Indian Journal of Agronomy **52** (1) : 77–79 (March 2007)

Effect of organic and inorganic sources of nitrogen with different irrigation schedules on growth and yield of sunflower (*Helianthus annuus*)

V. SUMATHI* AND D. S. KOTESWARA RAO

Department of Agronomy, S.V. Agricultural College, Tirupati, Andhra Pradesh 517 502

Received : July 2006

ABSTRACT

A field experiment was conducted during 2001 and 2002 to study the combined effect of organic and inorganic sources of nitrogen (N) with different irrigation schedules on growth and yield of sunflower (*Helianthus annuus* L.). There were three irrigation schedules (IW:CPE ratios 0.6, 0.8 and 1.0) and five N-management practices (the control, recommended dose of N through fertilizer, substitution of 25, 50 and 100 per cent recommended dose of N through FYM). Irrigation schedule at irrigation water (IW): cumulative pan evaporation (CPE) ratio 1.0 significantly improved the growth, yield, N uptake and net returns of sunflower. The supply of entire dose of N through fertilizer gave significantly higher values of all the parameters, which were on a par with those under 75 per cent N through fertilizer + 25 per cent N through FYM. The interaction of IW:CPE ratio 1.0 in combination with supply of entire dose of N through fertilizer resulted in better growth and yield.

Key words: Sunflower, Irrigation, FYM, Yield, Water-use efficiency, Uptake, Economics

Sunflower (*Helianthus annuus* L.) is a widely accepted and adapted oilseed crop. In the alfisols of southern agroclimatic zone of Andhra Pradesh, sunflower fits in very well with several cropping systems owing to its shorter duration and photo-insensitive nature. Positive effect of nitrogen and irrigation was reported by Tomar *et al.*, (1997). Though considerable research has been carried out since the introduction of sunflower in southern agroclimatic zone of Andhra Pradesh, the information on optimum combination of organic and inorganic sources of nitrogen for this crop along with different irrigation schedules was lacking. Hence this study was made.

MATERIALS AND METHODS

A field experiment was conducted at Tirupati during January to April 2001 and 2002. The experiment comprised three irrigation schedules, viz. irrigation water (IW): cumulative pan evaporation (CPE) ratios 0.6 (I_1), 0.8 (I_2) and 1.0 (I_3), and five nitrogen-management practices, viz. the control (N_0), 100 per cent recommended N through fertilizers (N_1), 75 per cent N through fertilizer + 25 per cent N through farmyard manure (FYM) (N_2), 50 per cent of the N through fertilizer and FYM (N_3) and 100 per cent through FYM (N_4). The treatments were replicated thrice and arranged in factorial randomized block design. The soils were sandy loam, neutral in reaction (pH 7.42), low in organic carbon (0.241%) and available N (168 kg/ha), and medium in available phosphorus (29.2 kg/ha) and potassium (197 kg/ha). The available moisture at field capacity was 22.75 mm and at permanent wilting point was 6.68 mm, with a bulk density of 1.38 g/cm^3. To avoid the seepage loss, around each plot 1 m deep and 30 cm wide trenches were dug and lined with polythene sheet. An equated amount of FYM for different treatments was calculated based on its nutrient composition (N=0.365, P= 0.261 and K=0.423%) and incorporated 15 days before sowing. The recommended dose of fertilizer was 80:50:30 kg/ha N, P_2O_5 and K_2O. The entire dose of P and K was applied basal and N was applied as per the treatment in two splits, i.e. half at sowing and the remaining half at 30 days after sowing (DAS) IrrigatioN was scheduled as per the treatment, when CPE reached 50.0, 62.5 and 83.3 mm for IW:CPE ratios 1.0, 0.8 and 0.6 respectively. Two common irrigations were given, one as pre-sowing and one at 7 DAS to ensure good plant stand. A measured quantity of water, equated to 50 mm, was applied to each plot. Sunflower ('MSFH 17') was sown at 45 x 30 cm spacing. All the plant-protection measures were adopted to ensure healthy crop.

RESULTS AND DISCUSSION

Growth parameters

Successive increase in the frequency of irrigation from IW:CPE ratio 0.6 to 1.0 significantly improved the growth

***Corresponding author :** E-mail : vuppucherla@rediffmail.com

parameters (Table 1). Among N-management practices, supply of entire dose of N through fertilizer recorded significantly higher growth parameters, which was however on a par with that under supply of 75 per ent N through fertilizer + 25 per cent N through FYM(N_2). The growth parameters were the lowest when the recommended dose of N was supplied through FYM, which was significantly superior to the control. The interaction between both the components was significant, where the combination of IW:CPE ratio 1.0 with supply of entire dose of N through fertilizer resulted in significantly superior growth parameters due to possible increase in N use, owing to adequate availability of soil moisture.

Yield attributes and yield

The yield attributes and yields were significantly more at IW:CPE ratio 1.0 than at IW:CPE ratio 0.8. This might be due to better moisture availability. Reduced yield attributes and yield at IW:CPE ratio 0.6 might be due to insufficient moisture during the critical stages i.e. at flowering, which is critical for determining the size of the sink (Velu and Palaniswamy, 2001).

Yield attributes (Table 1) and the yields of seed (Table 2) and stalk (Table 3) were significantly increased when the entire dose of N was supplied through fertilizer. Increased nitrogen assimilation due to adequacy of instant N ions might have increased the dry-matter production and better partitioning to yield. This nitrogen-management practice was, however, on a par with N_2. The yield attributes and yield of sunflower declined in proportion to the dose of nitrogen substitution through FYM, owing to slow release nature of N, which probably was not sufficient to meet the N requirement of the crop.

The interaction between both the components was significant, where the combination of IW:CPE ratio 1.0 with the supply of entire dose of nitrogen through fertilizer resulted in signficiantly superior yield attributes and yield (Table 2) than all other combination except I_3N_2.

Table 2. Seed yield (q/ha) of sunflower as influenced by irrigation schedule, nitrogen-management practices and their interaction (mean data of 2 years)

Treatment	N_0	N_1	N_2	N_3	N_4	Mean
I_1	5.7	15.3	14.6	13.2	11.7	12.1
I_2	6.3	18.7	17.6	16.6	15.8	15.0
I_3	7.8	20.0	19.4	18.6	16.9	16.5
Mean	6.6	18.0	17.2	16.1	14.8	
		I	*N*	*I×N*		
CD (P=0.05)		0.6	0.9	1.5		

Increased moisture availability had inverse relationship with oil content of seed; hence IW:CPE ratio 1.0 recorded the lowest oil content. This might be due to improved seed yield, which could have caused dilution effect of accumulated fatty acids in the seed. Similarly, oil content of seed was lowest when entire N was given as fartilizer. Sosa *et al.* (1999) reported similar results. The interaction between irrigation and N-management on oil content were not significant.

Moisture usage

The estimated moisture extraction from top layer of the soil (0-30 cm) was higher where the crop received the irrigation at IW:CPE ratio 1.0. When the irrigations were scheduled at IW:CPE ratio 0.6, the moisture extracted from the deeper layer of soil (30-60 cm) was higher than that at IW:CPE ratio 1.0. It is well documented that water deficit causes significant shift in the rooting pattern and decreases the root mass in the upper layer. Among the N-management practices, the moisture consumption was

Table 1. Growth and yield-attributes of sunflower as influenced by irrigation schedule and N-management (mean data of 2 years)

Treatment	Plant height at harvest (cm)	LAI at 60 DAS	Dry-matter production at harvest (kg/ha)	Head diameter (cm)	Seeds/ head	Filled seeds/ head	1,000-seed weight (g)
Irrigation schedule							
I_1	116.4	1.21	4,168	12.8	496	382	38.8
I_2	127.5	1.40	4,960	13.6	592	466	42.6
I_3	137.7	1.42	5,308	14.5	662	541	44.7
CD (P=0.05)	1.9	0.09	114	0.7	38	24	1.2
N-management practice							
N_0	99.9	0.89	3,190	9.9	351	251	38.1
N_1	140.0	1.58	5,449	15.5	684	562	45.2
N_2	138.3	1.56	5,344	15.0	653	536	44.1
N_3	131.1	1.41	5,211	14.4	646	498	42.5
N_4	126.6	1.37	4,864	13.5	589	453	40.1
CD (P=0.05)	2.4	0.13	130	0.9	50	40	1.5

Table 3. Stalk yield, moisture usage, nitrogen uptake and economics of sunflower as influenced by irrigation schedule and nitrogen-management practices (mean data of 2 years)

Treatment	Stalk yield (q/ha)	Oil content of seed (%)	Moisture-extraction pattern (%) at soil depth		WUE (kg/ha-mm)	N uptake (kg/ha)	Net retuns (Rs/ha)	Benefit : cost ratio
			0-30 cm	30-60 cm				
Irrigation schedule								
I_1	30.1	35.0	81.4	18.6	4.81	46.6	6,166	1.56
I_2	33.5	34.6	84.1	15.9	4.57	56.4	10,008	1.88
I_3	35.8	33.4	86.9	13.1	4.46	60.6	12,150	2.07
CD (P=0.05)	0.9	0.9			0.21	2.1	1,814	0.24
N-management practice								
N_0	21.5	36.8	83.7	16.3	36.8	31.2	492	1.06
N_1	37.7	33.3	86.7	13.3	33.3	63.8	13,922	2.24
N_2	37.0	33.5	85.6	14.4	33.5	62.3	13,412	2.23
N_3	35.6	33.8	85.0	15.0	33.8	59.7	11,897	1.91
N_4	33.5	34.1	84.9	15.1	34.1	55.5	7,612	1.57
CD (P=0.05)	1.3	1.4			1.4	2.6	2,114	0.31

higher from the top layer of the soil where entire dose of N was given through fertilizer, whereas reduced supply of N through fertilizer resulted in extraction of higher percentage of moisture from the deeper layers (30-60 cm).

The water-use efficiency (WUE) at IW:CPE ratio 0.6 was significantly higher because the decrease in irrigation frequency did not lead to proportional decrease in seed yield due to low stomatal conductance and photosynthetic acclimation to moisture stress. Nitrogen supplied through fertilizer had a favourable effect on WUE. Hence N_1 recorded significantly higher WUE, closely followed by N_2. The interaction of 1.0 IW:CPE ratio in combination with supply of entire dose of nitrogen through fertilizer achieved higher WUE, perhaps owing to higher dry-matter production, which was reflected in higher physiological activity of the crop to exploit the moisture supplied and available nitrogen, resulting in production of higher economic yield for every unit of water consumed by the crop. Sunil Kumar *et al.* (1992) also reported such a favourable interaction.

Nitrogen uptake and Economics

The highest nitrogen uptake was recorded with the irrigation at IW:CPE ratio 1.0, which was significantly superior to other two irrigation schedules. Increased nitrogen uptake was due to efficient root system with improved permeability, coupled with better absorption due to better availability of nutrients in the soil solution. The nitrogen uptake was the highest when the entire dose of nitrogen was supplied through fertilizer, which was on a par with that of N_2. Sunil Kumar *et al.* (1992) reported similar findings.

The net returns and benefit : cost ratio were higher when irrigation was scheduled at IW:CPE ratio 1.0, among the irrigation schedules, and when the entire dose of nitrogen was supplied through fertilizer. The interaction of entire dose of nitrogen through fertilizer in combination with IW:CPE ratio 1.0 gave higher net returns. However, the benefit:cost ratio obtained with N_1 and N_2 in combination with IW:CPE ratio 1.0 was found similar. The proportionate change in the cost of cultivation with the practices of N_2 was not reflected in proportionate change in seed yield. Hence the supply of 75 per cent N through fertilizer+ 25 per cent N through FYM at IW:CPE ratio 1.0 was considered economically feasible combination, which also satisfies the criteria of sustainability of soil health.

REFERENCES

Sosa, L.J., Echeverria, H.E., Dosia, G.A.A. and Aguirrezabal, L.A.N. 1999. Nitrogen nutrition of sunflower cultivated in Balcare (Buenos Aires, Argentina). *Ciencial del Suelo* **17**(1): 20–26.

Sunil Kumar, Dixit, R.S. and Tripathi, H.P. 1992. Effect of moisture regimes and nitrogen levels on growth and yield of sunflower (*Helianthus annuus* L.). *Narendra Deva Journal of Agricultural Research* **7:** 192–194.

Velu, G. and Palaniswamy, K. 2001. Impact of moisture stress and amelioration on growth and yield of sunflower. *Madras Agricultural Journal* **88**(10–18)**:** 660–665.

Tomar, H.P.S., Singh, H.P. and Dadhwal, K.S. 1997. Effect of irrigation, nitrogen and phosphorus on growth and yield of spring sunflower (*Helianthus annuus* L.). *Indian Journal of Agronomy* **42:** 169–172.