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Effect of Nitrogen and Spacing on Growth and Yield of Sunflower (*Helianthus annuus* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was carried out during *kharif season* of 2022, at crop research farm of Department of Agronomy at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj in North Eastern plains of Eastern Uttar Pradesh, India with the objective to study the effect of nitrogen and spacing on growth and yield of Sunflower (*Helianthus annuus* L.)with 10 treatments of which treatments (T_1-T_{10}) with different combination of nitrogen along with spacing and T_{10}The soil experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1)

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The result revealed that application of 70 kg N/ha + 55 X 20 cm recorded Maximum plant height (148.48 cm), plant dry weight (60.53 g), test weight (41.40 g), capitulum diameter (15.13 cm). seed yield (1918.65) , Stover yield (3818.31). Harvest Index % (33.45 %).

Keywords: Growth; sunflower; nitrogen (N); spacing; yield.

1. INTRODUCTION

Oil seed production ranks second in importance next to food production. The shortage of edible oil has become a chronic economic and dietary problem in India with increasing demographic pressure. To increase the production of existing oilseeds and to bridge the gap between demand and supply, several attempts were made in the country during recent past through horizontal and vertical expansion including introduction of new oilseed crops for enhancing the oilseed production. Sunflower (*Helianthus annuus* L.) crop, native of South America and Mexico was introduced into India in the year 1969 with a view to supplement the yield of traditional oilseed crop [1].

Sunflower is one of the most important oil seed crop grown in temperate countries. It is a major source of vegetable oil in the world. In India it has gained popularity due to the national priority of vegetable oil production. India is one of the largest producers of oilseed crop in the world. Oilseeds occupy an important position in the Indian agricultural economy. It is an important oil seed crop contributes 14% of the total oilseed production from other major oil seed crops Among nutrients, nitrogen plays an important role in growth and yield of sunflower [2].

Nitrogen is the most essential, because it increase in root and leaf length, leaf area duration, photosynthesis and increase seed yield (Faisal et al. 2005, Khaliq et al. 2008, Nasim et al. 2011). Nutrient which helps early growth, better assimilation of carbohydrates and synthesis of proteins and as such must be supplied throughout the growth period of the crop. It also affects the seed quality by increasing protein, leads to increase in vegetative, reproductive growth and yield of the crop [2]. The plant spacing is an important factor, the optimum plant population should be maintained in the field for getting higher yield per unit area. reported that achene yield increased with increasing row spacing. Over crowding effecting sunflower yield and achenes oil percentage The number of seeds per head and the mean seed weight decrease significantly with an increasing plant density [3].

Plant spacing effects are highly pronounced in sunflower because there is no possibility of covering gaps between plants by branching or tillering. Thus, an optimum plant stand helps in harnessing the natural resourced in efficient manner towards achieving high crop yields. on the ground (planting geometry/spatial arrangement) as it helps in efficient harvesting of solar energy with least competition. Plant spacing effects are highly pronounced in sunflower because there is no possibility of covering gaps between plants by branching or tillering. Thus, an optimum plant stand helps in harnessing the natural resourced in efficient manner towards achieving high crop yields [4].

2. MATERIALS AND METHODS

A field experiment was conducted during *kharif* season of 2022, at Crop research farm of Department of Agronomy at Sam Higginbottom University of Agriculture, Technology, and Sciences, Praygraj which is located at 25^{o}24' 42" N latitude, 81^{o}50' 56" E longitude and 98 m altitude above the mean sea level (MSL). To assess the effect of nitrogen and spacing on growth and yield of Sunflower (*Helianthus annuus* L.). The experiment was laid out in Randomized Block Design comprising of 10 treatments which are replicated thrice. Each treatment net plot size is 3m × 3m. The treatment are categorized as with recommended dose of Nitrogen through Urea, Phosphorus through DAP and Potash through Muriate of Potash, in addition with sulphur when applied in combinations as follows, (T_1) 50 kg N/ha + 45 X 20 cm, (T_2) 50 kg N/ha + 55 X 20 cm, (T_3) 50 kg N/ha + 65 X 20 cm, (T_4) 60 kg N/ha + 45 X 20 cm, (T_5) 60 kg N/ha + 55 X 20 cm, (T_6) 60 kg N/ha + 65 X 20 cm, (T_7) 70 kg N/ha + 45 X 20 cm, (T_8) 70 kg N/ha + 55 X 20 cm, (T_9) 70 kg N/ha + 65 X 20 cm, (T_{10}) Control. “The sunflower crop was harvested treatment wise at harvesting maturity stage. Growth parameters viz. plant height (cm), dry matter accumulation (g/ plant) were recorded manually on five randomly selected representative plants from each plot of

each replication separately and after harvesting, seeds were separated from each net plot and were dried under sun for three days. Later winnowed, cleaned and grain yield per ha was computed and expressed in kgs per hectare. After complete drying under sun for 10 days stover yield from each net plot was recorded and expressed in kgs per hectare. The data was computed and analysed by following statistical method" of Gomez and Gomez [5]. The benefit: cost ratio was worked out after price value of seed with stover and total cost included in crop cultivation.

3. RESULTS AND DISCUSSION

3.1 Effect on Growth Parameters

3.1.1 Plant height

The application of 70 N kg/ha + Spacing 55x20 cm, resulted in the highest plant height was reported in Treatment 8 (148.48 cm), significantly superior overall other and treatments with 60 kg N/ha + 55 X 20 cm (147.67 cm) and Control (147.34 cm) was statistically at par with treatment 70 N kg/ha + Spacing 55x20. An increase in plant height with higher levels of nitrogen was probably due to its beneficial effect on cell elongation which might have resulted in internodal elongation. Thus, adequate supply of nitrogen might have helped the plants to grow taller in comparison to 50 and 60 kg N ha^{-1}. Similar findings were also reported by Taha et al. [6] and Sarkar et al. [7]. Plant height increased with decrease in plant density. Taller plant height in 55 X 20 cm spacing might be due to competition between space, light, carbon dioxide, oxygen and humidity which forced the plants to grow vertically rather than horizontally. The present findings are in accordance with Nawaz et al. [8].

3.1.2 Dry matter plant

The application of Nitrogen 70 kg/ha + Spacing 45x20 cm, resulted in the highest Dry matter of plant Treatment No-8 (60.53 g/plant) significantly superior overall other and treatments with 60 kg N/ha + 55 X 20 cm (59.37 g/plant) was statistically at par with treatment 70 N kg/ha + Spacing 55x20.The dry weight of sunflower increased significantly due to application of nitrogen. Dry matter production related to grain productivity contributes an important factor in source – sink relationship. Higher dry matter production attributed to enhanced photosynthesis accumulation. Wider row spacing provided more space around each plant resulting in better vegetative growth which ultimately resulted in plant dry weight. These results are in conformity with those reported by Reddi Ramu and Maheshwara Reddy [9] and Sarkar and Mallick [7], Ravichandran and Srinivasan [10].

3.2 Yield and Attributes

3.2.1 Capitulum diameter (cm)

Treatment 70 kg N/ha + 55 X 20 cm resulted in significantly highest capitulum diameter (15.13 cm). However, 60 kg N/ha + 55 X 20 cm was found to be statistically on par with 70 kg N/ha + 55 X 20 cm.

3.2.2 No. of seeds/Capitulum

Treatment 70 kg N/ha + 55 X 20 cm resulted in significantly highest seeds per capitulum (354.67). However, 60 kg N/ha + 55 X 20 cm and Control was found to be statistically on par with 70 kg N/ha + 55 X 20 cm.

3.2.3 Test weight

The statistical analysis on test weight was found to be significant. However, highest test weight (41.40 g) was recorded with treatment 70 kg N/ha + 55 X 20 cm and whereas treatment 60 kg N/ha + 55 X 20 cm, control (41.40 g and 40.33 g respectively) was found to be statistically at par with treatment 70 kg N/ha + 45 X 20 cm.

Significant increase in Capitulum diameter, number of seeds per capitulum and test weight was favoured by higher levels of nitrogen. Improved stem elongation and accumulated photosynthates as manifested by higher LAI and dry matter might have been responsible for larger head (Capitulum) diameter. Thus, higher Photosynthetic activity with adequate nitrogen fertilization enabled the plant to accumulate more dry matter and greater translocation of photosynthates to the developing head resulting in larger flower heads. Similar results were also obtained by Reddy et al. [11], Reddi and Reddy [9] and Sarkar and Mallick [7]. Maximum head diameter and test weight was observed in spacing (55 X 20 cm), it might be due to less competition exerted for light, moisture and nutrients, Sufficient interception of sunlight promotes efficient photosynthesis activities and ultimately greater accumulation of photosynthates under wider spacing. Narrow spacing with dense plant population resulted in the lower value of yield attributes. The reduction

in yield at with increase in plant density could be attributed to keen competition for moisture, photosynthesis and solar radiation. In wider spacing might be attributed to relatively less inter plant competition because of more space availability to individual plant. Similar results were also obtained by Sen et al. [12], Kumar et al. [13], Ali et al. [14].

3.2.4 Seed yield

Observations regarding seed yield (Kg/ha), stover yield (Kg/ha) and harvest index (%) of sunflower as influenced by nitrogen and spacing are depicted. The seed yield showed increasing trend with the application of nitrogen in sunflower. The highest seed yield was obtained with the treatment 70 kg N/ha + 45 X 20 cm (2102 Kg), however no other treatment was found to be statistically on par with 70 kg N/ha + 45 X 20 cm.

3.2.5 Stover yield

The stover yield of sunflower was also influenced by the application of nitrogen and spacing. Highest stover yield (4287.9 kg/ha) was recorded 70 kg N/ha + 45 X 20 cm, however, no other treatment was found to be statistically on par with 70 kg N/ha + 45 X 20 cm.

Table 1. Effect of Nitrogen and Spacing on Growth & yield Parameters of Sunflower

Sl no.	Treatment	Plant Hight	Dry weight
1	50 kg N/ha + 45 X 20 cm	141.19	52.16
2	50 kg N/ha + 55 X 20 cm	142.03	53.83
3	50 kg N/ha + 65 X 20 cm	139.73	50.15
4	60 kg N/ha + 45 X 20 cm	143.00	54.49
5	60 kg N/ha + 55 X 20 cm	147.67	59.37
6	60 kg N/ha + 65 X 20 cm	140.73	51.17
7	70 kg N/ha + 45 X 20 cm	144.82	56.51
8	70 kg N/ha + 55 X 20 cm	148.48	60.53
9	70 kg N/ha + 65 X 20 cm	141.43	53.29
10	Control	147.34	57.69
	F Test	S	S
	SEm(±)	1.00	0.53
	CD (P=0.05)	2.97	1.56

Table 2. Effect of Nitrogen levels and spacing on yield and yield attributes of Sunflower

S. No	Treatments	Capitulum diameter (cm)	Test weight (g)	Seed yield (Kg/ha)	Stover yield (Kg/ha)	Harvest index (%)
1	50 kg N/ha + 45 X 20 cm	12.70	36.27	1883.35	3830.76	32.96
2	50 kg N/ha + 55 X 20 cm	13.30	38.60	1692.81	3448.24	32.93
3	50 kg N/ha + 65 X 20 cm	12.03	35.22	1394.07	2855.08	32.81
4	60 kg N/ha + 45 X 20 cm	13.67	39.12	2003.72	4067.13	33.00
5	60 kg N/ha + 55 X 20 cm	14.67	40.33	1812.11	3642.39	33.22
6	60 kg N/ha + 65 X 20 cm	12.37	35.52	1514.87	3085.84	32.93
7	70 kg N/ha + 45 X 20 cm	14.03	39.25	2102.00	4287.92	32.89
8	70 kg N/ha + 55 X 20 cm	15.13	41.40	1918.65	3818.31	33.45
9	70 kg N/ha + 65 X 20 cm	13.00	38.36	1638.20	3310.80	33.10
10	Control	14.47	39.81	1646.63	3293.34	33.33
	SEm(±)	0.18	0.64	29.60	59.60	0.04
	CD (5%)	0.53	1.90	87.95	177.07	0.12

Table 3. Effect of Nitrogen and Spacing on Oil content of sunflower var. 'KBSH-1'

Sr. no	Treatment	Percentage (%)
1	50 kg N/ha + 45 X 20 cm	37.47
2	50 kg N/ha + 55 X 20 cm	39.80
3	50 kg N/ha + 65 X 20 cm	36.42
4	60 kg N/ha + 45 X 20 cm	40.32
5	60 kg N/ha + 55 X 20 cm	41.01
6	60 kg N/ha + 65 X 20 cm	36.72
7	70 kg N/ha + 45 X 20 cm	40.45
8	70 kg N/ha + 55 X 20 cm	41.53
9	70 kg N/ha + 65 X 20 cm	39.56
10	Control	42.27
	F test	NS
	SEm±	1.35
	CD (P=0.05)	-

3.2.6 Harvest index

The data showed significant difference in harvest index, however, 70 kg N/ha + 45 X 20 cm recorded highest value of (33.45 %) and lowest value (32.81 %) was recorded 50 kg N/ha + 65 X 20 cm.

Higher seed and stover yield under higher nitrogen application was due to good growth and availability of adequate nitrogen might lead to increased accumulation of amino acid and amide substance and their translocation to the reproductive organs has improved the seed yield through increased seed setting and filling. It was evident that plant spacing increased up to 45 X 20 cm showed highest seed and stover yield but increased spacing beyond this decreased the seed and stover yield per plant to noticeable extent. The results are similar with results obtained by Seshadri Reddy et al. [15], Reddi Ramu and Maheswara Redy [9] and Sarkar and Mallick [7], Kumar et al. [13], Ali et al. [14,16].

3.3 Oil Content

The data revealed that there was no significant increase in oil content. The highest oil content was found in the treatment T_{10} control (42.27 %).

4. CONCLUSION

It was concluded that Treatment of 70 kg N/ha + 55 X 20 cm recorded Maximum plant height (148.48 cm) , plant dry weight (60.53 g/plant) , test weight (41.40 g), capitulum diameter (15.13 cm) and Number of seeds/ capitulum(354.67) , Test weight (41.40) , seed yield (2102.00 kg/ha), Stover yield (4287.92 kg/ha) , Harvest index (32.89 %) which may be more preferable for farmers. There for the trails may be required form farther conformation.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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