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Effect of irrigation and nitrogen on growth yield, oil content, nitrogen uptake and water-use of summer sesame (*Sesamum indicum*)

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ABSTRACT

In a 2-year study at Pusa, maximum average yield (2.81 q/ha) of summer sesame (*Sesamum indicum* L.) was recorded with 3 irrigations each of 6 cm at IW : CPE of 0.7. Further reduction in frequency of irrigation to 1 or 2 based on IW : CPE or days after sowing resulted in a significant reduction in seed yield. The yield was minimum (1.78 q/ha) under the rainfed control. Among levels of nitrogen, significant increase in yield was recorded up to 90 kg N/ha (2.61 q/ha). A significant increase in leaf-area index (LAI), number of capsules/plant and 1,000-grain weight was recorded up to 2 irrigation. For LAI response to nitrogen was noticed up to 90 kg N/ha, whereas for number of capsules/plant and 1,000-seed weight increased only up to 30 kg N/ha. Maximum oil (%) was recorded with 2 irrigations and at 30 kg N/ha. Higher N levels depressed oil (%) in sesame. Nitrogen uptake by plants increased significantly up to 3 irrigations and 90 kg N/ha. A major part of soil-moisture depletion was recorded from 0–60 cm profile layer. In deeper layer (60–90 cm) depletion was more in drier regimes than in wet ones.

Sesame (*Sesamum indicum* L.) is traditionally grown as rainy-season (*kharif*) crop in eastern India. Of late the crop is being introduced in summer and has better yield potential due to low incidence of diseases and insect pests as well as better water management. Since the crop has been introduced in summer, its agronomic parameters are required to be standardized for realizing its yield potential, especially from marginal lands where major area remains fallow during the summer period. Among agronomic inputs, irrigation and nitrogen are the most important for boosting the yield and quality of summer sesame. However, the limited work done on this aspect does not provide a comprehensive information on its irrigation requirement and economic feasibility. Therefore the present experiment was planned to evaluate the performance of summer sesame to irrigation and nitrogen in calcareous soil of North Bihar.

MATERIALS AND METHODS

The field experiment was conducted during summer (February–June) season of 1990 and 1991 at Farm of Rajendra Agricultural University, Pusa, Bihar. The soil of the experimental plot was sandy loam (Entisol) with pH 8.5 and free $CaCO_3$ 25.4%. It had 0.43% organic carbon, 11.9 kg P_2O_5/ha and 109 kg K_2O/ha before sowing. The field capacity and permanent wilting point were 21.5% and 8.2% respectively in 0–30 cm soil layer, and the bulk density in the same layer was 1.45 g/cc. The seed was sown on

Table 1. Effect of irrigation and nitrogen on growth and ancillary characters of summer sesame

Treatment	Plant height (cm)		Branches/ plant		Leaf-area index		Capsules/ plant		1,000-seed weight (g)	
	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991
Irrigation										
0.3 IW : CPE	66.0	69.7	3.11	3.20	1.95	2.06	28	29	2.63	2.62
0.5 IW : CPE	69.4	72.1	3.56	3.67	2.13	2.19	34	36	2.68	2.69
0.7 IW : CPE	76.0	80.2	4.58	4.78	2.32	2.41	41	45	3.04	3.05
2 irrigations (30 + 60 DAS)	73.9	76.0	3.66	3.70	2.31	2.38	36	39	2.87	2.86
CD (P = 0.05)	3.06	2.74	0.705	0.903	0.129	0.108	7.0	8.0	0.16	0.20
Nitrogen (kg/ha)										
0	60.8	62.4	2.77	2.95	1.82	1.92	24.0	25.0	2.59	2.57
30	68.1	70.2	3.40	3.56	2.06	2.13	32.0	34.0	2.72	2.74
60	72.4	75.0	3.88	3.98	2.21	2.32	35.0	38.0	2.82	2.84
90	74.9	80.2	4.05	4.18	2.35	2.42	38.0	41.0	2.86	2.86
CD (P = 0.05)	2.73	2.45	0.630	0.060	0.115	0.080	6.3	7.5	0.15	0.16

21 February 1990 land 4 March 1991 and harvested on 5 June 1990 and 15 June 1991 respectively. The trials were conducted in randomized block design with 3 replications. The irrigation levels consisted of 5 moisture regimes (0.3, 0.5 and 0.7 IW : CPE, 2 irrigations at 30 and 60 days and the rainfed control) and 4 nitrogen levels (0, 30, 60 and 90 kg/ha). Full nitrogen as per treatment and a common dose of 40 kg each of P_2O_5 and K_2O/ha were applied at sowing. A common depth of 6 cm water was applied in each irrigation. The irrigation water was measured by Parshall flume having a throat width 7.5 cm. The water-table depth was always below 4 m and therefore perhaps did not contribute to water supply for the root zone.

Leaf-area index (LAI) was calculated at 60 days after sowings when the pods were completely formed and leaf formation was almost negligible. Oil content of seeds was estimated by pulsed NMR technique. Total nitrogen uptake was calculated by multiplying the N content (%) with dry-matter yield where total nitrogen content in plant was measured by photo-colorimeter as suggested by Arthur and Herbert (1977). Water-use efficiency was calculated by dividing the seed yield recorded in a particular treatment to that of its total water applied.

RESULTS AND DISCUSSION

Growth and yield attributes

Growth parameters like plant height, number of branches and leaf-area index increased up to an IW : CPE ratio of 0.7 with 3 irrigations compared with 1 or 2 irrigations scheduled at IW : CPE ratios of 0.3 and 0.5 respectively or 2 irrigations at 30 and 60 days after sowing (Table 1). Mini-

Table 2. Effect of irrigation and nitrogen on the seed yield, oil content, total N uptake, water requirement and water-use efficiency of sesame

Treatment	Seed yield (kg/ha)		Oil (%)		Total N uptake (kg/ha)		Irrigation water applied inclusive of rainfall (cm)		Water-use efficiency (kg/ha-cm)	
	1990	1991	1990	1991						
					1990	1991	1990	1991	1990	1991
Irrigation										
0.3 IW : CPE	144	243	45.9	44.9	23.5	28.6	8.07	19.12	17.8	12.7
0.5 IW : CPE	166	260	46.0	45.8	26.2	32.8	14.07	25.12	11.8	10.4
0.7 IW : CPE	247	316	45.5	45.1	34.9	39.6	20.07	31.12	12.3	10.1
2 irrigations (30 + 60 DAS)	195	266	46.0	45.9	30.0	33.4	14.07	25.12	13.9	10.6
CD (P = 0.05)	18.6	16.0	0.138	0.120	2.26	1.77				
Nitrogen (kg/ha)										
0	128	197	45.5	45.0	20.4	25.0				
30	166	254	47.0	46.4	26.0	29.8				
60	194	292	45.9	45.5	29.8	35.2				
90	216	307	45.1	44.9	32.7	38.2				
CD (P = 0.05)	16.0	15.0	0.123	0.103	2.03	1.51				

mum yield was recorded under rainfed condition. Significant increase in these characters was recorded up to 90 kg N/ha except number of branches which responded only up to 60 kg N/ha. The capsules/plant were similar at IW : CPE ratios of 0.5 and 0.7 as well as 2 irrigations; however there was a significant reduction at an IW : CPE ratio of 0.3 and the rainfed control. Response to nitrogen was only up to 30 kg/ha. Similar trend was recorded for 1,000-grain weight.

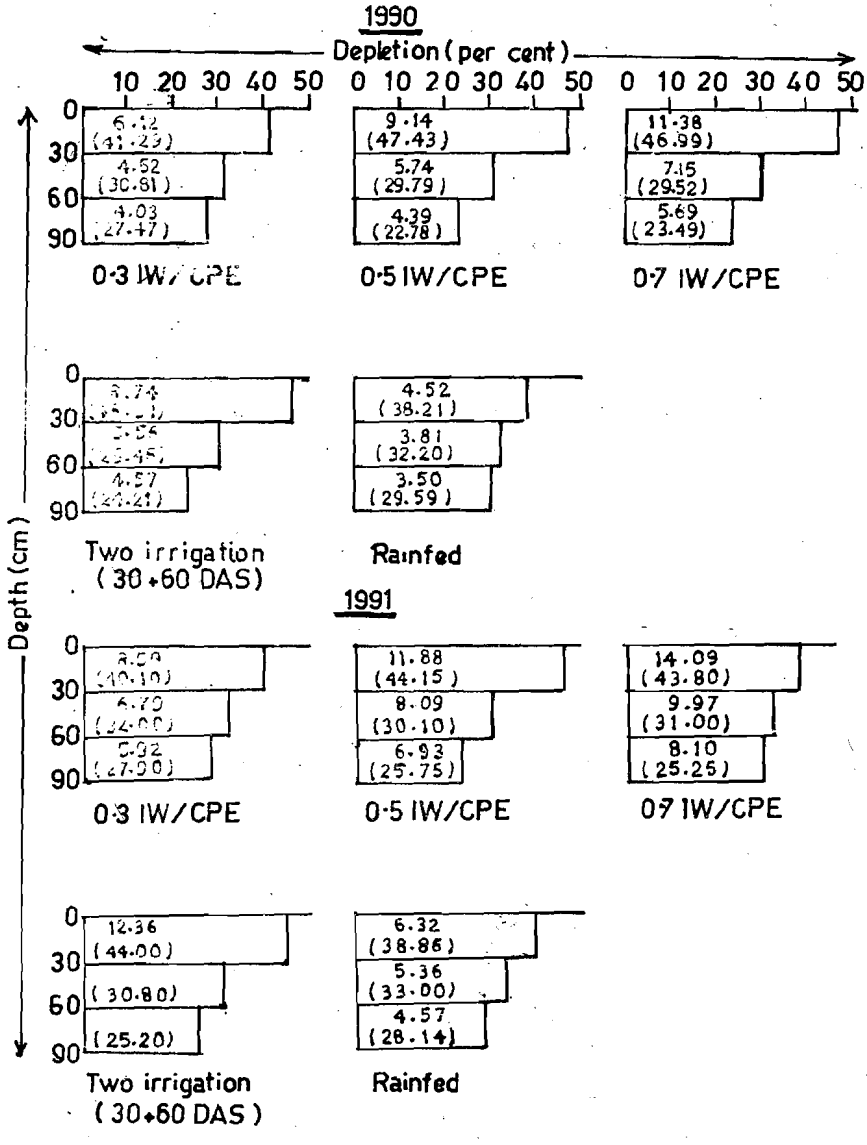

Fig. 1. Effect of irrigation level on soil-moisture depletion from different soil layers (figures in parentheses indicate % value)

Seed yield and oil (%)

Maximum yield was recorded at an IW : CPE ratio of 0.7, followed by 2 irrigations at 30 and 60 days after sowing. Minimum yield was recorded under the rainfed control. Such response up to 2 irrigations was also reported by Ghosh and Biswas (1984) and Rai *et al.* (1984). Higher yield under 3 irrigations was due to proper moisture in the root zone which helped in translocation of nutrient as well as proper functioning of bio-chemical reactions. Maximum yield was recorded at 90 kg N/ha, which was significantly higher than the rest of the doses. But oil content was maximum at 2 irrigations, beyond or below which there was fall in oil content. Metwally *et al.* (1986) also reported that due to high moisture resulting in more vegetative growth caused reduction in oil (%). Response to nitrogen was recorded only up to 30 kg N/ha, above which there was decrease in oil (%) Total nitrogen uptake was found to be maximum at IW : CPE ratio of 0.7 and 90 kg N/ha.

Water-use efficiency

Water-use efficiency was higher under moisture stress and attained the maximum value of 62.4 kg/ha-cm in 1990 and 17.3 kg/ha-cm in 1991 in the rainfed control. Since the difference in yield due to levels of irrigation was relatively less than evapotranspiration, a trend of decreasing water-use efficiency was recorded with increasing levels of irrigation except 2 irrigations at 0.5 IW : CPE which recorded minimum water-use efficiency of 11.8 kg/ha-cm in 1990 (Table 2).

Soil-moisture depletion

Soil-moisture depletion was maximum under 0–30 cm soil depth, followed by 30–60 cm layer (Fig. 1). The minimum depletion was recorded under 60–90 cm depth. However, under rainfed and 1 irrigation the relative depletion than 2 irrigations was maximum under 60–90 cm layer probably due to larger root-system which developed in search of water in deeper layer, whereas under higher moisture the density of root was higher in upper layer.

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