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Effect of irrigation schedules and mulches on yield, soil temperature, water use and economic of sunflower (*Helianthus annuus* L.)

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ABSTRACT

A field experiment was carried out during *rabi* 2003-04 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad to study the effect of irrigation schedules and mulches on yield, soil temperature, water use studies and economic of sunflower on medium deep black clayey soil of Northern Transitional Tract of Karnataka. The experiment was laid out in split plot design with three replications. The treatments comprised of four irrigation schedules (0.4, 0.6, 0.8 IW/CPE ratios and critical stages) as main plots and three mulching (control, maize straw mulch and polythene mulch) as sub plots. The results indicated significantly higher seed yield (1938 kg/ha) in 0.8 IW/CPE ratio irrigation schedules as compared to 0.4, 0.6 IW/CPE ratios and critical stages. The significantly higher seed yield (1868 kg/ha) was recorded in mulch with polythene over rest of the treatments. The interaction effect between irrigation schedules and mulches was significant with respect to yield. The significantly higher seed yield of sunflower (2230 kg/ha) was recorded in 0.8 IW/CPE ratio with polythene mulch. The highest soil temperature at the both the depths (5 and 10 cm) was recorded in mulch with polythene over rest of the treatments. The seasonal consumptive use of water were higher (316.0 mm) in 0.8 IW/CPE with polythene mulch. Highest WUE of 8.19 kg per ha mm was recorded in irrigation schedule at critical stages. The soil moisture extraction was highest in the top layers irrespective of irrigation treatments and decreased with increasing depth of soil (35, 24, 20 and 16% in 0-15, 15-30, 30-45 and 45-60 cm depth, respectively). The maximum gross returns and net returns were also high (Rs. 40140 and 29129/ha) in treatment combination of 0.8 IW/CPE with polythene mulch. However, higher B:C ratio was recorded in 0.8 IW/CPE with no mulch. Scheduling irrigation at 0.8 IW/CPE ratio with polythene mulch can be recommended for Northern Transitional Tract of Karnataka during post rainy season.

Key words : Sunflower, Irrigation, Mulche, Soil temperature

INTRODUCTION

Sunflower is an important oil seed crop gaining paramount importance in the world and ranks next only to soybean and groundnut in the total world production of oil seeds. In India, sunflower is being cultivated over an area of 1.34 million ha with total production of 0.733 million tones with an average productivity of 549 kg per ha (Anon., 2002), which constitute 6.17 per cent and 2.72 per cent of worlds area and production, respectively. In Karnataka, safflower occupies an area of 6.9 lakh ha with production of 2.55 lakh tones of seed with an average productivity of 370 kg per ha (Anon., 2002). Its low productivity is mainly due to its cultivation in rainfed condition, can be enhanced to great extent by successfully growing in *rabi* and summer seasons under irrigated conditions, but water for irrigation is a scare resource, therefore, water use optimization is fundamental to water resource use. It permits better utilization of all other production factors thus, leading to increased yield per unit area and time. The judicious application of water to crop is possible only by some scientific basis. One such approach which guides us to apply water in a more scientific manner is climatological approach (IW/CPE ratio) of scheduling irrigation. Judicious irrigation management is crucial in sunflower production (Andhale and Kalabhar, 1978). Among different conservation measures, mulching is an important practice for crop production. The main objectives of mulching are preventing and control of soil and run-off losses, check on evaporation of water, increase in moisture status of soil and controls fluctuation of soil temperature. The information on irrigation schedules and mulching in sunflower on medium deep black clayey soil of northern Karnataka is limiting. Therefore, present investigation was undertaken to find out the effect of irrigation schedules and mulches on yield, soil temperature, water use studies and economic of sunflower on medium deep black clayey soil of northern Transitional Tract of Karnataka.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* 2003-04 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad. The experiment was laid out in split plot design with three replications. There were 12 treatment combinations consisting of four irrigation schedules (0.4, 0.6 and 0.8 IW/CPE and critical stages)

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assigned to main plots and three mulch treatments (no mulch, maize straw mulch and polythene mulch) to sub plots. The soil was medium deep black clayey with pH 7.53 having field capacity of 33.97 per cent, wilting coefficient 16.92 per cent and bulk density was 1.29 Mg/ m^3. Sunflower hybrid (RSFH-1) was used for experimentation. It is derived from a cross between CMS-103 x RHA-64 NB. It is high yielder than MSFH-17 and also have 23 per cent higher in oil content. A uniform fertilizer dose of 60:90:60 kg N, P_2O_5 and K_2O per ha was applied. Scheduling of irrigation was done based on IW/CPEratio with 60 mm depth of water in each irrigation. Maize straw @ 6 t/ha and transparent polythene sheet of 7 micron thickness were mulched at 25 days after sowing as per the sub plot treatment. These were spread uniformly between the sunflower crop rows without giving any gap in plots after weeding. The soil moisture was estimated by gravimetric method. The irrigation was measured by using Parshall flume (7.5 cm). The water table depth during experiments was below 2 meter from soil surface. The consumptive use was computed as suggested by Dastane (1967).

RESULTS AND DISCUSSION

The seed yield, soil temperature at 5 cm and 10 cm as influenced by irrigation schedules and mulches are presented in Table 1.

Significantly higher seed yield (1938 kg/ha) was recorded in 0.8 I/W CPE ratio irrigation schedule over 0.6 (1813 kg/ha), 0.4 IW/CPE ratios (1714 kg/ha) and critical stages (1714 kg/ha) and it was higher by 6.89, 33.10 and 13.06 per cent, respectively. Such difference in the seed yield may be attributed to favourable water regime in soil for better mobilization of nutrients and also enhanced source capacity and sink strength which inturn influenced yield attributing characters favourably like head diameter, number of seeds per head and seed weight per head. These results are in accordance with the results of Tomar *et al.* (2003).

Significantly higher seed yield of sunflower was recorded in mulch with polythene (1868 kg/ha) over no mulch (1609 kg/ha) and mulch with maize straw (1717 kg/ha) and were higher by 16.09 per cent and 8.79 per cent over control, which was attributed to higher head diameter and number of seeds per head. Moody *et al.* (1963) who reported increased availability of moisture in the root zone because of conservation of the soil moisture and reduced evaporation losses with application of mulches.

The interaction effect of irrigation schedules and

Table 1 : Seed yield (kg/ha), 1000 seed weight (g), soil temperature (°c) at 5 and 10 cm of sunflower as influenced by irrigation schedules and mulches

Irrigation schedules (I)	Seed yield (kg/ha)				1000-Seed weight (g)				Soil temperature at 5 cm (°C)				Soil temperature at 10 cm (°C)			
	Mulches (M)															
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
I1	1246	1541	1580	1456	39.00	39.17	42.22	40.13	32.79	31.24	34.81	32.95	30.47	29.41	31.10	30.33
I2	1725	1825	1890	1813	37.72	40.53	42.92	40.38	32.46	32.03	34.21	32.89	29.94	28.82	30.96	30.02
I3	1779	1805	2230	1938	42.33	43.00	46.87	44.06	31.84	30.59	34.72	32.39	30.22	29.27	31.30	30.15
I4	1675	1696	1772	1714	37.82	38.45	41.88	39.38	30.77	29.13	34.24	31.38	30.31	29.30	30.97	30.19
Mean	1609	1717	1868		39.22	40.29	43.47		31.96	30.75	34.49		30.23	29.20	31.09	
For comparison	S.E.±		C.D. (P=0.05)		S.E.±		C.D. (P=0.05)		S.E.±		C.D. (P=0.05)		S.E.±		C.D. (P=0.05)	
Irrigation schedules (I)	29.8		103.4		0.79		2.75		0.58		NS		0.08		NS	
Mulches(M)	25.8		77.5		0.94		2.82		0.61		1.83		0.07		0.23	
I x M	51.7		156.2		1.73		NS		1.15		NS		0.15		NS	

Note:

NS-Non significant

I_1 : 0.4 IW / CPE
I_2 : 0.6 IW / CPE
I_3 : 0.8 IW / CPE
I_4 : Critical stages

M_1 : No mulch (control)
M_2 : Mulch with maize straw
M_3 : Mulch with polythene

mulches were significant with respect to seed yield. Significantly higher seed yield of sunflower (2230 kg/ha) was recorded in 0.8 IW/CPW ratio and mulch with polythene treatment combination over other treatment combinations. This might be due to higher head diameter and number of seeds per head. Mulch with polythene recorded highest soil temperature at harvest compared to no mulch and mulch with maize straw at the both the depths (5 and 10 cm). Similar results were also reported by Muragan *et al*. (2003).

Seasonal consumptive use of water is closely related to the amount of water applied through irrigation and the frequency of irrigations. The irrigation scheduled at 0.8 IW/CPW ratio recorded highest consumptive use of water (315 mm) and lowest (209 mm) in 0.4 IW/CPE ratio irrigation schedule (Table 2). The highest seasonal consumptive use of water in 0.8 IW/CPE ratio irrigations schedule is attributed due to frequent irrigations in this treatment which has resulted in continuous wetting of the surface layer which in turn resulted in maximum evapotranspiration losses. The lowest consumptive use of water in 0.4 IW/CPE ratio which might be due to relatively less soil moisture supply owing to the less number of irrigations received by this treatment and lowest amount of water applied. This results is in conformity with that of Kaushal *et al*. (2002). The WUE is mainly dependent on two factors *viz.*, seed yield and consumptive use of water. The highest water use efficiency (8.19 kg/ ha mm) was recorded in irrigation schedule at critical stages and lowest water use efficiency was recorded in 0.8 IW/CPE ratio irrigation schedule due to low seed yield of sunflower. Similar trend was also noticed by Singh *et al*. (2001).

Among the irrigation schedules, 0.8 IW/CPE ratio extracted maximum soil moisture (59.59%) from the surface layer (0-15 cm) and extraction from layer decreased marginally with less irrigation frequency 0.4, 0.6 and critical stages. The surface layer (0-15 cm) contributed more moisture irrespective of mulches treatments (35.33%). Mulch with polythene treatment extracted relatively more (36.65%) moisture from the top layer (0-15 cm) as compared to mulch with maize straw (35.80%) and no mulch (34.28%).

Among the different treatment combinations, significantly higher gross returns (Rs. 40140/ha) net returns (Rs. 29129/ha) were recorded in 0.8 IW/CPW ratio and mulch with polythene treatment combination over rest of the treatment combinations (Table 3). Higher net returns obtained due to higher seed yield. However, higher B:C ratio was recorded in irrigation scheduled at critical stages and no mulch (3.23) treatment combination but was at

Table 2 : Irrigation studies in sunflower as influenced by irrigation schedules and mulches

Irrigation schedules	Seasonal consumptive use of water (mm)				Water use efficiency (kg/ha-mm)				Soil moisture extraction pattern								
					Mulches (M)												
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M1	M2	M3	Mean
					0-15 cm				15-30				30-45 cm			
I1	208	208	211	209	5.79	7.15	7.30	6.75	33.9	35.6	36.1	35.2	22.9	23.2	24.6	23.6	19.2	20.0	21.0	20.07
I2	264	264	267	266	6.52	6.91	7.07	6.81	34.2	35.7	36..3	23.3	22.8	23.3	24.9	23.7	19.4	20.2	21.1	20.23
I3	314	315	316	315	5.66	5.72	7.05	6.15	34.3	35.8	36.7	35.6	23.0	23.4	24.9	23.8	19.8	20.3	21.3	20.47
I4	215	215	216	215	8.04	8.14	8.39	8.19	34.0	35.5	36.1	35.2	22.5	23.1	24.4	23.3	19.0	20.0	21.1	20.03
Mean	250	250	215		6.42	6.84	7.39	34.1	35.7	27.2	34.1		22.8	23.25	24.7	19.4	20.1	21.1	19.4	

Note:

I_1 : 0.4 IW / CPE
I_2 : 0.6 IW / CPE
I_3 : 0.8 IW / CPE
I_4 : Critical stages

M_1 : No mulch (control)
M_2 : Mulch with maize straw
M_3 : Mulch with polythene

Table 3 : Total cost of cultivation (Rs./ha), gross returns (Rs./ha), net returns (Rs./ha), benefit : cost ratio of sunflower as influenced by irrigation schedules and mulches

Treatment combinations	Total cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	Benefit : cost ratio
I_1M_1	7136	22440	15304	2.14
I_1M_2	8396	31083	19354	2.30
I_1M_3	10061	28452	18391	1.83
I_2M_1	7571	31050	23479	3.10
I_2M_2	8831	32850	24019	2.72
I_2M_3	10496	34032	23536	2.24
I_3M_1	8086	32034	23948	2.96
I_3M_2	9346	32502	23156	2.48
I_3M_3	11011	40140	29129	2.65
I_4M_1	7136	30150	23014	3.23
I_4M_2	8396	30526	22132	2.64
I_4M_3	10061	31902	21341	2.17
S.E.±	-	1231.8	931.7	0.10
C.D. (P=0.05)	-	3612.4	2732.3	0.30

Note:

I_1 : 0.4 IW / CPE
I_2 : 0.6 IW / CPE
I_3 : 0.8 IW / CPE
I_4 : Critical stages

M_1 : No mulch
M_2 : Mulch with maize straw
M_3 : Mulch with polythene

par with 0.6 IW/CPE and no mulch (3.10) and 0.8 IW/CPE ratio with no mulch (2.96), respectively. Higher B:C ratio is due to low cost of cultivation. Lower gross returns (Rs.22440/ha) and net returns (Rs.15304/ha) were noticed in 0.4 IW/CPE ratio with no mulch treatment combination. Thus scheduling irrigation at 0.8 IW/CPE ratio and mulch with polythene was found better for maximum yield, water use efficiency and net returns of sunflower on medium deep black clayey soils of northern Transitional Tract of Karnataka.

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