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Effect of phosphorus and sulphur fertilization in safflower (*Carthamus tinctorius*)

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ABSTRACT

A field experiment was conducted during 1990–91 and 1991–92 under partial irrigated condition to evaluate the effect of phosphorus and sulphur on productivity of safflower (*Carthamus tinctorius* L.) in Vertisol. Growth, yield and yield-attributing characters increased with P level up to 17.6 kg/ha over the control. However, no significant difference was noticed between 17.6 and 26.4 kg P/ha and 26.4 and 17.6 kg P/ha, giving 19.21 and 13.82% higher seed yield over the control respectively. Seed yield and number of branches/plant increased significantly up to 20 kg S/ha, while plant height, capitulum/plant and biomass yield were significantly better at 40 kg S/ha. No significant difference existed between 40 and 60 kg S/ha, recording 20.07 and 16.35% more seed yield over the control. Interaction of P and S was significant only for seed yield, 17.6 kg P with 20 kg S/ha recorded significantly higher seed yield. Maximum additional net return of Rs 3,649.80 and Rs 3,963/ha was recorded at 26.4 kg P/ha and 40 kg S/ha respectively. Better cost : benefit ratio was obtained at 17.6 kg P and 20 kg S/ha.

There is an immense possibility of growing safflower (*Carthamus tinctorius* L.) in Vertisol of Madhya Pradesh as winter-season (*rabi*) crop, since it is hardy in nature and has capacity to withstand drought conditions (Knowles and Miller 1965). Little fertilizers are used in this crop with practically no application of phosphorus and sulphur. Yield of oilseed crops can increased by application of P and S (Tandon, 1984). The present investigation was therefore conducted to study the response of safflower to P and S in Vertisol of north-western Madhya Pradesh under partial irrigated conditions.

MATERIALS AND METHODS

An experiment was conducted during 1990–91 and 1991–92 under partial irrigated condition at College of Agriculture, Mandsaur. Experimental soil was clay loam with pH 8.2, organic carbon 0.68%, electrical conductivity 0.457 mmhos/cm and available N, P, K and S @ 265, 9.03, 310 and 18 kg/ha respectively. Four levels each of P (0, 8.8, 17.6 and 26.4 kg/ha) and of S (0, 20, 40 and 60 kg/ha) in all 16 combinations were tested in randomized block design with 3 replications. N and K each @ 25 kg/ha and full dose of phosphorus were applied basal through urea, muriate of potash and diamonium phosphate respectively. The sulphur were applied through elemental sulphur 21 days before sowing and just irrigated for ready convertion in available form. Remaining 25 kg N/ha was top-dressed at 30 days after sowing. Plot size was 1.8 m x 3.0 m with row-to-row and plant-to plant

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distances of 45 and 15 cm respectively. 'JSF 2' safflower was used in the experiment. Observations were recorded on 10 random plants/plot on capitulum/plant. Biomass and seed yield were recorded on plot basis and converted in q/ha. Economics was also worked out. Pooled analysis was performed.

RESULTS AND DISCUSSION

Growth and yield attributes

Significant response to phosphorus levels was observed in all growth and yield-attributing characters. Plant height, number of branches and capitulum/plant increased significantly with increasing levels of P up to 17.6 kg/ha and further increase in dose of 26.4 kg P/ha did not increase the values in these characters. No significant response of 8.89 kg P/ha was obtained over the control for plant height, but it increased branches and capitulum/plant over the control. Better test weight was observed at higher levels of P and the minimum at the control (Table 1).

Increasing levels of S inceased plant height, branches and capitula/plant. Signifiantly more plant height and capitula/plant were observed up to 40 kg S/ha. Response to 20 kg S/ha was not significant with the control for plant height. Number of branches/plant was signifiantly superior at 20 kg S/ha than the control. No significant difference existed between 40 and 60 kg S/ha for plant height, number of branches and capitula/plant. A marginal increase in test weight was observed with increasing dose of sulphur.

Seed yield, biomass production and harvest index

Seed yield, biomass yield and harvest index increased with increasing levels of P up to 17.6 kg/ha and no significant difference was noticed between 17.6 and 26.4 kg P/ha, though marginal increase in values were noted at 26.4 kg P/ha for these characters (Table 2). P @ 8.8 kg/ha was significantly superior to the control for biomass yield and harvest index. However, 0 and 8.8 kg P/ha did not differ significantly for seed yield. P @ 26.4, 17.6 and 8.8 kg/ha gave 19.21, 13.82 and 6.75% higher seed yield than the control respectively. Non-significant difference was also noticed between 8.8 and 17.6 kg P/ha for harvest index. Similar results were reported by Ahmed *et al.* (1985), Sagre *et al.* (1986) and Veer *et al.* (1992). Since phosphorus plays an important role in extensive root development and translocation of photosynthates and phospholipids, its application increases different growth and yield parameters.

Significantly superior harvest index was observed for 60 kg S/ha with no significant difference between 20 and 40 kg S/ha for this character. Biomass yield increased significantly up to 40 kg S/ha, but seed yield increased significantly up to 20 kg S/ha; however, 60, 40 and 20 kg S/ha recorded 16.35, 20.07 and 14.88% higher seed yield than the control respectively. Lowest values of seed yield and harvest index were recorded at 0 kg S/ha. Biomass yield at 0 kg S/ha was found on a par with 20 kg S/ha. Similar results were reported in oilseed crops by Rathore and Tomar (1990). The improved nutritional management as a result of increased sulphur supply might have favourably influenced by carbohydrate metabolism and this favourable effect led to increased transformation of photosynthates towards yield and yield-attributing characters with slight increase in test weight.

All interaction combinations containing 0 level of S or P recorded significantly lower seed yield than other combinations higher level except 8.8 kg P/ha, 20 kg S/ha, which

Table 1. Effect of P and S levels on growth and yield attributes in safflower

Treatment	Plant height (cm)			Branches/plant			Capitulum\plant			Test weight (g)	
	A	B	Pooled	A	B	Pooled	A	B	Pooled	A	B
P (kg/ha)											
0	96.42	98.50	97.56	7.84	7.33	7.58	29.67	28.08	28.87	4.15	4.08
8.8	96.92	102.05	99.49	9.25	8.08	8.66	36.33	31.67	34.00	4.42	4.30
17.6	99.25	105.67	102.46	9.64	8.75	9.19	38.92	32.00	35.46	4.49	4.58
26.4	100.92	106.92	103.84	10.95	9.00	9.97	40.83	32.42	36.62	4.51	4.58
CD (P = 0.05)	3.38	5.98	3.47	1.76	0.83	0.98	3.23	3.52	2.40		
S (kg/ha)											
0	95.28	98.91	97.08	7.75	7.50	7.62	31.50	26.33	28.91	4.17	4.21
20	97.92	101.92	99.92	9.12	8.25	8.68	36.17	31.42	33.79	4.35	4.31
40	100.50	106.08	103.29	10.41	8.75	9.58	38.41	33.25	35.83	4.49	4.52
60	99.83	106.25	103.04	10.39	8.67	9.53	39.67	33.17	36.42	4.57	4.50
CD (P = 0.05)	3.38	5.98	3.47	1.76	0.83	0.98	3.23	3.52	2.40		

A, 1990–91; B, 1991–92

Table 2. Effect of P and S levels on seed yield, biomass production and harvest index in safflower

Treatment	Seed yield (q/ha)			Biomass yield (q/ha)			Harvest index (%)		
	A	B	Pooled	A	B	Pooled	A	B	Pooled
P (kg/ha)									
0	22.36	26.26	24.31	118.75	125.67	122.21	16.62	22.00	19.31
8.8	24.13	27.78	29.95	124.42	133.33	128.87	17.12	23.16	20.14
17.6	25.44	29.91	26.67	136.08	134.92	135.50	17.57	23.92	20.74
26.4	26.01	31.95	28.98	139.50	139.42	139.46	18.41	23.83	21.12
CD (P = 0.05)	1.08	3.38	1.70	8.16	4.45	4.65	0.92	1.17	0.75
S (kg/ha)									
0	21.92	25.67	23.79	122.67	126.50	124.58	16.00	21.92	18.96
20	25.82	28.84	27.33	126.75	131.33	129.04	17.57	23.25	20.41
40	26.03	31.30	28.66	133.08	136.67	134.87	18.46	23.58	21.02
60	24.28	31.08	27.68	136.25	138.83	137.54	17.69	24.17	20.93
CD (P = 0.05)	1.08	3.38	1.70	8.16	4.45	4.65	0.92	1.17	0.75

A, 1990–91; B, 1991–92

Table 3. Interaction effect of P and S on seed yield of safflower

S (kg/ha)	P (kg/ha)				
	0	8.8	17.6	26.4	Mean
0	21.29	23.05	25.21	25.62	23.79
20	24.12	25.57	28.51	31.17	27.33
40	27.72	27.69	30.12	29.14	28.66
60	24.13	27.52	28.51	29.99	27.68
Mean	24.31	25.95	27.67	28.98	
CD (P = 0.05)			4.82		

Table 4. Economics of P and S application in safflower

Treatment	Pooled seed yield (q/ha)	Seed yield increased over control (%)	Additional seed yield over control (q/ha)	Additional income (Rs/ha)	Additional cost of fertilizer (Rs/ha)	Additional net return (Rs/ha)	Cost : benefit ratio
P (kg/ha)							
0	24.31						
8.8	25.95	6.75	1.64	1,476	148.40	1,292	1 : 8.00
17.6	27.67	13.82	3.36	3,024	368.80	2,655	1 : 8.20
26.4	28.98	19.21	4.67	4,203	553.20	3,650	1 : 7.60
S (kg/ha)							
0	23.79						
20	27.33	14.88	3.54	3,186	210.00	2,976	1 : 15.17
40	28.66	20.07	4.87	4,283	420.00	3,963	1 : 10.44
60	27.68	16.35	3.89	3,501	630.00	2,871	1 : 5.56

Cost of P, Rs 9.22 and of S, Rs 10.00/kg; safflower seed, Rs 900/q

Table 5. Economics of interaction P x S combination (Rs/ha)

S (kg/ha)	P (kg/ha)				
	0	8.8	17.6	26.4	Mean
0	19,161	20,664	22,527	22,815	21,291
20	21,508	22,732	25,297	27,610	24,287
40	24,548	24,440	26,546	25,583	25,279
60	21,117	24,087	24,897	26,148	24,062
Mean	21,583	22,981	24,816	25,539	
CD (P = 0.05)			4,338		

was on par with combinations having lower level (Table 3). All higher level combinations recorded significantly better seed yield. The highest seed yield was obtained at 17.6 kg P/ha + 40 kg S/ha. The best combinations for seed yield would be 17.6 kg P/ha + 20.0 kg S/ha and 8.8 kg P/ha + 40 kg S/ha on the basis economics (Table 5).

Economics

Maximum additional net return of Rs 3,649.80 and Rs 3,963.00/ha was observed at 26.4 kg P/ha and 40 kg S/ha respectively (Table 4). However, better cost : benefit ratio was obtained at 17.6 kg P/ha and 20 kg S/ha. Increase in seed yield over the control ranged from 1.64 to 4.67 q/ha for P levels and from 3.54 to 4.87 q/ha for S levels. The higher cost : benefit ratio was obtained at lower levels of P and S because of increased cost of fertilizers.

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