Madras Agric. J., 84(11,12): 695 - 698 November, December 1997
https://doi.org/10.29321/MAJ.10.A00949

IRRIGATION REGIMES AND PHOSPHORUS FERTILIZATION WITH BIO-SOFTWARE ON THE YIELD OF HYBRID SUNFLOWER

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ABSTRACT

To find out the effect of irrigation regimes and phosphorus levels with phosphate soulbilizing micro-organisms on yield components and yield of hybrid sunflower, field experiments were conducted in split-plot design at Tamil Nadu Agricultural University with three irrigation regimes and two levels of phosphorus with and without phosphobacteria application. Irrigating at higher level (Irrigation water : Cumulative pan evaporation ratio of 0.75) of irrigation at 5 cm depth recorded higher yield components and seed yield of sunflower. Similarly application of 90 kg P_2O_5 ha^{-1} along with phosphobacteria application significantly influenced the yield components and yield of sunflower.

KEY WORDS : Sunflower, irrigation, phosphorus, phosphate solubilizing micro-organisms, yield

Sunflower is an important oil seed crop of the World and ranks third next only to cotton seed and groundnut in the total world production of oil seeds. In India, sunflower is being cultivated over an area of 11.45 lakh ha with a production of 5.85 lakh tonnes of seeds (Anon, 1994). It is better adapted to water stress condition than any other oil seed crop. Because of its high quality oil, sunflower cultivation gains importance presently. However, poor seed set is one of the most commonly encountered problems in sunflower cultivation. Poor seed filling led to higher per cent of hollow seeds and lower test weight.

Although sunflower is drought resistant than many other crops it responds well to irrigation. Information on response of sunflower to moisture levels may go a long way in contributing to the knowledge of the total water requirement of the crop and scheduling of irrigation water. Phosphorus (P) is the most important nutrient limiting sunflower productivity (Blamey and Chapman, 1981). P nutrition to plants is complex because most of the inorganic P in tropical soils is fixed in unavailable form and hence only a samll fraction of total P is available. Due to the fixation of P in the form of either aluminium, iron or calcium phosphates in soils, on an average, the utilisation of added P by the crop ranges from 15 - 25 per cent only. Phosphate solubilizing micro-organisms (PSM) increase the availability of phosphates to plants by solubilising inorganic phosphates and mineralizing organic P compounds. Soil moisture can affect P uptake because diffusion is the main mechanism of P movement towards roots. Moreover, microbial changes are most closely related to soil moisture fluctuations. In this context, an attempt was made to investigate the effect of irrigation regimes as well as P fertilization with phosphate solubilizing micro-organisms in increasing the sunflower productivity.

MATERIALS AND METHODS

The experiments were carried out during *kharif* 1994 and summer 1995 at the Eastern Block of Central Farm, Tamil Nadu Agricultural University, Coimbatore. The soils of the experimental field was deep, moderately well drained, sandy clay loam with low in available N. medium in available P and high in available K. Sunflower hybrid MSFH-8 was chosen for this study. The experiments were conducted in split-plot design with three replications. The spacing adopted was 60 cm x 30 cm. The size of the gross plot was 5.4 m x 3.6 m (19.44 m^2) and the net size of the net plot was 4.2 m x 3.0 m (12.60 m^2)

Treatment details

Main plot treatments 3 ; I_1 : Irrigation at IW/CPE ratio of 0.75 ; I_2 : Irrigation at IW/CPE ratio of 0.60 ; I_3 : Irrigation at IW/CPE ratio of 0.45 (Depth of irrigation 50 mm).

Sub plot treatments - 4; Phosphorus levels with phosphobacteria S_1 : 90.00 kg P_2O_5 ha^{-1} without phosphobacteria ; S_2 : 90.00 kg P_2O_5 ha^{-1} with phosphobacteria ; S_3 : 67.50 kg P_2O_5 ha^{-1} without phosphobacteria ; S_4 : 67.50 kg P_2O_5 ha^{-1} with phosphobacteria.

The N, P and K were supplied through urea, single super phosphate and muriate of potash respectively. The recommended level of 60 kg N and 60 kg K were applied to the crop. Fifty per cent of N and K was applied at the time of sowing and the remaining 50 per cent was top dressed on 30 days after sowing (DAS). was applied basally as per the treatments. The phosphobacteria culture was obtained from the Department of Agricultural Microbiology, Tamil Nadu Agricultural University, Coimbatore. The seeds which have to be sown in plots receiving phosphobacteria application were treated with two pockets of culture just before sowing. Eight pockets of phosphobacteria culture were mixed with well decomposed farm yard manure and applied in furrows of respective treatment plots 3 DAS when life irrigation was given.

Irrigation was given to the field immediately after sowing and life irrigation was given 3 DAS to all the treatments. Subsequent irrigation was given as per the treatments. Irrigation scheduling was based on climatological approach. Data on evaporation rate was collected every day from agri-met observatory of Department of Agronomy, Tamil Nadu Agricultural University. When cumulative pan evaporation reached the level of 66 mm, 83 mm and 111 mm in the case of IW/CPE ratio of 0.75, 0.60 and 0.45 respectively irrigation was given to the concerned treatment. The water was measured through 7.5 cm throat width Parshall flume fitted at the head of the experimental field. Effective rainfall was calculated through soil sampling upto 45 cm depth. The recommended package of practices was followed for raising sunflower. In the net plot area, five plants were selected at random and labeled for taking observations. The data on the various parameters studied during the course of investigation were analysed statistically as per the method suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of irrigation regimes

Irrigation regimes significantly influenced the yield components and seed yield of sunflower (Table 1). The yield components were significantly higher with irrigation at IW/CPE ratio of 0.75 (I_1) over irrigation at IW/CPE ratio of 0.60 (I_2) and 0.45 (I_3). Similarly, irrigation at I_1 explicitly boosted the seed yield over I_2 and I_3. The increase in seed yield was 6.74 and 13.77 per cent for *kharif* 1994 and 5.39 and 13.15 per cent for summer 1995. Transport of ^{14}C metabolites from the source to sink under moisture stress was more towards the outer zone of the head in sunflower indicating that the moisture stress reduced the efflux of photosynthates from the leaves resulting in poor seed filling (Udayakumar *et al.*, 1976). The rate of net photosynthates and also the rate of translocation of photosynthates from leaves decreased due to moisture stress (Sung and Krieg, 1979). At higher level of irrigation (IW/CPE ratio of 0.75) the plant did not experience any moisture stress and the translocation of assimilates fromstem and leaves might have been distributed throughout the head resulting in increased number of seeds $head^{-1}$. Similarly the unrestricted and uniform availability of moisture under I_1 resulted in higher net photosynthesis and increased photosynthetic translocation from stem and leaves to seeds. This favourably influenced the number of total and filled seeds $head^{-1}$, test weight and per cent seed filling. So the variation in seed yield with varying levels of irrigation was due to variation in the yield compounds (total and filled seeds $head^{-1}$ and hundred seed weight) of sunflower. The seasonal total water consumption was higher in 0.75 IW/CPE ratio (I_1) than 0.60 (I_2) and 0.45 (I_3) in both the seasons (Table 2). Higher seasonal total water consumption associated with adequate moisture supply was due to relatively copious moisture availability in the soil throughout the crop period.

Effect of phosphorus and bio-softwares

P fertilization with phosphobacteria significantly influenced the yield components and seed yield of sunflower (Table 1). Application of

Table 1. Effect of irrigation regimes and phosphorus fertilization with phosphobacteria on yield components and seed yield of sunflower

Treatment	Head diameter (cm)	Total seeds $head^{-1}$	Filled seeds $head^{-1}$	% of filled seeds	100 seed weight (g)	Seed yield ($kg\ ha^{-1}$)
			kharif 1994			
IW/CPE ratio 0.75	13.8	551.6	464.8	84.13	4.19	1608
IW/CPE ratio 0.60	12.6	515.8	417.9	81.05	3.92	1507
IW/CPE ratio 0.45	11.6	485.5	383.4	78.84	3.89	1413
SED	0.09	1.69	3.07	0.33	0.014	11.0
CD (5%)	0.25	4.7	8.52	0.92	0.04	30.52
90.00 kgP_2O_5 ha^{-1} without phosphobacteria	13.1	526.9	433.5	82.3	4.05	1539
90.00 kg P_2O_5 ha^{-1} with phosphobacteria	14.2	538.1	445.6	82.59	4.07	1568
67.50 kg P_2O_5 ha^{-1} without phosphobacteria	11.2	498.4	398.9	79.84	3.83	1454
67.50 kg P_2O_5 ha^{-1} with phosphobacteria	12.1	507.4	410.1	80.62	4.05	1477
SED	0.06	5.24	8.60	0.83	0.016	16.2
CD (5%)	0.13	11	18.06	1.75	0.034	33.95
			Summer 1995			
IW/CPE ratio 0.75	13.6	559.8	467.3	83.31	4.13	1628
IW/CPE ratio 0.60	12.3	532.6	426	79.86	3.89	1544
IW/CPE ratio 0.45	11.4	495.6	385.4	77.63	3.85	1438
SED	0.03	1.63	2.91	0.28	0.002	3.6
CD (5%)	0.09	4.52	8.07	0.77	0.006	10.08
90.00 kgP_2O_5 ha^{-1} without phosphobacteria	13	542.7	443.6	81.5	4.04	1578
90.00 kg P_2O_5 ha^{-1} with phosphobacteria	13.9	545.3	448.8	82.06	4.04	1587
67.50 kg P_2O_5 ha^{-1} without phosphobacteria	10.9	511.5	401.1	78.21	3.78	1483
67.50 kg P_2O_5 ha^{-1} with phosphobacteria	11.9	517.9	411.5	79.29	3.99	1499
SED	0.07	2.14	3.36	0.29	0.004	5.8
CD (5%)	0.14	4.49	7.05	0.62	0.01	12.22

90 kg P_2O_5 ha^{-1} with phosphobacteria application recorded increased number of total and filled seeds $head^{-1}$, higher seed weight and seed yield of sunflower. P is an important element for seed formation. This is very true with energy rich crops like sunflower, where for the synthesis of higher ATP, P is highly essential. Moreover, sufficient supply of P in the early stage of the growth must be a vital factor in the full development of seeds. Increased P availability at higher level of P application with phosphobacteria increased the photosynthetic rate and net assimilation rate which resulted in increased number and proper filling of seeds. The effect of these increased yield

Table 2. Seasonal total water consumption (mm)*

Particulars	*kharif* 1994			summer 1995		
	I_1	I_2	I_3	I_1	I_2	I_3
Number of irrigations	7	6	5	8	6	5
Seasonal irrigation (mm)	350	300	250	400	300	250
Soil moisture + effective rainfall (mm)	93.9	102.6	107.2	90.4	94.4	106.3
Seasonal total water (mm)	443.9	402.2	357.2	490.4	394.4	356.3
Irrigation intervals (days)	13	16	19	11	15	18
Daily water use (mm day^{-1})	4.77	4.32	3.84	5.57	4.48	4.05

* Data not statistically analysed

ttributing characters were finally reflected on the eed yield of sunflower.

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(Received : December 1996 Revised : May 1997)

adras Agric. J., 84(11,12): 698 - 699 November, December 1997

RESEARCH NOTES

EFFECT OF VITAMIN NUTRIENTS ON GERMINATION AND SEEDLING GROWTH OF CASUARINA

Casuarina equisetifolia is a popular ommercial tree in India. Germination of fresh eds of Casuarina ranges from 40 to 50 per cent in amil Nadu. The dismal germination potential of ulk seeds of *C. equisetifolia* is a major impediment in catering to the seedling demands of the entrepruners. GA, Kinetins, ABA, auxins, ethylene, vitamins and other regulatory substances are vitally important and their application to seeds intensify the metabolism and improve germination and plant

able 1. **Effect of vitamin nutrients on germination and seedling growth of *Casuarina***

Vitamin	Germination (%)	Root length (cm)	Shoot length (cm)	Drymatter production (mg/10 seedling)	Vigour index
scorbic acid					
1	51 (45.57)	1.21	2.90	14	210
2	53 (46.72)	1.20	2.90	15	217
3	53 (46.72)	1.33	2.90	15	225
4	55 (47.57)	1.98	3.10	16	278
5	58 (49.60)	2.07	3.40	16	298
aphthalic acid					
1	42 (40.40)	1.10	1.95	11	128
2	40 (39.23)	1.20	2.02	12	128
3	48 (43.85)	1.18	1.98	12	150
4	50 (45.00)	1.20	2.50	12	186
5	50 (45.00)	1.25	2.70	13	197
yridoxin					
1	50 (45.00)	1.12	2.80	16	196
2	51 (45.57)	1.12	2.90	17	205
3	54 (47.29)	1.36	2.90	17	229
4	56 (48.45)	1.36	3.10	17	250
5	60 (50.77)	1.48	3.40	18	290
ontrol	30 (32.21)	1.08	2.10	13	117
reatment					
Ed	0.721	0.627	0.0004	0.0004	6.2
D	1.473	0.1281	0.0009	0.0009	12.7
evels					
Ed	1.79	0.081	0.001	0.001	8.0
D	3.65	0.165	0.002	0.002	16.4
xL					
Ed	1.79	0.081	0.001	0.001	13.9
D	NS	0.155	NS	0.002	NS

igures in parantheses are transformed values)