the four frequency of irrigation.

It is evident from this results that the plant height and weight per seed of the two cultivars were less responsive to frequency of irrigation. Nevertheless, cultivar Khidir tended to have heavier seeds than Promo.

Table2: Effect of four irrigation intervals on plant height (cm) of two sesame varieties

Treatment		Plant height (cm)
Variety	Days between irrigation	
Khidir	5	80
	10	83
	15	78
	20	84
Promo	5	77
	10	77
	15	75
	20	73
S.E ±		4.2

Table3: Effect of four irrigation intervals on weight per seed (mg) of two sesame varieties

Treatment		
Variety	Days between irrigation	Weight per seed (mg)
Khidir	5	4.07
	10	4.13
	15	4.23
	20	3.83
Promo	5	3.81
	10	3.50
	15	3.87
	20	3.29
S.E ±		0.298

Cultivars responses across the irrigation intervals were highly significantly different (P = 0.01), with regard to number of pods per plant, in which variety Promo had more pods per plant than variety Khidir (Table 4). Similarly, the irrigation intervals over the two cultivars showed a highly significant difference between them, where shorter intervals tended to influence the plant to produce more pods per plant. Number of pods per plant for irrigation intervals ranged from 96 to 71.

Also the data of number of pods per plant exhibited a highly significant interaction of cultivar x irrigation interval (P = 0.01), indicating a differential response of the two sesame varieties to frequency of irrigation.

Table4: Effect of four irrigation intervals on number of pods per plant of two sesame varieties

variety	Days between irrigation				Variety mean
	5	10	15	20	
	Number of pods per plant				
Promo	120	92	73	77	90
Khidir	71	73	68	67	69
Mean	96	82	71	72	80
S.E ±	Variety = 5.06; irrigation interval = 7.15 Variety x irrigation interval = 10.11				

The data of water use efficiency of the two varieties presented in Table 5, indicated that as the days between irrigation increased it tends to increase water use efficiency of the two cultivars significantly at (P = 0.01), as well as over the two cultivars. It was apparent that, the differences in water use efficiency between the two cultivars across irrigation intervals were highly significant (P = 00.01), in which cultivarPromo had 0.52 kg m^{-3} and Khidir had 0.24 kg m^{-3} water use efficiency. The irrigation intervals effect over the two cultivars presented water use efficiency ranging from 0.201 kg m^{-3} to 0.616 kg m^{-3}.

Table5: Effect of four irrigation intervals on water use efficiency (kgm^{-3}) of two sesame varieties

Variety	Days between irrigation				Variety mean
	5	10	15	20	
	Water use efficiency (kg m^{-3})				
Promo	0.242	0.392	0.585	0.862	0.52
Khidir	0.160	0.197	0.277	0.328	0.24
Mean	0.201	0.294	0.431	0.595	0.38
S.E ±	Variety = 0.027, irrigation interval = 0.039 Variety x irrigation interval = 0.055				

Statistical analysis of seed yield data showed no variety x irrigation interval interaction (P = 0.05), as shown in Table 6. Seed yield for each irrigation interval treatment was averaged across cultivars, and it indicated a significant difference effect among the irrigation intervals (P = 0.05). However, when the seed yield for each cultivar was averaged across irrigation interval, it exhibited a highly significant difference between the two cultivars (P = 0.01), with cultivar Promo out-yielding variety Khidir, and the yield was 545 and 349 kg ha^{-1}, respectively. Also, we found better performance of the two cultivars together under more frequent irrigation, and the yield ranged from 623 to 457 kg ha^{-1}.

Table6: Effect of four irrigation intervals on yield (kg ha^{-1}) of two sesame varieties

Variety	Days between irrigation				Variety mean
	5	10	15	20	
	Yield (kg ha^{-1})				
Promo	623	561	503	494	545

Khidir	457	339	318	282	349
Mean	540	450	411	388	
S.E ±	Variety = 39.4; irrigation interval = 55.7 Variety x irrigation interval = 78.8				

In the present study, we found increased water use efficiency of longer irrigation interval was associated with a decrease in seed yield, thus longer irrigation interval affected economic yield of sesame crop negatively. However, the higher seed yield of sesame crop in this study was related to higher number of pods per plant and this confirmed the fact that, number of pods per plant is an important parameter to be considered if one wants to improve sesame yield (Khidir and Osman, 1970).

Economic evaluation: Partial budget for sesame variety Khidir was shown in Table 7 Dominance analysis indicated that the most promising treatments were 20, 10 and 5 days intervals. Treatment 5 days interval gave the highest net benefits with high return on investment as indicated by the high MRR (691%) (Table8). This means that for every SD1 invested intreatment 5 days interval, the farmer can expect to get back that SD1 plus an additional SD 6.91.

Table 7: Partial budget for sesame variety Khidir

Irrigation interval (days)	Yield (kg ha^{-1})	Gross benefit (SD ha^{-1})	Costs that vary (SD ha^{-1})	Net benefits (SD ha^{-1})
5	457	77233	6302	70931
10	339	57291	3781	53510
15	282	47658	2521	45137
20	318	53742	1891	51851

Table 8: Marginal analysis of undominated treatments, sesame variety Khidir

Irrigation interval (days)	Cost that vary (SD ha^{-1})	Marginal costs (SD ha^{-1})	Net benefits (SD ha^{-1})	Marginal net benefits (SD ha^{-1})	Marginal rate of Return (%)
20	1260	-	46398	-	-
15	1891	631	51851	5453	864.183
10	3151	1260	54140	2289	181.66
5	5672	2521	71561	17421	691.035

Table 9 showed partial budget for sesame variety Promo. Marginal analysis (Table 10), indicated adequately high MRR for treatments; 15, 10 and 5 days intervals. It is evident that treatment 5 days intervals gave the highest net benefits with high MRR (316%).

Table 9: Partial budget for sesame variety Promo

Irrigation interval (Days)	Cost that vary (SD ha^{-1})	Marginal costs (SD ha^{-1})	Net Benefits (SD ha^{-1})	Marginal net benefits (SD ha^{-1})
5	623	105287	5672	99615
10	561	94809	3151	91658
15	503	85007	1891	83116
20	495	83486	1260	82226

Table10: Marginal analysis of undominated treatments of sesame variety Promo

Treatment	Costs that vary (SD ha^{-1})	Marginal costs (SD ha^{-1})	Net benefits (SD ha^{-1})	Marginal net benefits (SD ha^{-1})	Marginal rate of return (%)
20	1260	-	82226	-	-
15	1891	631	83116	890	141.046
10	3151	1260	91658	8542	677.937
5	5672	2521	99615	7957	315.629

IV. Conclusion

The plant height and weight per seed for both cultivars were not affected by the irrigation interval treatments used in this study. Nevertheless, variety Khidir had the tendency to have heavier weight per seed than Promo, and both cultivars tended to produce heavier seed weight in 15 days irrigation interval but this is not reflected in the seed yield.

Average number of capsules per plant across the irrigation interval for each variety indicated a highly significant difference between the two varieties, in which variety Promo had more capsules per plant than Khidir, A decrease in number of capsules per plant was associated with longer irrigation intervals, furthermore,

the data of number of capsules per planted indicated a differential response of the two varieties to irrigation interval, as a result of a significant interaction effect of cultivar x irrigation interval.

In the present study, we found an increase in water use efficiency of longer irrigation interval was associated with a decrease in seed yield, thus longer irrigation interval had a negative effect on economic yield of sesame crop. On the other hand, average water use efficiency across irrigation interval for variety indicated a highly significant difference among the two varieties, where variety Promo had high water use efficiency than Khidir and this is reflected in the economic yield of the two varieties.

The two cultivars yield response to combined irrigation interval effect was highly significant, with variety Promo yielding 545 kg ha^{-1} and variety Khidir 349 kg ha^{-1}. It is clear from this work that high yield of sesame crop was due to light and more frequent irrigation. On the other hand, differences in yield between the two varieties were attributed to differences in number of capsules per plant.

The economic evaluation showed that, for both varieties, frequent irrigation of 5 days interval is superior over other treatments giving the highest net benefits with adequately high return on investment.

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