

## **Effect of genotype, irrigation and fertility on yield, nitrogen-recovery and its use efficiency in spring sunflower (*Helianthus annuus*)**

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### **ABSTRACT**

A 2-year field study was conducted with spring sunflower (*Helianthus annuus* L.) at Hisar, comprising 2 genotypes, 3 levels of irrigation and 5 levels of nitrogen + phosphorus. Sunflower hybrid 'MSFH 8' gave higher seed yield, N uptake, apparent N recovery as well as N-use efficiency. Scheduling irrigation at 0.6 ID : CPE ratio was better than other irrigation schedules for seed yield and N uptake at harvest. With each increment of N + P<sub>2</sub>O<sub>5</sub> level from 0 + 0 to 120 + 60 kg/ha, there was a significant increase in the seed yield as well as N uptake. Apparent recovery of applied N and N-use efficiency were higher when irrigation was scheduled at 0.6 ID : CPE ratio. Application of 30 + 15 and 60 + 30 kg N + P<sub>2</sub>O<sub>5</sub>/ha recorded higher apparent N recovery and N-use efficiency.

**Key words :** Sunflower, N, P, Irrigation, NUE, Yield

The productivity of sunflower is low mainly due to lack of judicious irrigation management and insufficient supply of nutrients, particularly of nitrogen and phosphorus. Semi-arid regions of northern plains have sandy-loam soil with low water-holding capacity, low amount of organic matter coupled with high pH causes deficiency of available N in these soils. The N-use efficiency (NUE) is considerably reduced due to N-losses in these soils. Nitrogen deficiency in these soils is further accentuated by low urease enzymic activities (Beri and Brar, 1978). The magnitude of N-use efficiency further depends on the degree of available soil water, which con-

trols the movement of N in the active root zone. Since the information is meagre on this aspect of sunflower, an experiment was conducted on N uptake, recovery and N-use efficiency in relation to irrigation and N and P application.

### **MATERIALS AND METHODS**

A field experiment was conducted during spring season of 1992 and 1993 at Hisar (75°46'E, 22°10'N, 215 m above mean sea-level). The soil was sandy loam (Typic Ustochrepts), consisting of 58.0% sand, 24.2% silt and 17.7% clay in 0–90 cm soil profile. It contained 18.3% soil moisture at

Table 1. Effect of variety, irrigation and fertilizer on seed yield (q/ha) of sunflower

Treatment	N + P <sub>2</sub> O <sub>5</sub> (kg/ha)					Mean
	0 + 0	30 + 15	60 + 30	90 + 45	120 + 60	
<i>Variety</i>						
'EC 68415 C'	10.50 (8.86)	13.41 (12.36)	15.70 (15.05)	17.40 (16.65)	18.34 (17.84)	15.07 (14.15)
'MSFH 8'	13.02 (12.60)	17.13 (16.15)	19.84 (18.24)	21.50 (19.91)	22.71 (20.88)	18.84 (17.56)
<i>Irrigation (ID : CPE ratio)</i>						
0.2	8.30 (7.95)	12.21 (11.60)	14.71 (13.87)	16.94 (15.91)	18.18 (16.15)	14.06 (13.09)
0.4	12.95 (11.85)	16.34 (15.32)	18.77 (17.77)	20.15 (19.15)	21.23 (20.70)	17.89 (16.96)
0.6	14.00 (12.40)	17.27 (15.83)	19.82 (18.28)	21.26 (19.80)	22.20 (21.25)	18.89 (17.51)
Mean	11.76 (10.73)	15.27 (14.25)	17.77 (16.64)	19.95 (18.28)	20.53 (19.36)	
CD (P = 0.05)						
Variety		0.95 (1.25)				
Irrigation		1.17 (1.39)				
Fertilizer		1.03 (1.17)				

Figures in parentheses refer to those of 1993

Table 2. Effect of variety, irrigation and fertilizer on N uptake (kg/ha) in seed of sunflower

Treatment	N + P <sub>2</sub> O <sub>5</sub> (kg/ha)					Mean
	0 + 0	30 + 15	60 + 30	90 + 45	120 + 60	
<i>Variety</i>						
'EC 68415 C'	19.6 (18.1)	29.1 (28.1)	38.2 (38.1)	43.5 (45.6)	54.7 (52.3)	37.0 (38.4)
'MSFH 8'	24.2 (26.2)	36.9 (36.3)	47.2 (45.1)	52.7 (54.0)	61.1 (61.4)	44.3 (46.6)
<i>Irrigation (ID : CPE ratio)</i>						
0.2	14.8 (14.2)	23.8 (22.7)	33.2 (31.9)	39.8 (38.8)	46.7 (46.4)	31.7 (30.9)
0.4	24.4 (24.9)	35.1 (36.6)	45.8 (46.0)	50.2 (54.6)	63.3 (60.7)	43.7 (44.6)
0.6	26.9 (26.3)	39.2 (35.8)	49.7 (47.7)	54.9 (56.8)	66.2 (62.7)	47.4 (45.9)
Mean	22.0 (21.9)	32.6 (31.9)	42.9 (41.8)	48.2 (50.0)	58.4 (56.8)	
CD (P = 0.05)						
Variety		3.40 (3.90)				
Irrigation		2.53 (4.28)				
Fertilizer		2.86 (3.37)				

Figures in parentheses refer to those of 1993

**Table 3.** Effect of variety, irrigation and fertilizer on apparent N recovery (%) in seed of sunflower

Treatment	N + P <sub>2</sub> O <sub>5</sub> (kg/ha)				Mean
	30 + 15	60 + 30	90 + 45	120 + 60	
<i>Variety</i>					
'EC 68415 C'	31.5 (33.5)	30.9 (33.3)	28.5 (30.6)	27.2 (28.5)	29.5 (31.6)
'MSFH 8'	39.2 (33.8)	38.3 (32.1)	31.6 (30.8)	30.7 (29.3)	35.0 (31.9)
<i>Irrigation (ID : CPE ratio)</i>					
0.2	31.9 (28.8)	30.8 (28.6)	27.8 (27.4)	25.8 (26.9)	28.9 (27.9)
0.4	36.0 (39.1)	35.7 (35.2)	32.7 (33.0)	31.4 (29.8)	33.9 (34.3)
0.6	41.1 (39.6)	38.1 (35.7)	33.0 (33.9)	31.7 (30.3)	36.0 (34.9)
Mean	35.7 (34.9)	34.8 (32.9)	30.7 (31.2)	29.4 (29.0)	

Figures in parentheses refer to those of 1993

**Table 4.** Effect of variety, irrigation and fertilizer on N-use efficiency (kg seed/kg N applied) in sunflower

Treatment	N + P <sub>2</sub> O <sub>5</sub> (kg/ha)				Mean
	30 + 15	60 + 30	90 + 45	120 + 60	
<i>Variety</i>					
'EC 68415 C'	14.5 (14.7)	12.7 (13.2)	10.1 (11.1)	9.8 (9.7)	11.8 (12.2)
'MSFH 8'	18.3 (15.0)	16.2 (13.7)	12.9 (11.4)	11.4 (10.0)	14.7 (12.5)
<i>Irrigation (ID : CPE ratio)</i>					
0.2	15.5 (14.2)	13.6 (12.9)	11.8 (11.5)	10.3 (9.8)	12.8 (12.1)
0.4	16.7 (16.4)	16.7 (13.6)	11.5 (11.6)	10.9 (10.1)	13.9 (12.7)
0.6	19.4 (14.3)	16.7 (14.2)	12.6 (11.8)	11.0 (10.3)	14.9 (12.9)
Mean	16.9 (14.9)	14.8 (13.5)	11.8 (11.9)	10.7 (10.0)	

Figures in parentheses refer to those of 1993

-0.03 MPa and 8.0% at -1.5 MPa on gravimetric basis with bulk density of 1.41-1.45 g/cc. The soil contained 115 kg available N, 15 kg available P and 315 kg available K, with pH 8.1. The weather during 1992 was dry (16.4 mm precipitation, April 3.6 and May 12.8 mm) but cloudy at reproductive stage. During 1993, 12.2, 7.3, 10.7 and 10.5 mm rain was received during February, March, April and May respectively. In 1992, pan evaporation (mm/day) was 3.1, 4.3, 5.6 and 9.2 during February, March, April and May. In 1993, pan evaporation for corresponding months was 3.4, 3.8, 5.9 and 10.0 mm/day. The experiment was laid out in split-plot design, having 3 replications with combination of 2 sunflower genotypes ('EC 68415 C' and 'MSFH 8') and 3 irrigation schedules (ID : CPE ratios of 0.2, 0.4 and 0.6) in main plots,

and 5 fertilizer levels (N and P<sub>2</sub>O<sub>5</sub> @ 0 + 0, 30 + 15, 60 + 30, 90 + 45 and 120 + 60 kg/ha) in subplots.

The crop was sown on 16 and 17 February in 1992 and 1993 respectively with pre-sowing irrigation. Seeds were dibbled at 30-cm interval in rows 60 cm apart. Full dose of N and P as per treatments was drilled at the time of sowing. Post-sowing irrigations to sunflower were scheduled at fixed ID : CPE ratios keeping irrigation depth 6 cm.

## RESULTS AND DISCUSSION

### Seed yield

In both the years, hybrid 'MSFH 8' gave significantly higher seed yield than composite 'EC 68415 C', increase being 25.0 and 24.4% in 1992 and 1993 respectively (Table 1). It could be due to higher yield potential as

a consequence of better yield components of 'MSFH 8' than 'EC 68415 C'. Irrigation at 0.6 ID : CPE ratio recorded significantly higher seed yield than that of 0.2, but was on a par with 0.4. The seed yield was 33.9 and 3.5% higher with irrigation scheduling at ID : CPE 0.6 than ID : CPE 0.2 and 0.4 respectively. Higher seed yield with this treatment could be due to higher plant water status as a consequence of stomatal conductance, resulting in higher rate of cell-division and cell-elongation and better partition of photosynthates for development of seeds (Evans and Wardlaw, 1976). Application of 120 kg N + 60 kg P<sub>2</sub>O<sub>5</sub>/ha gave higher seed yield, however, it did not differ significantly from that with 90 kg N + 45 kg P<sub>2</sub>O<sub>5</sub>/ha. On an average, the seed yield was 31.34, 53.05, 67.09 and 75.01% higher with 30 kg N + 15 kg P<sub>2</sub>O<sub>5</sub>, 60 kg N + 30 kg P<sub>2</sub>O<sub>5</sub>, 90 kg N + 45 kg P<sub>2</sub>O<sub>5</sub> and 120 kg N + 60 kg P<sub>2</sub>O<sub>5</sub> than no N + P<sub>2</sub>O<sub>5</sub> application (control). The response of sunflower to applied NP might be ascribed to the favourable effect on plant vigour and yield attributes. The findings confirm the results of Sarmah *et al.* (1992) and Kathuria *et al.* (1995).

### Nitrogen uptake

'MSFH 8' recorded significantly higher N uptake in seed than 'EC 68415 C' (Table 2), due to higher seed yield of 'MSFH 8' than 'EC 68415 C'. Sarmah (1991) also reported varietal differences in N uptake in sunflower. The N uptake in seed was highest at 0.6 ID : CPE ratio. The decrease in ID : CPE ratio from 0.6 to 0.2 reduced the N mobility and consequently the N uptake in seed. It could be due to reduction in seed yield under 0.2 ID : CPE ratio than at higher ratio. The results confirm the findings of Vivek (1990). Application of N + P<sub>2</sub>O<sub>5</sub> increased the N uptake in

seed with each increment of NP fertilizers, but the magnitude of increase was comparatively more between 0 + 0 and 60 + 30 kg N + P<sub>2</sub>O<sub>5</sub>/ha.

### Apparent N recovery

'MSFH 8' recorded higher apparent N recovery than 'EC 68415 C' when irrigation was scheduled at 0.6 ID : CPE ratio. Higher N recovery was recorded with 30 + 15 and 60 + 30 kg N + P<sub>2</sub>O<sub>5</sub>/ha (Table 3). Similarly, recovery of applied N was higher with 90 + 45 kg N + P<sub>2</sub>O<sub>5</sub>/ha compared with 120 + 60 kg N + P<sub>2</sub>O<sub>5</sub>/ha.

### N-use efficiency

'MSFH 8' recorded higher N-use efficiency than 'EC 68415 C'. The highest N-use efficiency was recorded when irrigation was scheduled at 0.6 ID : CPE ratio (Table 4). N-use efficiency decreased with each successive increase in N + P<sub>2</sub>O<sub>5</sub> level.

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