HELIA, **32**, Nr. 50, p.p. 115-122, (2009) UDC 633.854.78:631.67
DOI: 10.2298/HEL0950115R

EFFECT OF IRRIGATION SCHEDULING AND METHOD OF IRRIGATION ON PRODUCTIVITY AND WATER ECONOMY IN HYBRID SUNFLOWER (*Helianthus annuus* L.)

Ramamoorthy, K.[1,2*], Murali Arthanari, P.[2] and Subbian, P.[2]

[1]*Agricultural Research Station, Bhavanisagar, Erode District, Tamil Nadu, India 638 451*
[2]*Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore - 641 003, Tamil Nadu, India*

Received: September 21, 2006
Accepted: March 12, 2009

SUMMARY

An experiment was conducted during summer and *kharif* seasons of 2004 and 2005 at Agricultural Research Station, Bhavanisagar, to study different irrigation methods and regimes (IW/CPE ratio) on yield attributes, yield and water economy in hybrid sunflower (MSFH 17). Yield and yield attributes varied significantly during both summer and *kharif* seasons of 2004 and 2005. Irrigation at 0.80 and 0.60 IW/CPE ratios under alternate furrows and paired row system of irrigation (80/40 × 30 cm) proved better than other treatment combinations with regard to water use efficiency gross return, net return and B0 : C ratio.

Key words: **hybrid sunflower, irrigation schedule, method of irrigation, water economy**

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is an important oil crop. Sunflower acreage and productivity are consequences of its early maturity, photo-thermo insensitiveness, drought and salinity tolerance. Sunflower seeds contain good quality oil (34-52%) as well as high amounts of protein (14%), as reported by Singh *et al.* (1997). The oil is high in linoleic content with low cholesterol values and it is considered to be good for human consumption and heart patients. Due to such important quality parameters, the crop fetches higher market price leading to increased acceptance by farmers.

* Corresponding author

Table 1: Yield, WUE and economics as influenced by irrigation regime and irrigation method (2004)

Treatment	Head diameter (cm)		No. of filled grains/head		Unfilled grains/head		100-grain weight (g)		Grain yield (kg/ha)		WUE (kg/ha/mm)		Net returns (Rs/ha)	
	S04	K04	S04	K04	S04	K04	S04	K04	S04	K04	S04	K04	S04	K04
I_1	12.0	15.4	546	1036	348	131	3.72	4.51	701	2905	3.53	9.97	3008	23737
I_2	12.2	15.7	543	968	331	97	3.85	4.61	648	3331	2.62	10.13	1388	28301
I_3	13.0	14.7	615	1015	220	139	4.12	4.52	788	2966	2.49	7.99	3851	24106
CD (P = 0.05)	NS	NS	NS	59	NS	42	0.35	0.11	NS	215	-	-	-	-
M_1	13.0	14.7	567	854	246	102	3.77	4.52	724	3070	2.16	7.11	3207	25413
M_2	12.2	14.5	488	977	388	124	3.90	4.54	616	2853	1.79	6.60	2026	23033
M_3	11.6	15.5	653	1079	321	205	3.91	4.56	638	2977	3.19	11.50	2265	24380
M_4	12.7	16.3	563	1117	242	57	4.02	4.57	871	3368	4.38	12.23	4828	28678
CD (P=0.05)	0.9	0.9	36	75	45	32	0.31	0.13	118	189	-	-	-	-

S 04 = summer 2004; K 05 = *kharif 2004*

Table 2: Yield, WUE and economics as influenced by irrigation regime and irrigation method (2005)

Treatment	Head diameter (cm)		No. of filled grains/head		Unfilled grains/head		100-grain weight (g)		Grain yield (kg/ha)		WUE (kg/ha/mm)		Net returns (Rs/ha)	
	S05	K05	S05	K05	S05	K05	S05	K05	S05	K05	S05	K05	S05	K05
I_1	14.2	11.7	573	667	234	194	4.42	4.59	1898	2016	6.86	6.59	12675	13971
I_2	16.4	12.1	583	719	206	182	4.51	4.68	2122	2245	6.89	6.99	15272	16358
I_3	15.7	12.2	686	777	165	220	4.42	4.38	2469	2307	6.33	6.08	18639	16854
CD (P = 0.05)	1.1	NS	48	175	24	56	0.20	0.38	114	116	-	-	-	-
M_1	14.3	11.7	613	708	250	211	4.38	4.40	2078	1836	5.58	4.05	14505	11843
M_2	15.0	12.4	651	721	188	220	4.41	4.56	2096	2104	5.67	4.63	14699	14787
M_3	15.9	11.4	638	595	186	206	4.47	4.41	2250	2296	8.44	10.1	16397	16906
M_4	16.6	12.5	688	859	182	156	4.55	4.80	2261	2521	7.07	7.41	16514	19374
CD (P=0.05)	1.6	NS	43	133	17.1	64	0.21	0.40	99	123	-	-	-	-

S 04 = summer 2005; K 05 = *kharif 2005*

Hybrid sunflower (*Helianthus annuus* L.) responds relatively better to management factors, especially irrigation, than local sunflower varieties. It has been found that yield of sunflower is greatly influenced by irrigation and better results in terms of both seed and oil yield can be achieved by the application of optimum irrigation. The efficient method of irrigation for the hybrid sunflower crop not only saves water, to solve the problem of water shortage, but also regulates irregular and erratic distribution of rainfall through proper conservation/drainage practices. Hence, there is a vast scope for improved water use efficiency and enhanced productivity of sunflower per unit area. Most of the research work on irrigation is based on either soil moisture depletion or critical growth stage approach without any consideration for climatic parameters. Hence, an attempt was made to study the effect of irrigation levels and irrigation methods on seed yield, water use efficiency (WUE) and its economics in hybrid sunflower.

MATERIALS AND METHODS

The experiment was conducted at the Agricultural Research Station, Bhavanisagar, during summer and *kharif* seasons of 2004 and 2005. The experiments were laid out in a split plot design with three replications. Main plot treatments comprised of three irrigation regimes of IW/CPE ratio, 0.40 (I_1), 0.60 (I_2) and 0.80 (I_3), and sub-plot treatments comprised of four irrigation layouts, check basin (M_1), ridges and furrows (M_2), alternate furrows (M_3) and paired rows ridging (M_4) (Table 3).

Table 3: Grain yield (kg/ha) as influenced by irrigation regime and method of irrigation (2004)

Method of irrigation	Irrigation regime							
	I_1		I_2		I_3		Mean	
	S 04	K 04	S 04	K 04	S 04	K 04	S 04	K 04
M_1 -Check basin	865	2918	522	3319	784	2972	724	3070
M_2 -Ridges and furrows	496	2671	648	3010	705	2879	616	2853
M_3 -Alternate furrows	599	2609	587	3482	728	2841	638	2977
M_4 -Paired rows (80/40×30 cm)	843	3420	834	3513	936	3172	871	3368
Mean	701	2905	648	3331	788	2966		

CD (P = 0.05)	Summer 04	*Kharif* 04
Irrigation regimes (I)	NS	215
Irrigation methods (M)	118	189
M at I	NS	238
I at M	NS	352

Hybrid sunflower MSFH 17 was sown in rows spaced at 60 cm width and 30 cm between plants in the row. Sowings were performed on 8 February 2004 and 16 June 2004 in summer and *kharif* 2004 and 19 January 2005 and 12 July 2005 in

summer and *kharif* 2005, respectively. The crop was fertilized with the recommended doses of 90, 60 and 60 kg N, P and K/ha, respectively. The soil was red sandy loam (32% sand, 24% silt and 44% clay) with a neutral reaction (pH 7.4) and the electrical conductivity of 0.20 dSm^{-1} at 25°C. It was low in organic carbon (0.31%) and available nitrogen (197 kg N/ha) and medium in available phosphorus (10.8 kg P_2O_5/ha) and available potash (224 kg K_2O/ha). The soil moisture contents at field capacity and permanent wilting point were 22.1 and 10.4 %, respectively, at 0-30 cm soil depth. The quantity of irrigation water applied was 50 mm per irrigation. Irrigation was performed with a constant irrigation discharge module having a discharge capacity of 6 l/s. All other agronomic practices were followed as per recommendations. Observations of yield parameters and yield were recorded and analyzed statistically. Water use efficiency (WUE), gross return, net return and B:C ratio were also worked out for the various treatments using the prevailing market price.

RESULTS AND DISCUSSION

Effect of irrigation regime

The effect of irrigation regime on yield attributes and yield was significant except for head diameter (Tables 1 and 2). Irrigating hybrid sunflower at 0.80 and 0.60 IW/CPE ratios gave consistently better performance for yield parameters and yield than that of 0.40 IW/CPE ratios during the test seasons. The increase in growth, yield parameters and yield in the above treatments might be due to the presence of adequate soil moisture. The expansion of cells and cell divisions are enhanced due to adequate supply of water resulting in stem elongation, increased leaf number and weight of stems, leaves and reproductive parts. Tomer *et al.* (1997) and Prabhudeva *et al.* (1998) also observed improvement in overall growth of sunflower receiving adequate moisture supply. Soil moisture has been found to influence rapid cell division and elongation and most of the physiological processes in plants (Patel and Singh, 1980). Though water saving could be achieved with 0.40 IW/CPE ratio, water use efficiency was higher under 0.60 and 0.80 IW/CPE ratios during *kharif* and summer seasons, respectively. This was mainly due to higher grain yield in these treatments with adequate water supply. These findings are in accordance with earlier findings of Chanaria *et al.* (1989). The increase in grain yield during summer 2005 was mainly due to the local climate and increased rainfall received during the crop period.

Effect of irrigation methods

Among the irrigation methods, the paired row method (80/40 × 30 cm) showed better performance than the other methods in respect of plant growth and yield parameters and it resulted in significantly higher grain yields in both test seasons. This method was closely followed by the alternate furrow method of irrigation.

Water use efficiency was also higher in these treatments due to higher water saving and increased grain yields. The results are in close conformity with those of Sarkar (1985) and Buttar *et al.* (1999).

Economics

The highest gross return, net return and B:C ratio were obtained by scheduling irrigation at 0.60 IW/CPE ratio during *kharif* season and 0.80 IW/CPE ratios during summer seasons in both years (2004 and 2005), under the paired row method of irrigation as well as under the alternate furrow method. This was mainly due to higher grain yields obtained in these treatments as shown in Tables 3 and 4.

Table 4: Grain yield (kg/ha) as influenced by irrigation regime and method of irrigation (2005)

Method of irrigation	Irrigation regime							
	I_1		I_2		I_3		Mean	
	S 05	K 05	S 05	K 05	S 05	K 05	S 05	K 05
M_1 – Check basin	1813	1751	2006	1867	2415	1890	2078	1836
M_2 – Ridges and furrows	1975	1952	1959	2045	2314	2096	2104	2853
M_3 – Alternate furrows	1874	2121	2361	2353	2515	2415	2250	2296
M_4 – Paired rows (80/40×30 cm)	1929	2238	2260	2716	2593	2608	2261	2521
Mean	1896	2016	2122	2245	2469	2307		

CD (P = 0.05)	Summer 05	*Kharif* 05
Irrigation regimes (I)	114	116
Irrigation methods (M)	99	123
M at I	171	216
I at M	186	208

Hence, irrigating hybrid sunflower at 0.60 IW/CPE ratios during *kharif* and 0.80 IW/CPE ratio during summer under the paired row method and alternate furrow method of irrigation were found optimum and economical in terms of increased grain yield, water use efficiency, net returns and B:C ratio.

CONCLUSION

It was concluded from this study that the yield and yield attributes were greatly influenced by the season. Field irrigation has greater impact than the seasonal effect with respect to IW/CPE ratio. Hence, judicious irrigation management based on climatic factors will directly influence the yield of the crop.

Table 5: Economics as influenced by irrigation regime and irrigation method (2004 and 2005)

Treatments	Gross return (Rs/ha)		Net return (Rs/ha)		B:C ratio		Gross return (Rs/ha)		Net return (Rs/ha)		B:C ratio	
	S04	K04	S04	K04	S04	K04	S05	K05	S05	K05	S05	K05
I_1	12618	52290	3008	23737	1.31	1.83	34164	36288	12675	13971	1.59	1.63
I_2	11664	59958	1388	28301	1.14	1.89	38196	40410	15172	16358	1.67	1.68
I_3	14184	53388	3851	24106	1.37	1.82	44442	41526	18639	16854	1.72	1.68
M_1	13032	55260	3207	25413	1.33	1.85	37404	33048	14505	11843	1.63	1.56
M_2	11088	51354	2026	23033	1.22	1.81	37728	37872	14699	14787	1.64	1.64
M_3	11484	53586	2265	24380	1.25	1.83	40500	41328	16397	16906	1.68	1.69
M_4	15678	60624	4828	28678	1.44	1.90	40698	45378	16514	19374	1.68	1.75

S 04 = summer 2004
S 05 = summer 2005
K 04 = *kharif* 2004
K 05 = *kharif 2005*
* Economic data were not analyzed statistically

REFERENCES

Anonymous, 1981. Annual report for 1980-81. All India Co-ordinated Research Project on Water Management. Agricultural Research Station, Bhavanisagar, pp. 48-50.

Buttar, G.S. and Uppal, H.S., 1999. Effect of date of method of planting and irrigation on quality and seed yield of sunflower (*Helianthus annuus* L.). Haryana J. Agron. 15(2): 132-135.

Chanaria, N.T., Patel, J.C., Malavia, D.D. and Baldha, N.M., 1989. Effect of irrigation, nitrogen and phosphorus on the productivity of sunflower. Indian J. Agron. 34(4): 399-401.

Patel, J.C. and Singh, R.M., 1980. Effect of irrigation, mulching and bio regulators on the productivity of sunflower. Indian J. Agron. 25(1): 122-128.

Prabhudeva, T.V., Chalapathi, M.V., Thimmegowda, S., Devakumar, N., Gangadhereswar, G.R. and Mallikarjuna, K., 1998. Soil moisture stress and drought susceptibility index in sunflower. Indian Agri. 42(4): 187-289.

Prihar, S.S., Sandhu, B.S. and Singh, N.T., 1975. A critical approach of research on irrigation scheduling of crops. Proceedings of Second World Congress on Water Resources, IWRA, New Delhi, 343-349.

Sarkar, R.K., 1985. Water Management for Sunflower. Indian Fmg. 35(9): 13-16.

Singh, H., Agarwal, S.K. and Singh, K.P., 1997. Sunflower production technology–a review. In: Agro's Ann. Rev. of Crop Ecology. 1 (Ed) A.K. Dahama, pp. 243-258, Agro Botanica, Bikaner, India.

Tomar, H.P.S., Singh, H.P and Dadhawal, K.S., 1997. Effect of irrigation, nitrogen and phosphorus on growth and yield of spring sunflower (*H. annuus*). Indian J. Agron. 42(1): 169-172.

EFECTO DEL ESQUEMA Y MÉTODO DE RIEGO SOBRE LA PRODUCTIVIDAD Y LA ECONOMÍA DEL AGUA EN GIRASOL HÍBRIDO (*Helianthus annuus* L.)

RESUMEN

Se condujo un experimento durante las estaciones de verano y *Kharif* de 2004 y 2005 en la Agricultural Research Station de Bhavanigasagar para estudiar el efecto de diferentes regímenes de riego (relación IW/CPE) sobre atributos asociados al rendimiento, rendimiento y economía del agua en el híbrido de girasol MSFH 17. El rendimiento y sus atributos asociados variaron significativamente durante las estaciones de verano y *Kharif* de 2004 y 2005. Las relaciones IW/CPE de 0,80 y 0,60 bajo el sistema de dos hileras apareadas con surco de por medio (80/40 × 30 cm) probaron ser mejor que otras combinaciones de tratamientos con un incremento en la eficiencia en el uso del agua, ingreso bruto, ingreso neto y relación costo/beneficio.

INFLUENCE DU TEMPS ET DE LA MÉTHODE D'IRRIGATION SUR LA PRODUCTIVITÉ ET LA CONSOMMATION RATIONNELLE D'EAU CHEZ LE TOURNESOL HYBRIDE (*Helianthus annuus* L.)

RÉSUMÉ

Une experimentation a été menée durant les saisons d'été et du *kharif* de 2004 et 2005 à la Station de Recherches Agricoles de Bhavanisagar afin d'étudier différentes méthodes et régimes (rapport eau apportée par l'irrigation/ eau consommée par l'évapotranspiration; IW/CPE ratio) sur le rendement et ses composantes et sur l'économie d'eau chez l'hybride de tournesol MSFH 17. Le rendement et ses composantes ont varié considérablement au cours des deux

saisons et des deux années. Des régimes d' irrigation à 0.80 ou 0.60 IW/CPE avec un système de sillons d'irrigation alternés ou couplés (80/40 × 30 cm) se sont avérés être les meilleurs combinaisons avec une augmentation de l'efficience de l'eau consommée en marge brute ou nette, et du ratio B: C ratio.