

Response of rainy-season sunflower (*Helianthus annuus*) to irrigation and nitrogen under north-western Rajasthan

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ABSTRACT

A field experiment was conducted during the rainy (*khari*) season of 1990, 1991 and 1992 to study the response of sunflower (*Helianthus annuus* L.) to 6 levels of irrigation and 3 levels of nitrogen. Four post-sowing irrigations to sunflower based on irrigation water : cumulative pan evaporation (IW : CPE) ratio 0.8 or based on physiological stages at 25 days after sowing (DAS) + initiation of flower buds + mid-flowering + seed-setting stage recorded higher values of yield attributes, seed yield and oil content. Various yield attributes, viz. plant height, disc diameter and test weight and consumptive use of water and water-use efficiency (WUE) increased linearly up to 80 kg N/ha. However, oil content in seed reduced as the N dose increased from 40 to 80 kg N/ha. Maximum consumptive use of 401 mm water and WUE of 2.83 kg/ha/mm were recorded when 4 irrigations were applied on the basis of IW : CPE ratio 0.8.

Among oilseed crops, cultivation of rainy-season (*khari*) sunflower (*Helianthus annuus* L.) has been recently attracting the attention of farmers, as it is more remunerative crop and can fit well in summer green-gram–rainy-season sunflower–wheat rotation. However, meagre information is available on agronomic aspects in general on requirements of irrigation and nitrogen in particular about this crop under different sets of agro-climate conditions. Water and fertilizer are scarce and costly commodities and their judicious application is essential to achieve higher benefits, especially under limited resource conditions. The present experiment was, therefore, carried out to study the effect of irrigation and nitrogen on seed yield and consumptive use of water by rainy-season sunflower under agro-climatic conditions of north-west Rajasthan.

MATERIALS AND METHODS

The field experiment was carried out

with 'MSFH 8' sunflower during 3 consecutive rainy season of 1990, 1991 and 1992 in split-plot design having 3 replications. The treatment combinations comprised 6 levels of irrigations in main plots and 3 levels of nitrogen in subplots (Table 1). The soil of experimental field was sandy loam in texture having pH 8.2, organic carbon 0.2%, and available phosphorus and potassium 33 kg/ha and 330 kg/ha respectively. The field capacity, permanent wilting point and bulk density (0–120 cm) were 16.5%, 4.5% and 1.5 gm/cm³ respectively.

The crop was sown on 16 and 31 July and 21 August during 1990, 1991 and 1992 respectively. The spacing was 50 cm between rows and 30 cm between plants and seed rate was 15 kg/ha. Initial application of 40 kg P₂O₅/ha through single superphosphate and nitrogen as per treatment through urea were applied below the seed by drilling at the time of sowing. A pre-sowing irrigation of 10 cm was given and post-sowing irriga-

tions each of 7 cm depth were applied as per treatments. The quantity of water to be given was measured with the help of 15 cm throat Parshall flume fixed in the irrigation channel. The total rainfall during the 3 crop seasons was 19.28, 9.14 and 16.33 cm during first, second and third years respectively. The rainfall distribution during 1990 was not uniform but 6.4 cm rainfall was received on 19 September 1991, which resulted skipping of 1 irrigation at mid-flowering stage and both irrigation water : cumulative pan evaporation (IW : CPE) ratios. Similarly, during 1992, 9.76 cm rainfall was recorded on 4 September and another 5.9 cm rainfall was received up to 18 September which resulted in skipping 1 irrigation at 25 days after sowing (DAS) as well as both IW : CPE ratios. There was no moisture contribution from ground water-table.

The crop was harvested on 14 October,

11 and 26 November during 1990, 1991 and 1992 respectively. Seed yield was recorded and seed was analysed for oil content. Consumptive use of water was calculated by gravimetric soil-moisture determination method in successive soil layers of 0–30, 30–60, 60–90 and 90–120 cm depths at planting before and after each irrigation and finally at harvest (Dastane, 1972).

RESULTS AND DISCUSSION

Seed yield and yield attributes

Increasing levels of irrigation and nitrogen significantly increased the seed yield and yield attributes during all 3 years (Table 1). Seed yields recorded under the I_4 (4 irrigations applied at 25 days + initiation of flower buds + mid-flowering + seed-setting stages) and IW : CPE ratio of 0.8 (4 irrigations) were at par and significantly superior to all other irrigation treatments during

Table 2. Effect of different levels of irrigation and nitrogen on consumptive use of water and water-use efficiency in rainy-season sunflower

Treatment	Consumptive use (mm)				Water-use efficiency (kg/ha/mm)*	Et : EO*
	1990	1991	1992	Mean		
<i>Irrigation level</i>						
I ₁	290	280	309	293	1.79	0.56
I ₂	348	357	371	359	2.04	0.68
I ₃	381	367	382	377	2.44	0.71
I ₄	396	394	400	397	2.83	0.75
I ₅	359	399	383	380	2.38	0.72
I ₆	384	416	402	401	2.83	0.78
<i>N (kg N/ha)</i>						
N ₁	352	361	365	359	2.16	0.67
N ₂	361	382	376	373	2.48	0.69
N ₃	367	395	382	381	2.54	0.73

*Pooled data of 3 years

Details of treatments are given in Table 1

1990, 1991 and 1992 although there was an exception that irrigation treatment I_5 (IW:CPE ratio of 0.6) was found statistically at par with I_6 (0.8 ratio) during 1991. Vivek and Chakor (1992) also reported similar trend of results in sunflower. In mean data, the seed yield of 11.37 q/ha obtained under I_6 was significantly higher by 6.13, 4.07, 2.15 and 2.28 q/ha than seed yield obtained under I_1 (control), I_2 (2 irrigations) I_3 (3 irrigations) and I_5 (3 irrigations) respectively. The corresponding increase was 117, 54, 23 and 25%.

Seed yield of rainy-season sunflower increased significantly with each successive increase in N during all the 3 years. In mean data, 60 and 80 kg N/ha produced respectively 1.5 and 1.95 q/ha higher seed yield than 40 kg N/ha. The corresponding increase was 16 and 20%. The mean oil content in seed, however, decreased significantly with the increase in N level beyond 60 kg N/ha. Plant height, disc size and test weight increased linearly and significantly with increase in levels of irrigation and N. The increase in seed yield might be ascribed to the combined effect of disc size and test weight of seed obtained with each increment in irrigation and N levels. Bindra and Kharwara (1992) and Sarmah *et al.* (1992) also reported similar results of yield variation at different fertility levels.

Consumptive use and water-use efficiency

Consumptive use of water and water-use efficiency (WUE) increased with increasing levels of irrigation during all the 3 years and similar trend was also observed in pooled mean (Table 2). Maximum mean consump-

tive use of water (401 mm/397 mm), WUE (2.83 kg/ha/mm) and ET : EO (0.78/0.75) were recorded with 4 irrigations applied at I_6 or I_4 treatment. Since 4 irrigations applied at IW : CPE ratio of 0.8 or at growth stages of 25 days after sowing + initiation of flower buds + mid-flowering + seed-setting are the most sensitive stages for irrigations, these might have helped in increasing yield attributes like disc diameter and test weight and in getting higher seed yield, resulting in higher WUE.

Consumptive use of water did not differ much due to N application, but WUE showed a good increase with increasing levels of N.

It was concluded that 4 post-sowing irrigations applied at IW : CPE ratio 0.8 or at growth stages of 25 DAS + initiation of flower buds + mid-flowering + seed-setting is the most suitable irrigation schedule for the rainy-season sunflower to obtain the maximum seed yield.

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