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Effect of moisture stress and management practices on productivity of rainfed sunflower (*Helianthus annuus*)

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ABSTRACT

An experiment conducted during 1992--94 showed that moisture stress of more than 12 days at grain-filling and flowering stage was more sensitive and influenced the seed yield of sunflower (*Helianthus annuus* L.). Sunflower with stress-free environment gave 54 and 51% additional seed yield and monetary gains than rainfed environment. Supplemental irrigation of 5 cm at flowering stage followed by grain-filling stage and addition of N after it and soil mulch through additional interculture during soil-moisture stress at vegetative phase stabilized the yield and income from rainfed sunflower.

Key words : *Moisture stress, Productivity, Rainfed sunflower.*

Sunflower an important oilseed cash crop is grown extensively in rainfed alfisols for higher yield and income. It is also grown as an alternative crop in the traditional castor-grown areas under delayed sowing conditions. But the productivity of rainfed sunflower often fluctuates widely because of vagaries of monsoon and also intermittant dry spells both in terms of intensity and period (Hegde and Havanagi, 1989). The moisture stress effects on productivity of rainfed sunflower can be minimized by suitable management practices such as altering plant densities, planting dates, seed soaking, seed hardening, chemical sprays and reflectants (Kamali and Miller, 1982; and Pathak and Dixit, 1986). In this direction, an experiment involving various management practices at different growth stages and moisture stress periods was conducted to get stabilized yield and income in sunflower under rainfed environment.

MATERIALS AND METHODS

The experiment was conducted at the Central Research Institute for Dryland Agriculture (CRIDA) farm, Hyderabad, during rainy (*kharif*) seasons of 1992—94. The experimental site was sandy loam in texture, neutral in pH (6.8), low in available nitrogen (225 kg/ha) and phosphorus (10 kg P_2O_5/ha), and medium to high in available potassium (300 kg K_2O/ha). The sunflower cultivar ('MSFH 8') with 0.75 lakh/ha of

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population with a row spacing of 60 cm was sown in July and fertilized with 10 kg N and 30 kg P_2O_5/ha at the time of sowing and 40 kg N/ha top dressing in the form of urea at 30 days after sowing (DAS). The management practices, viz. soil mulch through additional interculture, additional N (10 kg/ha) after relief of stress and 5 cm of supplemental irrigations were imposed at varied moisture stress periods i.e. early (0–30 DAS), mid (30–60 DAS) and terminal (60–90 DAS) along with controls (stress free and stressed environments) throughout growth periods. The management practices were imposed whenever soil moisture deficit reached 50% in different years. The treatments were replicated three-times in randomized block design.

RESULTS AND DISCUSSION

Yield and economic returns

The sunflower crop received the rainfall of 346, 399 and 380 mm during its growth periods in 1992, 1993 and 1994 respectively. In 1992, the crop experienced dry spells of 15 days each at the time of flowering (mid moisture stress) and grain filling (terminal moisture stress periods) stages. Also, the crop suffered from moisture stress of 12, 11 and 13 days of dry spell in vegetative, flowering and grain filling stages in 1993. During 1994, the sunflower crop underwent moisture stress for more than 12 days at all the critical growth stages. The sunflower with stress free environment recorded higher seed and monetary gains by 59 and 51% respectively, than rainfed environment over the years (1,181 kg/ha and Rs 10,629/ha). The supplemental irrigation of 5 cm during vegetative phase (0–30 DAS) recorded additional seed yield of 347 and 289 kg/ha, while at the time of flowering (mid-stress period) registered additional seed yields of 410, 364 and 370 kg/ha in 1992, 1993 and 1994, respectively, and at terminal moisture stress gave increased seed yields of 503 kg/ha and also gross returns of Rs 4,739/ha over rainfed sunflower in 1992 and 1993, respectively. Similar kind of response for stalk yields was observed with supplemental irrigations. On an average, stress-free sunflower followed by the supplemental irrigation of 5 cm given at grain filling and flowering recorded highest gross returns/ha. Among the management practices, soil mulch through additional interculture in dry spells of early and mid growth stages gave higher seed yields by 10 to 14% and consequently increased monetary gains by 25 and 14%, respectively, than that of the no additional interculture. Additional nitrogen after relief of early and mid moisture stress periods (vegetative and flowering phases) recorded higher seed yields of 273 to 277 kg/ha and gross returns of Rs 2,457 to 2,496/ha compared to rainfed sunflower (Table 1).

Growth components

The dry-matter accumulation, leaf area index, nutrient uptake and rainfall use efficiencies in seed and stalk yield at varied stress periods were significantly reduced than that of stress free sunflower during all the years (Table 2). Similar response with regard to higher growth and yield components was observed.

The rainfed sunflower during early, mid and terminal moisture stress periods recorded reduced dry-matter by 40, 34 and 39% and also leaf area index (LAI) by 37, 45 and 51% respectively, than that of the stress free sunflower. The management practices, viz. soil mulch through additional interculture, additional nitrogen after relief of stress and supplemental irrigation at

Table 1. Influence of management practices on yields and monetary gains in sunflower

Management practice	Seed yield (kg/ha)				Stick yield (kg/ha)				Gross returns (Rs/ha)			
	1992	1993	1994	Mean	1992	1993	1994	Mean	1992	1993	1994	Mean
Rainfed crop	1,092	1,438	1,012	1,181	1,238	1,798	1,750	1,595	9,828	12,942	9,108	10,629
Interculture* in early stress		1,562	1,124	1,344		1,928	1,833	1,881		14,058	10,125	12,092
Fertilizer* in early stress		1,705	1,203	1,454		2,080	1,906	1,993		15,345	10,827	13,086
Irrigation** of 5 cm in early stress		1,785	1,301	1,542		2,448	2,082	2,265		16,065	11,709	13,887
Interculture* in mid-stress	1,242	1,540	1,160	1,314	1,303	2,001		1,652	11,178	13,860	10,440	11,826
Fertilizer* in mid-stress	1,385	1,740	1,250	1,458	1,350	2,096	1,946	1,793	12,465	15,560	11,250	13,125
Irrigation** of 5 cm in mid-stress	1,502	1,802	1,359	1,554	1,439	2,180	2,260	1,960	13,518	16,218	12,231	13,989
Irrigation** of 5 cm in terminal stress	1,565	1,850		1,708	1,460	2,190		1,825	14,085	16,650		15,368
Stress-free	1,805	1,962	1,610	1,884	1,690	2,284	2,411	2,289	16,245	17,658	14,490	16,160
CD (P = 0.05)	66	82	46		89	102	79					

*Additional; ** supplemental

early stress period recorded higher increment of dry matter by 24, 35 and 61% and leaf area index by 16, 25 and 50% than that of rainfed sunflower. At 60 DAS, the management practices of supplemental irrigation of 5 cm, additional nitrogen and additional interculture imposed at the time of flowering (mid-moisture stress period) recorded additional benefit of 44, 35 and 11% over stressed sunflower respectively. Thus management practices imposed in early and mid stress periods showed higher magnitude of influence in getting higher growth and yield components in the order of supplemental irrigation followed by additional N after relief of stress. Moisture stress at the time of grain filling (terminal stress) resulted in more unfilled seeds with less test weight and low seed yields (Daulay and Singh, 1983).

Nitrogen uptake

Sunflower under stress free environment showed higher N uptake by 47% than stressed environment over the years. The management practices imposed during early stress period in 1994 recorded additional N uptake by 20, 32 and 41% respectively, than rainfed sunflower while additional interculture, fertilizer N and supplemental irrigations of 5 cm during mid stress period increased N uptake by 12, 31 and 47%, respectively, while supplemental irrigation of 5 cm at the time of grain filling showed higher N uptake by 50% over rainfed sunflower in 1992.

These studies clearly showed that moisture stress with dry spells of more than 12 days at flowering and grain filling stages reduced the growth and yield components, N uptake and grain filling in sunflower (Pirjol

Table 2. Rainfall-use efficiency and nitrogen uptake as influenced by management practices in sunflower

Management practice	Rain water-use efficiency (kg/ha-mm)†		N uptake (kg/ha)					
	Seed	Stalk	1992		1993		1994	
			Seed	Stalk	Seed	Stalk	Seed	Stalk
Rainfed crop	3.20	5.38	27.8	19.6	48.3	28.9	29.3	26.3
Interculture* in early stress	3.54	5.03			52.0	30.5	33.8	27.4
Fertilizer* in early stress	3.82	5.06			57.6	31.7	38.5	31.0
Irrigation** of 5 cm in early stress	3.91	5.51			60.7	32.7	42.7	34.6
Interculture* in mid-stress	3.76	6.08	33.0	20.2	52.6	30.6		
Fertilizer* in mid-stress	3.96	6.20	37.9	24.3	58.9	32.7	40.0	32.4
Irrigation** of 5 cm in mid-stress	3.72	5.24	43.4	26.1	59.7	34.8	43.4	34.6
Irrigation** of 5 cm in terminal stress	4.06	5.88	44.4	26.5	61.7	36.8		
Stress-free	3.98	5.88	57.4	27.3	65.7	43.4	52.4	38.0
CD (P = 0.05)			3.9	4.8	4.0	4.4	4.1	5.0

†Mean data of 3 years, *additional, **supplemental

et al., 1971). However, higher root/shoot ratio, with extensive root system helped stressed sunflower to utilize moisture from deeper layers for its survival and growth. So, the reduced growth and yield components in stressed environment is attributed for getting decreased seed yields, rainfall use efficiencies compared to the stress free environment (Hegde and Havanagi, 1989; Pathak and Dixit, 1986).

The increase in seed and biomass yields with supplemental irrigations at grain-filling stage with dry spells of 12 days is because of improvement in grain filling, seed weight, N uptake and rainfall use efficiencies (Pal and Yadav, 1974). The seed yield and biomass increase with additional N after relief of early and mid moisture stress are because of higher compensation of dry matter, leaf area index, N uptake and also better utilization of available moisture (Sarkar, 1985; Swamy *et al.*, 1986). Soil mulch through additional interculture in early and mid moisture stress periods helped to get higher seed yields than that of no additional interculture because of minimization of soil moisture loss through evaporation and also higher conservation of moisture after relief of stress periods (Jambhale and Thorat, 1988).

Thus, soil mulch by additional interculture in vegetative phase and addition of 10 kg N/ha after relief of drought in vegetative and flowering phases helps to get higher and stable yields in rainfed environment. Alternatively, supplemental irrigation of 5 cm at flowering or grain filling or even at vegetative phase during dry spells of more than 12 days improves the seed yields by 28 to 35% wherever water is available through rain water harvesting.

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