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Effect of different nutrient management practices on growth and yield of hybrid sunflower (*Helianthus annuus* L.)

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Abstract
A field experiment was conducted during *rabi* season of 2009-10 at oilseeds research station, Latur to study the effect of different nutrient management practices on growth and yield of hybrid sunflower (LSFH-35). The investigation was carried out in RBD design with three replication and nine no. of treatments (different fertilizer levels along with micronutrient involving nine treatment combinations were tested) such as T_1 = 100% NP, T_2 = 50% RDF, T_3 = 100% RDF, T_4 = 150% RDF, T_5 = RDF + Sulphur, T_6 = RDF + Sulphur + Boron, T_7 = RDF + Sulphur + Boron + Zinc, T_8 = RDF + Sulphur + Zinc, T_9 = control. The result of experiment revealed that among the treatments, application of 150% RDF was recorded significantly higher growth, yield attributes and yield over T_9 (control), T_2 (50% RDF), T_1 (100% NP) and T_3 (100% RDF), whereas, it was at par with the application of T_7 (RDF + S + B + Zn), T_6 (RDF + S + B), T_8 (RDF + S + Zn) and T_5 (RDF + S).

Keywords: Sunflower, nutrient management, micronutrient, RDF, growth, yield attributes and yield

Introduction
Sunflower (*Helianthus annuus* L.) belongs to family Compositae originated in North America and was recently introduced in India as an oilseed crop for commercial cultivation. Sunflower is one of the most important oil seed crops due to high quality nutritional value, favourable agricultural policies and it holds great promise because of its short duration, photo-insensitivity, wide adaptability and drought and salinity tolerance. It can be grown round the year and can serve as an ideal catch crop during the periods when land is otherwise left fallow (Aglave *et al.*, 2009) [1]. India is the largest grower of sunflower during 2006-07. Around 2.3 million ha, were planted in the country accounting for nearly 10% of the total sunflower area in the world (Anonymous, 2008) [3]. The average yield of 500-600 kg ha^{-1} in India is one of the lowest as compared to world average of 1322 kg ha^{-1} (Anonymous, 2003) [2]. The important sunflower growing states in the country are Karnataka, Andhra Pradesh, Maharashtra and Tamil Nadu. Almost 50% of the area and production is accounted by Karnataka followed by Andhra Pradesh, Maharashtra and Tamil Nadu. Maharashtra ranks third in area and production. In Maharashtra sunflower is grown on an area of 3.55 lakh ha with the production of 2.06 lakh tonnes having productivity of 580 kg ha^{-1} (Shekhawat *et al.*, 2009) [6].
Effects of N fertilization on sunflower yield and quality have come under scientific scrutiny (Hocking and Steer, 1995) [4], because N is a major nutrient for plants and it increases total biomass production, yield and its components. Phosphorus is necessary to increase oil content and potash helps in grain filling and disease resistant. Sulphur is an essential secondary plant nutrient and plays a vital role in improving yield and quality of oilseed crops. Our country is facing acute shortage of edible oils mainly because of heavy demand due to population pressure, raised standard of living and high demand from oil consuming industries. This demand is partly meet by import of edible oils. Under such situation it needs to build up self – sufficiency in oil production through potential oilseed crop to meet the situation.
Sunflower oil is a rich source of linoleic acid which helps in washing out cholesterol deposition in the coronary arteries of the heart and thus is good for heart patient.

Sunflower seed is highly nutritious containing 45-50% quality oil and high amount of quality protein in cake *i.e.*, 40-44%. It contains about 30-35% carbohydrates (Robertson and Russel, 1972) [5]. Sunflower is a photo and thermo-insensitive crop. During monsoon season, loss of N is quite obvious hence its rational application at right stages of crop growth is desired for higher productivity.

Materials and Methods

The field experiment was conducted during *rabi* season of the year 2009-10 at oilseeds research station, Latur to study the effect of different nutrient management practices on growth and yield of hybrid sunflower (LSFH-35). The experimental field was levelled and well drained. The soil was clayey in texture, low in nitrogen (175.61 kg ha^{-1}), low in phosphorus (14.25 kg ha^{-1}), rich in potash (343.15kg ha^{-1}) and alkaline in reaction.

One hybrid and nine no. of treatments *i.e.*, different fertilizer levels along with micronutrient involving nine treatment combinations were tested in randomized block design (RBD) with three replications. The treatments details are T_1 = 100% NP, T_2 = 50% RDF, T_3 = 100% RDF, T_4 = 150% RDF, T_5 = RDF + Sulphur, T_6 = RDF + Sulphur + Boron, T_7 = RDF + Sulphur + Boron + Zinc, T_8 = RDF + Sulphur + Zinc, T_9 = control. The net plot size was 4.2 m X 3 m. Sowing was done on 1st November, 2009. The spacing of 60 cm X 30 cm was maintained. The recommended cultural practices and plant protection measures were taken.

Results and Discussion

Effect nutrient management on growth and growth attributes

The effect of different treatments was noticed on important growth parameters *viz.*, plant height (cm), number of functional leaves, Mean head diameter (cm) and total dry matter $plant^{-1}$ (g) presented in Table 1 and it was influenced significantly due to various nutrient management practices. The application of 150% RDF (T_4) was recorded significantly higher mean plant height (168.2 cm) and higher mean number of functional leaves (27.06) over control treatment (T_9), 100% NP (T_1), 50% RDF (T_2) and 100% RDF (T_3), whereas, it was at par with RDF + S + B + Zn (T_7), RDF+S+B (T_6), RDF + S + Zn (T_8) and RDF + S (T_5). The application of RDF + S + B + Zn (T_7) was recorded significantly higher mean plant height over the control (T_9), 100% NP (T_1) and 50% RDF (T_2), whereas it was at par with the RDF + S + B (T_6), RDF + S + Zn (T_8), RDF + S (T_5) and 100% RDF (T_3). The application of 100% RDF (T_3) was significantly superior over control (T_9), whereas, it was at par with the100% NP (T_1) and 50% RDF (T_2).

At harvest, the application of 150% RDF (T_4) was recorded significantly higher mean head diameter (13.20 cm) and total dry matter accumulation (142.1 g) over control (T_9), 100% NP (T_1) and 50% RDF (T_2), whereas, it was at par with the RDF + S + B + Zn (T_7), RDF + S + B (T_6), RDF + S + Zn (T_8), RDF + S (T_5) and 100% RDF (T_3). The application of RDF + S + B (T_6) and RDF + S + Zn (T_8) was recorded significantly higher mean head diameter over control treatment (T_9), whereas it was at par with the RDF + S (T_5), 100% RDF (T_3), 50% RDF (T_2) and 100% NP (T_1).

The application of 150% RDF (T_4) was recorded significantly higher total dry matter accumulation (142.1 g) than control treatment (70.6 g), 100% NP (T_1), 100% RDF (T_3) and RDF+S (T_5), whereas, it was at par with the RDF + S + B + Zn (T_7), RDF + S + B (T_6) and RDF + S + Zn (T_8). The application of RDF + S + B + Zn (T_7) was significantly superior over control treatment (T_9) and 50% RDF (T_2), whereas, it was at par with the RDF + S + B (T_6), RDF + S + Zn (T_8), RDF + S (T_5), 100% RDF (T_3) and 100% NP (T_1). The lowest total dry matter accumulation was observed in T_9 (control treatment) was 70.6 g.

Table 1: Mean plant height (cm), number of functional leaves, mean head diameter (cm) and total dry matter (g) of sunflower as influenced by various treatments.

Trt. No.	Treatment details	Plant height (cm)	Number of functional leaves	Mean head diameter (cm)	Total dry matter (g)
T_1	100% NP	149.2	23.46	10.53	85.5
T_2	50% RDF	147.5	21.86	10.53	77.3
T_3	100% RDF	151.6	23.93	11.80	96.8
T_4	150% RDF	168.2	27.06	13.20	142.1
T_5	RDF + Sulphur	151.1	23.93	11.73	97.8
T_6	RDF + Sulphur + Boron	157.4	24.53	11.80	118.8
T_7	RDF + Sulphur + Boron + Zinc	158.9	24.80	12.30	122.4
T_8	RDF + Sulphur + Zinc	151.6	24.06	11.80	110.8
T_9	Control	130.0	18.80	9.93	70.6
	SE(m)+	5.78	0.965	0.570	13.0
	C.D. at 5%	17.3	2.89	1.70	38.9
	General mean	151.6	23.60	11.51	102.5

Effect nutrient management on yield and yield attributes

The data on mean seed yield (kg ha^{-1}), stalk yield (kg ha^{-1}), dry weight of capitulum (kg ha^{-1}) and harvest index (%) of sunflower as influenced by various treatments are presented in Table 2. The effect of different fertilizer levels along with micro nutrients on seed yield (kg ha^{-1}) was found to be significant. The application of 150% RDF was significantly higher seed yield 1300 kg ha^{-1} over control (T_9), 100% NP (T_1), 50% RDF (T_2), 100% RDF (T_3), RDF + S (T_5) and RDF + S + Zn (T_8), whereas, it was at par with the RDF + S + B + Zn (T_7) and RDF + S + B (T_6). The application of RDF + S + B + Zn (T_7) was recorded significantly higher seed yield 1135 kg ha^{-1} over control (T_9) and 50% RDF (T_2), whereas, it was at par with the application of RDF + S + B (T_6), RDF + S + Zn (T_8), RDF + S (T_5), 100% RDF (T_3) and 100% NP (T_1). The lowest seed yield 738 kg ha^{-1} was observed in control treatment.

Table 2: Seed yield (kg ha^{-1}), stalk yield (kg ha^{-1}), dry weight of capitulum (kg ha^{-1}), harvest index (%) of sunflower as attributes influenced by different treatments.

Trt. No.	Treatment details	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Dry weight of capitulum (kg ha^{-1})	Harvest index (%)
T_1	100% NP	981	3666	1640	18.48
T_2	50% RDF	940	3638	1493	19.86
T_3	100% RDF	1042	3701	1847	18.78
T_4	150% RDF	1300	4125	2744	21.42
T_5	RDF + Sulphur	1101	3970	1956	18.07
T_6	RDF + Sulphur + Boron	1117	4016	2140	18.23
T_7	RDF + Sulphur + Boron + Zinc	1135	4029	2209	18.19
T_8	RDF + Sulphur + Zinc	1071	4000	2057	18.17
T_9	Control	738	3438	1214	15.89
	SE(m)+	62.49	131.2	116.0	
	C.D. at 5%	187.07	392.8	346.8	
	General mean	1054	3842	1866	18.56

The effect of fertilizer levels along with micronutrients on stalk yield (kg ha^{-1}) was found to be significant. The application 150% RDF was recorded significantly higher stalk yield 4125 kg ha^{-1} over control, 50% RDF (T_2), 100% NP (T_1) and 100% RDF (T_3), whereas, it was at par with the application of RDF + S + B + Zn (T_7), RDF + S + B (T_6), RDF + S + Zn (T_8) and RDF + S (T_5). The application of RDF + S + B + Zn (T_7) was significantly superior over control treatment, whereas it was at par with rest of all the treatments.

The application of 150% RDF (T_4) was recorded was significantly higher dry weight of capitulum 2722 kg ha^{-1} over control (T_9), 50% RDF (T_2), 100% NP (T_1) and 100% RDF (T_3), whereas, it was at par with the application of RDF + S + B + Zn (T_7), RDF + S + B (T_6), RDF + S + Zn (T_8) and RDF + S (T_5). The application of RDF + S + B (T_6) was significantly superior over control (T_9), 100% NP (T_1), 50% RDF (T_2), RDF + S + B + Zn (T_7), RDF + S (T_5) and 100% RDF (T_3). The application of RDF + S (T_5) was significantly superior over control (T_9) and 50% RDF (T_2), whereas, it was at par with 100% RDF (T_3) and 100% NP (T_1). In respect of dry weight of capitulum the lowest dry weight of capitulum was observed in control treatment. The data on harvest index (%) as influenced by various treatments are presented in Table 2. The mean harvest index (%) was recorded as 18.56%.

Conclusion

On the basis of present investigation, it may be concluded that for getting maximum height application of 150% RDF was found best to sunflower crop. More growth attributes (viz., plant height, number of functional leaves, head diameter and total dry matter accumulation) and yield and yield attributing characters viz., seed yield (kg ha^{-1}), stalk yield (kg ha^{-1}), Dry weight of capitulum (kg ha^{-1}) were found higher with application of 150% RDF (T_4), RDF + S + B + Zn (T_7), RDF + S + B (T_6), RDF + S + Zn (T_8) and RDF + S (T_5) to sunflower crop.

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