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EFFECT OF MOISTURE, PLANT POPULATION AND FERTILIZER REGIMEN ON YIELD OF SUNFLOWER

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SUMMARY

Field experiments were conducted for three years (1984-1986) during summer season (Jan-Apr) at theUniversity of Agricultural Sciences, Bangalore, India, to study the effect of moisture regimes, plant density and fertilizer levels on grain yield of sunflower. Moisture regimes, plant density and fertilizer levels independently influenced the seed yield. At this agroclimatic condition prevailing during summer season around Bengalore, maximum seed yield in sunflower can be realised by irrigating the crop at 0.6 CPE at the plant density of 55,555 plants ha^{-1}. Increase in fertilizer levels increased the seed yield in sunflower and maximum seed yield was realised at the higher fertilizer dose of 90:135:90 kg N:P:K ha^{-1}.

Water use efficiency interms of seed yield produced per unit amount of irrigation water applied increased with increased quantity of irrigation. Increase in plant density reduced water use efficiency. Water use efficiency increased with increase in fertilizer levels.

Key words: Sunflower, moisture regimes, plant population, fertilizer regimes, water use, water use efficiency.

INTRODUCTION

Sunflower is credited with considerable drought resistance and a higher tolerance to low temperature and poor soils than many other crops. Whereas Rawson and Turner (1983) reported that sunflower is in efficient in its water economy. As regards the fertilizer requirement, it is reported that being a deep rooted crop, it is a heavy feeder. Still the effect of applied nutrients on seed yield and yield attributes have been often inconsistent. Plant population effects in sunflower have been studied by several workers but somewhat with conflicting results (Prunty, 1981). Jones (1984) was of the view that sunflower compensates within a wide range of populations by adjusting head size, seed weight and seed number.

Crop yields can be manipulated by varying moisture regimes, plant population and fertilizer doses. Having this in view, a field experiment was conducted to study the influence of moisture regimes, plant population and fertility regimes on yield and yield components of sunflower.

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MATERIALS AND METHODS

A field experiment was conducted for three years during 1984, 1985 and 1986 summer (January to April) at University of Agricultural Sciences, Bangalore, India. The soil of the experimental site was sandy loam. There was no rain during the experimental period during all the three years. The evaporation data for the crop growth period is presented in Table 1, and the soil moisture constants of the experimental site for two soil layers (0-15 and 15-30 cm) are given in Table 2.

The treatments included were two moisture regimes viz., weekly replenishment of 0.4 (I_1) and 0.6 (I_2) Cumulative Pan Evaporation (CPE), two plant density regimes of 55,555 (P_1) and 74,074 (P_2) plants ha^{-1}, and three fertility regimes viz., 30:45:30 (F_1), 60:90:60 (F_2) and 90:135:90 (F_3) kg N:P:K ha^{-1}. The twelve-factorial treatment combinations were laid out as a completely randomised block design with three replications. Sunflower cultivar BSH-1 was sown at a uniform depth of 5 cm and routine cultural and plant protection measures were followed.

The data pertaining to head diameter (cm), filled seeds per head (%), hundred seed weight (g), seed yield per plant and seed yield per hectare were recorded. The samples of grains from all the plots were collected and percentage of oil in grains was estimated by Soxlet extraction (AOAC, 1980). The water use was calculated by using the following formula.

Water use = (Depth of water [mm] at the beginning - Depth of water [mm] at the end) + Effective rainfall [mm] + Quantity of irrigation water applied [mm]

Water use efficiency was calculated as a ratio of grain yield to the water use. The data were statistically analysed with three factor ANOVA using personal computers with a statistical package M-STAT.

RESULTS AND DISCUSSION

Effect of moisture regimes

The grain yield differed significantly due to moisture regimes (Table 3). Higher grain yield was obtained with 0.6 CPE irrigation followed by 0.4 CPE in all years. Higher grain yield with 0.6 CPE is probably due to sufficient moisture throughout the crop growth. Similar results have been reported by Patel and Singh (1983), Suraj Bhan and Khan (1983) and Pal (1981).

Increase in grain yield due to increased moisture regimes can be attributed to grain yield per plant. Increase in grain yield per plant at higher level of available soil moisture can be attributed to increased hundred seed veight (4.2 g) and head diameter (14.2 cm), when compared to 0.4 CPE. Percentage of seed filling was not affected by moisture regimes. Such variations in yield parameters due to variation in moisture regimes have been reported by Jana et al. (1982). However, oil percentage was not influenced by moisture regimes.

Effect of plant population regimes

Maximum yield for a particular genotype at a given environment is realised at the density of plants at which the competition within the plant is minimal. Grain yield was

Table 1. Evaporation (mm) data during the months of crop stand in the field

Standard Week	Normal (1973-1983)	Actual 1984	1985	1986
1	4.2	4.2	6.8	5.2
2	4.9	6.4	5.5	5.4
3	4.6	6.4	5.0	5.5
4	5.5	7.0	7.2	6.3
5	5.7	6.9	6.4	6.1
6	5.2	6.7	6.7	6.5
7	3.7	6.5	6.4	6.6
8	6.3	7.2	7.2	7.5
9	6.3	8.0	7.3	7.9
10	4.2	8.1	7.5	7.8
11	7.1	7.7	7.9	8.1
12	9.8	7.8	7.8	8.6
13	8.6	7.4	8.4	8.4
14	8.7	6.6	8.6	8.5
15	7.3	6.2	8.6	8.5
16	8.2	6.6	9.2	8.3
17	8.9	7.6	8.2	8.0

Table 2. Soil moisture constants of the experimental site

Moisture constant	Depth (cm) 0-15	15-30
Field capacity (%)	14.86	16.65
Moisture percentage at 15 bars	3.38	6.32
Bulk density (g cc^{-1})	1.48	1.35

Table 3. Effect of moisture, population and fertilizer regimes on yield and yield components of sunflower

Treatment details	Seed yield (kg ha^{-1}) 1984	1985	1986	Mean	Head diameter (cm)	Filled seeds per head (%)	Hundred seed weight (g)	Seed yield per plant (g $plant^{-1}$)	Oil content (%)
					Mean of three years				
A. *Moisture regimen*									
0.4 CPE (I_1)	1658	1880	2325	1954	12.70	86.84	3.78	30.39	32.58
0.6 CPE (9_2)	2233	2345	2822	2467	14.19	86.74	4.23	39.05	32.98
F-test	*	*	*	*	*	N.S	*	*	N.S
LSD (P<0.05)	221	108	267	120	0.7	-	0.2	2.8	-
B. *Population regimen*									
55,555 (P_1)	2071	2294	2742	2369	14.12	87.41	4.12	38.31	32.89
74,074 (P_2)	1819	1931	2405	2052	12.77	86.17	3.88	31.14	32.66
F-test	*	*	*	*	*	N.S	*	*	N.S
LSD (P<0.05)	221	108	267	120	0.7	-	0.2	2.8	-
C. *Fertilizer regimen*									
30:45:30 (F_1)	1665	1870	2412	1982	13.19	87.18	3.79	32.44	31.71
60:90:60 (F_2)	2046	2246	2558	2283	13.59	87.03	4.12	35.95	33.41
90:135:90 (F_3)	2124	2223	2751	2366	13.56	86.16	4.09	35.77	33.21
F-test	*	*	N.S	*	N.S	N.S	*	*	*
LSD (P<0.05)	271	133	-	147	-	-	0.2	3.4	1.1

N.S = Non significant, LSD = Least significant difference

highest at the plant population of 55,555 plants per hectare during all the three years, followed by plant population of 74,074 plants per hectare.

At a plant density of 55,555 ha^{-1}, hundred seed weight, head diameter and grain yield per plant were more when compared to population level of 74,074 ha^{-1}. The oil percentage was not affected by plant population levels.

Effect of fertilizer regimes

Increase in the fertilizer regimes from F_1 to F_3 significantly increased the grain yield. Higher grain yield was obtained with F_3 followed by F_2. Similar results in grain yield due to variation in fertilizer regimes were also reported by Daulay and Singh (1980) and Blamey and Chapman (1981).

Yield parameters like head diameter, percent filled seeds, hundred seed weight and seed yield per plant showed an increase with increasing feltilizer levels. The oil percentage also increased significantly with increase in fertilizer regimes. Increase in oil percent at high levels of fertilizers can be attributed to increased nutrient availability and uptake by the plants. These results are in accordance with the findings of Vikram Singh (1977) and Roy et al. (1977).

Water use and water use efficiency

The influence of moisture, plant population and fertilizer regimes on water use and water use efficiency are presented in Figure 1. The water use differed significantly due to

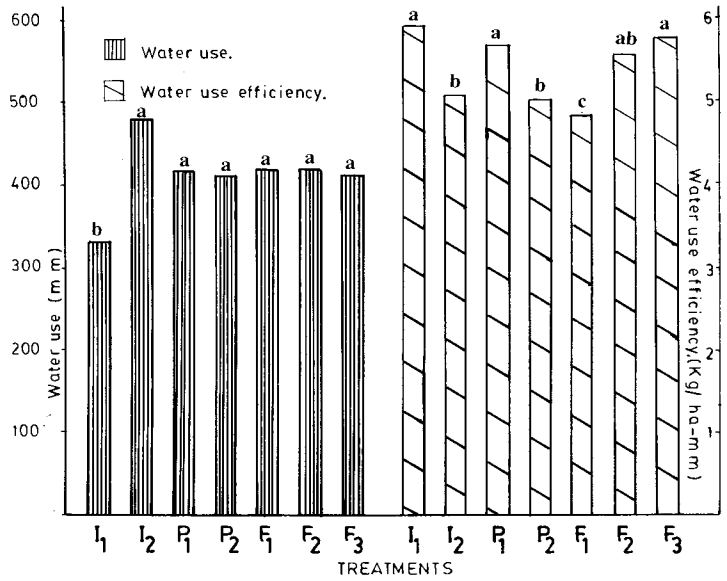

Figure 1. – Effect of moisture, plant population and fertilizer regimes on water use and water use efficiency of sunflower. (The bars with the same lower-case letter do not differ significantly at $p < 0.05$)
(I_1 - irrigation at 0.4 CPE; I_2 - irrigation at 0.6 CPE; P_1 - 55,555 plants ha^{-1}; P_2 - 74,074 plants ha^{-1}; F_1 - 30:45:30 kg N,P,K ha^{-1}; F_2 - 60:90:60 kg N,P,K ha^{-1}; F_3 - 90:135:90 kg N,P,K ha^{-1})

moisture regimes, but not due to plant population or fertilizer regimes. Higher water use of 492 mm was obtained with 0.6 CPE followed by 0.4 CPE (328 mm). However, the water use efficiency reduced significantly due to increased moisture regimes. High water use efficiency value of 5.95 kg ha^{-1} mm was obtained with 0.4 CPE followed by 0.6 CPE (5.01 kg ha^{-1} -mm). Water use efficiency value was maximum at higher fertilizer regimes. However, increase in plant density reduced water use efficiency value. At higher fertilizer levels the available water was used more efficiently for seed production resulting in high water use efficiency. At higher plant density increase in the production of more biomass might have reduced the water available for seed development resulting in reduced water use efficinency values.

CONCLUSIONS

Based on the fore going results, it can be concluded that moisture regimes, fertilizer levels and plant density influences seed yield in sunflower independently. At the agroclimatic conditions prevailing during summer at Bangalore, maximum seed yield can be realised by irrigating the plants at 0.6 CPE with a plant density of 55,555 per hectare. Increase in fertilizer levels increased the yield markedly and the maximum yield was realised at 90:135:90 kg N:P:K ha^{-1}. However, water use efficiency was higher at 0.4 CPE. Increase in plant density reduced WUE values. With increase in fertilizer levels the WUE also increased.

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EFECTO DEL REGIMEN DE HUMEDAD, POBLACION DE PLANTAS Y FERTILIZANTES EN EL RENDIMIENTO DE GIRASOL

RESUMEN

Se llevaron a cabo experimentos de campo durante tres annos (1984-1986) en la Universidad de Ciencias de la Agricultura Bangalore, India, para estudiar el efecto del régimen de humedad, población y fertilización sobre el rendimiento de girasol.

Fueron observadas diferencias significativas en rendimiento (de 1954 a 2467 kg/ha^{-1}), debido al inoremento del rógimen de humedad de 0.4 a 0.6 evaporación acumulada en tanque. El incremento en densidad de población de 55.555 a 74.074 plantas ha^{-1} disminuyó el rendimiento significativamente (2369 a 2052 kg/ha^{-1}). El rendimiento de semilla se incrementó también significativamente debido al incremento de los niveles de fertilización (1982 a 2366 kg/ha^{-1}). El porcentaje de aceite no fue afectado ni por la humodad ni la población pero varió significativamente debido a los niveles de fertilización.

El uso de agua y la eficiencia del uso de agua también variacion significativemente debido al regiment de humedad pero el uso de agua no fue afectado ni por la densidad de población ni por el régimen de fertilización.

EFFET DE L'HUMIDITE, DE LA DENSITE DE PEUPLEMENT ET DU REGIME DE FERTILISATION SUR LE RENDEMENT DU TOURNESOL.

RÉSUMÉ

Une expérimentation au champ a été conduite durant l'été et pendant trois années (1984-1986) à l'Université des Sciences Agricoles de Bengalore (Inde), pour étudier l'effet de l'humidité, du peuplement et des régimes de fertilisation sur la production grainière du tournesol.

Des différences significatives de rendement en graines ont été observées (1954 à 2467 kg Ha-1), par suite de l'augmentation de l'humidité de 0.4 à 0.6 (évaporation cumulée mesurée en bac). L'augmentation de la densité de peuplement de 55 555 à 74 074 plantes ha-1 diminue significativement le rendement en graines (2369 a 2052 kg ha-1). la production grainière a augmenté également de façon significative par suite de l'augmentation des régimes de fertilisation (de 1982 à 2366 kg ha-1). La teneur en huile n'apparaît pas influencée par le niveau d'humidité ou la densité de peuplement mais est significativement affectée par les régimes de fertilisation.

L'utilisation de l'eau et l'efficacité de l'utilisation de l'eau diffèrent aussi significativement selon le niveau d'humidité, mais ni la densité de peuplement ni les régimes de fertilisation n'ont affecté l'utilisation de l'eau.