

the of N (90 kg/ha) resulted in reduction in oil content in seeds. These findings are in accordance with the observations of Singh and Saran (1987) and Singh *et al.* (1988).

Sulphur application had no significant effect on growth and yield attributes except seeds/siliqua and 1,000-seed weight; however, it had a marked effect on oil content, and seed and oil yields. The increase in oil content due to 45 kg S/ha was 12.5% compared well no sulphur. The highest seed and oil yields were obtained with 45 kg S/ha and the magnitude of increase at this level compared with no S, 15 and 30 kg S/ha was 23.1, 16.2 and 11.1% for seed yield; and

36.7, 21.9 and 11.8% for oil yield respectively. Similar results were also reported by Singh and Saran (1987).

Increasing levels of N and S increased the seed and oil yields of *toria*. Oil (%) increased linearly with S application and decreased above 60 kg N/ha.

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Response of sunflower (*Helianthus annuus*) to planting date and seed rate in rice fallows

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Sunflower (*Helianthus annuus* L.) is a new introduction in northern hills zone of Madhya Pradesh. However, information on its planting date with varying seed rates is not available under agro-climatic conditions of this zone. The present experiment was therefore conducted to evaluate the production potential of sunflower under varying planting dates and seed rates after harvest of rice.

The experiment was conducted during

the winter season (*rabi*) of 1990-91 at Ambikapur (23°-8' N and 83°-15' E) on sandy-loam soil, having 180, 14 and 270 kg/ha of available N, P₂O₅ and K₂O respectively, with pH 6.1. The experiment was laid out in split-plot design with combinations of 3 planting dates (15 December, 25 December and 4 January) and 3 seed rates (6, 8 and 10 kg/ha). A uniform dose of 40 kg N, 30 kg P₂O₅ and 20 kg K₂O/ha was applied at the time of sowing. Remaining 40 kg N/ha was

Table 1. Effect of planting date and seed rate on growth and seed yield of sunflower

Treatment	Plant population/m	Plant height (cm)	Seed yield (q/ha)	Net income (Rs/ha)	Benefit : cost ratio
<i>Planting date</i>					
15 December	3.7	160.1	6.50	1,431	1.28
25 December	4.2	159.8	6.22	1,151	1.23
4 January	3.9	145.4	5.47	401	1.08
CD (P = 0.05)	NS	10.6	0.55		
<i>Seed rate (kg/ha)</i>					
6	3.6	151.1	5.17	131	1.03
8	3.9	154.7	6.23	1,161	1.23
10	4.4	159.6	6.79	1,691	1.33
CD (P = 0.05)	0.6	4.6	1.01		

Market cost of sunflower seed @ Rs 1,000/q and labour cost @ Rs 24/day

applied at 45 days after sowing as top-dressing. Crop received 6 irrigations excluding 127.7 mm rains during crop season.

Sunflower-plant population was not influenced by different dates of sowing, but plant height significantly decreased due to delayed sowing. Sowing on 4 January significantly lowered the plant height compared with plant height recorded due to sowing on 15 and 25 December. Higher seed yield by 18.8 and 13.7% obtained respectively due to sowing on 15 and 25 December than that due to sowing on 4 January. However, difference in seed yield was not found significant between 15 and 25 December sowings. Application of seed at various levels caused significant variation in the plant population, plant height and also the yield of sunflower. The higher seed rate of 10 kg/ha gave significantly higher plant

population (4.4 plant/m) than the plant population (3.6 plant/m) recorded with lower seed rate (6 kg/ha). The plant height which tended to decline with delayed sowing, was also significantly increased with the use of higher seed rate (10 kg/ha) than that recorded at 6 kg/ha seed rate. Accordingly, higher seed rate (10 kg/ha) gave significantly higher seed yield (6.79 q/ha) than the lower seed rate (6 kg/ha), but it was on a par with the yield obtained with the 8 kg/ha seed rate.

Sowing on 15 December gave the highest net income (Rs 1,431/ha) on the basis of each rupee invested (1 : 1.28), followed by sowing on 25 December (Rs 1,151/ha) and 4 January (Rs 401/ha). The highest net return (Rs 1,691/ha) on each rupee invested (1 : 1.33) was also obtained with the use of 10 kg seed/ha compared with 6 and 8 kg seed/ha.