https://doi.org/10.29321/MAJ.10.A03026

Madras agric. J. 66 (12) : 783—788, Dec., 1979.

Effect of Irrigation and Phosphorus Levels on Growth Analysis Parameters in Sunflower (*Helianthus annuus* L)*

S. SOMASUNDARAM[1] and M R. IRUTHAYARAJ[2]

An experiment was conducted at the Agricultural Research Station, Bhavanisagar, during summer and at Agricultural College and Research Institute, Coimbatore during *kharif* season of 1978 with sunflower (variety EC 68413) with six irrigation treatments in main plots and four phosphorus levels in sub-plots. The results indicated that irrigation and phosphorus significantly influenced the LAI and CGR, but the effect on NAR and RGR was not significant. Irrigation at 1.05 IW/CPE ratio with 90 kg/ha of phosphorus recorded highest LAI and CGR in all stages of observation.

Sunflower (*Helianthus annuus* L.) is an important oilseed crop. The interest on this crop has increased since 1960 with the introduction of high yielding Russian varieties. Growth analysis is a useful tool to analyse the performance of crops. Since not much information is available in sunflower on growth analysis, an experiment was conducted at Tamil Nadu Agricultural University.

MATERIAL AND METHODS

The experiment was conducted at Agricultural Research Station, Bhavanisagar during summer and at the Agricultural College and Research Institute, Coimbatore, during *kharif* 1978. Bhavanisagar is situated at 11° 30' N latitude, 77° 10' longitude at an altitude of 247 m above mean sea level. Coimbatore is situated at 11° N latitude and 77° E longitude and at an altitude of 426.7 m above mean sea level.

The experiment was laid out in a split plot design, replicated thrice. The treatments were : Irrigation levels (main plot) : I_1-Farmer's method, I_2-60 per cent Available soil moisture (ASM), I_3 0.60 IW/CPE ratio, I_4-0.75 IW/CPE ratio, I_5-0.90 IW/CPE ratio and I_6-1.05 IW/CPE ratio; Phosphorus levels (sub-plots);P_0-0 kg P_2O_5/ha, P_{30}-30 kg P_2O_5/ha, P_{60}-60 kg P_2O_5/ha and P_{90}-90 kg P_2O_5/ha. The crop was sown with the spacing of 45 x 22.5 cm on 9.3.1978 and 22.6.1978 and harvested on 7.6.1978 and 22.9.1978 during summer and *kharif* seasons respectively. A uniform dose of 40 kg N and 40 kg K_2O/ha was applied. Half the N, entire K_2O and P_2O_5 (according to treatment) were applied as basal dose. The remaining half N was top dressed 30 to 34 days after sowing depending upon the irrigation treatments. The soil was low, medium and high in available status of nitrogen, phosphorus and potash respectively in both the seasons.

* Part of M.Sc. (Ag.) Thesis of the first author submitted to the Tamil Nadu Agricultural University, Coimbatore-641003.

1 & 2 : Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore.

The soil at Bhavanisagar is red sandy loam and at Coimbatore black clay loam.

The common irrigations, one at sowing and the other after four days of sowing were given with measured quantity of water. The depth of irrigation was fixed at 5 cm. The treatment I_1 was irrigated once in 8 days in summer and once in 10 days in *kharif* (farmers' method). The moisture content of the soil between field capacity and permanent wilting point was taken as the available moisture range. The evaporation from U.S.W.B. class. A open pan evaporimeter was recorded daily and 5 cm depth of irrigation was given to I_6, I_5, I_4, and I_3 treatments, whenever the cumulative pan evaporation reached 47.6, 55.5, 66.7 and 83.3 mm respectively. The number of irrigations, quantity of water applied, total rainfall and the effective rainfall received under the irrigation treatments in two seasons are furnished in Table I.

TABLE I. Quantity of water and rainfall received under different irrigation treatment

Treatment	No. of irrigation	Quantity of water applied (mm)	Total rainfall (mm)	Effective rainfall (mm)
		Summer		
I_1	10	545.0	153.8	99.8
I_2	11	530.0	153.8	122.4
I_3	8	380.0	153.8	96.6
I_4	10	480.0	153.8	97.4
I_5	11	530.0	153.8	114.2
I_6	13	630.0	153.8	97.2
		Monsoon		
I_1	8	434.0	53.4	49.1
I_2	9	430.0	53.4	40.8
I_3	6	280.0	53.4	51.9
I_4	8	380.0	53.5	50.4
I_5	9	430.0	53.4	45.6
I_6	11	530.0	53.4	38.2

Five plants were selected at random and labelled from the each net plot. The length and breadth of the leaves were measured at 30, 45, 60, 75 and 90th day. The leaf area was calculated with the length x breadth method using the factor 0.65 as given by Lazarov (1965). The leaf area index was calculated by dividing the leaf area by the area of the land occupied by the plant. Two plants from each plot were selected from sample rows and used to estimate dry matter production. From the dry matter production the growth parameters were calculated. The mean net assimilation rate was computed as suggested by Enyi (1962) and expressed in g/dm²/week.

$$NAR = \frac{(W_2 - W_1)}{(t_2 - t_1)} \times \frac{(\log_e L_2 - \log_e L_1)}{(L_2 - L_1)}$$

The mean relative growth rate was also calculated as suggested by Enyi (1962) by using the formula expressed as g/g/week

$$RGR = \frac{(\log_e W_2 - \log_e W_1)}{(t_2 - t_1)}$$

The crop growth rate was computed by Buttery (1970) and expressed in g/m² (land) day.

$$CGR = \frac{(W_2 - W_1)}{(t_2 - t_1)}$$

The observations were calculated between 30 and 45, 46 and 60, 61 and 75th days and 76th day harvest. The symbols W_1 and W_2 are initial and final total weight in g, L_1 and L_2 the initial and final leaf area in dm² and t_1 and t_2

the initial and final day of observations respectively.

RESULTS AND DISCUSSION

Leaf area index (LAI) (Table II): Leaf area index steadily increased and reached maximum at 60th day. After 60th day a decreasing trend was noticed. This is due to vigorous growth of plant upto 60th day and then entering into reproductive phase causing gradual senescence of leaves. This is in agreement with the findings of Thomas Varghese *et al.* (1976) and Sivasankaran (1978). Irrigation at 1.05 IW/CPE ratio (I_6) produced the highest leaf index and was on par with I_5 (60 per cent ASM) in both the seasons. Lower leaf area index at lower irrigation regimes may be due to the inadequate moisture supply which in turn, resulted in reduction in growth and development of leaves. Similar views have been expressed by Muriel and Downer (1977) and Selvaraj *et al.* (1977). Among phosphorus levels, P_{45} and P_{60} recorded higher LAI and were superior to other levels. Thomas Varghese *et al.* (1976) reported that phosphorus application recorded high LAI at all stages of crop growth. Similar views have been also expressed by Devasundaram (1976) and Sivasankaran (1978).

TABLE II. Effect of stages, irrigation and phosphorus on leaf area index

Treatment	Summer	*Kharif*
Stages		
S_{30}	1.55	1.67
S_{45}	3.11	3.54
S_{60}	4.42	5.42
S_{75}	3.68	4.43
S_{90}	2.62	2.89
S.E. ±	0.04	0.04
C.D. at 5%	0.11	0.11
Irrigation level		
I_1	2.89	3.40
I_2	3.31	3.86
I_3	2.61	3.11
I_4	2.98	3.47
I_5	3.25	3.75
I_6	3.42	3.93
S.E. ±	0.04	0.04
C.D. at 5%	0.11	0.11
Phosphorus level		
P_0	2.79	3.37
P_{30}	2.99	3.52
P_{60}	3.22	3.69
P_{90}	3.31	3.77
S.E. ±	0.03	0.04
C.D. at 5%	0.09	0.19

Net assimilation rate (Table III): Decreasing trend in NAR was noticed with increase in age of the crop. Thorne (1960) observed a decrease in NAR with the age of the crop and in monsoon rice Iruthayaraj (1975) also observed a similar trend. The decreasing trend at higher levels of irrigation and phosphorus may be due to more vegetative growth. The increased vegetative growth might have increased the respiration. High leaf area might have increased mutual shading of leaves with a resultant decrease in photosynthetic activity causing reduction in the NAR. Similar views have been expressed by Hayashi (1967) in rice, Hansen (1971) in maize, Jacquinot (1972) in pearl millet and Thomas Varghese *et al.* (1976) in sunflower.

TABLE III. Effect of stages, irrigation and phosphorus on net assimilation rate, relative growth rate and crop growth rate

Treatment	NAR g/dm²/week		RGR g/g/week		CGR g/m² of land/day	
	Summer	*Kharif*	Summer	*Kharif*	Summer	*Kharif*
Stages						
Between 30 and 45th day	0.6227	0.6522	1.0092	0.9545	20.3291	23.0775
Between 46 and 60th day	0.4317	0.4131	0.3253	0.3184	23.1687	25.8681
Between 61 and 75th day	0.1174	0.1767	0.0940	0.0985	10.3264	12.4252
Between 76 and 90th day	0.1160	0.1182	0.0419	0.0414	5.3086	5.9753
S.E. ±	0.0100	0.0071	0.0046	0.0048	0.1697	0.1479
C.D. at 5%	0.0285	0.0202	0.0131	0.0138	0.4833	0.4212
Irrigation levels						
I_1	0.3468	0.3440	0.3710	0.3563	14.1193	16.1665
I_2	0.3278	0.3339	0.3634	0.3502	15.6665	17.7014
I_3	0.3553	0.3538	0.3751	0.3595	13.1687	15.3572
I_4	0.3381	0.3380	0.3674	0.3541	14.4034	16.4505
I_5	0.3324	0.3374	0.3656	0.3520	15.3909	17.4300
I_6	0.3212	0.3295	0.3631	0.3472	15.9505	17.9134
S.E. ±	0.0123	0.0087	0.0057	0.0059	0.2079	0.1811
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	0.5921	0.5157
Phosphorus levels						
P_0	0.3449	0.3435	0.2962	0.3555	13.8404	16.9780
P_1	0.3398	0.3405	0.2950	0.3542	14.5116	16.6213
P_2	0.3326	0.3364	0.2930	0.3523	15.2304	17.1809
P_3	0.3305	0.3379	0.2913	0.3509	15.5500	17.5659
S.E. ±	0.0100	0.0071	0.0046	0.0048	0.1697	0.1479
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	0.4833	0.4212

N.S. — Not significant

Relative growth rate (Table III) : A declining trend in RGR was noticed with increase in the age of the crop. This may be due to the decrease in the rate of dry matter accumulation with the age of the crop though the total dry matter increased. Similar results were observed in rice by Iruthayaraj (1975) and in maize by krishnamurthy *et al.* (1974). The influence of irrigation and phosphorus levels on RGR was not significant.

Crop growth rate (Table III) : There was a significant difference in CGR among the stages of growth studied. CGR was maximum between 45 and 60 days. From 30 days, the CGR increased and reached a maximum between 45 and 60 days. Tisdale and Nelson (1960) reported that CGR followed the normal sigmoid curve in any crop. The present investigation confirmed this view. Irrigation at 1.05 IW/CPE ratio (I_6) recorded highest CGR and was on par with 60 per cent ASM (I_2) and 0.90 IW/CPE ratio (I_5) but superior to other irrigation schedules. Lower CGR at lower levels of irrigation may be due to inadequate moisture supply for better growth of crop. Among the phosphorus levels tried, P_{90} and P_{60} recorded higher CGR and were superior to other levels. Several workers reported that higher doses of fertilizers registered higher CGR (Muramoto *et al.* (1965) in cotton, Irvine (1967) in sugarcane, Krishnamurthy *et al.* (1973) in sorghum and maize.

The senior author wishes to express his sincere thanks to the Indian Council of Agricultural Research for the financial assistance rendered during this study and to the Tamil Nadu Agricultural University for permitting him to publish his M.Sc. (Ag) thesis.

REFERENCES

BUTTERY, B.R. 1970. Effect of variation in leaf area index of maize and soybeans. *Crop Sci.* 10 : 9-13.

DEVASUNDARAM. K. 1976. Studies of spacing. nitrogen and phosphorus in sunflower under rainfed and irrigated conditions. M.Sc. (Ag) thesis submitted to the Tamil Nadu Agricultural University. Coimbatore.(Unpub.)

ENYI. B.A.C. 1962. Comparative growth rates of upland and swamp rice varieties. *Ann. Bot.* 26 : 467-87.

HANSON. W.D. 1971. Selection of differential productivity among juvenile maize plants, associated net photosynthetic rate and leaf area changes. *Crop Sci.* 11 : 334-39.

HAYASHI. K. 1967. Efficiencies of solar energy conversion in rice varieties as affected by cultivating period. *Proc. Crop. Sci. Soc. Japan.* 36 : 422-28.

IRUTHAYARAJ. M.R. 1975. Studies on the influence of season. water management and nitrogen on the growth and yield of short duration rice varieties. Unpub. Ph.D. thesis submitted to the Tamil Nadu Agricultural University. Coimbatore.

IRVINE, J.E. 1967. Photosynthesis in sugarcane varieties under field conditions. *Crop Sci.* 7 : 297-300.

JACQUINOT. L. 1972. Results and perspectives of research conducted in Senegal into the potential of grain millet. (*Pennisetum typhoides*) *Agronomic Tropical.* 27:815-21.

KRISHNAMURTHY. K.. A BOMMEGOWDA. M.K. JAGANNATH. N. VENUGOPAL. T.V. RAMACHANDRA PRASAD. G. RAGHUNATHA and B.G. RAJASEKHARA. 1974. Relative production of yield in hybrid. composite and local maizes as influenced by nitrogen and

population levels. *Mysore J. agric. Sci.* 8 : 500-508.

KRISHAMURTHY, K., A. BOMME GOWDA, G. RAGHUNATHA, B.G. RAJASHEKHARA, K. VENUGOPAL, M. K JAGANNATHAN, G. JAYARAM and T.V. RAMACHANDRA PRASAD. 1973. Investigations on the structure on yield in cereals (maize and sorghum). Final report of the PL. 480 project Published by University of Agricultural Science, Bangalore.

LAZAROV, R. 1965. Coefficients for determining the leaf area in certain agricultural crop. *Rast. Nauki.* 2 : 27-37. (*Fld. Crop Abstr.* 19 : 568, 1966).

MURAMOTO, M., J. HESKETH and M.El. SHARKWAY. 1965. Relationship among rate of leaf area development, photosynthetic rete and rate of dry matter production among American cultivated cottons and other species. *Crop Sci.* 5 : 163-66.

MURIEL, J.L. and R.W. DOWNER. 1977. Effect of periods of moisture stress during various phases of growth of sunflower in the green house. In proceedings of the 6th International Sunflower Coference, Bucharest, Romania (Undated). (*Fld. Crop Abstr.* 30 : 7930, 1957)

SELVARAJ, K.V., R. KALIAPPA, A. DAMODARAN and P.P. RAMASAMY. 1977. The effect of different moisture regimes on the yield and yield components of sunflower (*Helianthus annuus* L.) *Oils and Oilseeds J.* 30 : 7-10.

SIVASANKARAN, D. 1978. Effect of weather and NPK on sunflower (EC 68413) Unpub. M.Sc. (Ag.) thesis submitted to the Tamil Nadu Agricultural University, Coimbatore.

THOMAS VARGHESE, P., N. SADANANDA and R. VIKRAMAN NAIR. 1976. A study on leaf area index and net assimilation rate of sunflower (*Helianthus annuus* L.) variety "Peredovik" as affected by graded doses of nitrogen and phosphorus. *Agrl. Res. J. Kerala.* 14 : 53-57.

THORNE, G.N. 1960. Variation with age in NAR and other growth attributes of sugarbeet, potato and barley in a controlled environment. *Ann. Bot.* 24 : 356-71.

TISDALE, S.L. and W.L. NELSON. 1960. Soil Fertility and Fertilizers. Mac Millan Co., New York 3rd ed.