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Effect of spacing and boron on growth and yield of sunflower (*Helianthus annuus*. L)

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Abstract
The field experiment entitled "Effect of Spacing and Boron on growth and yield of Sunflower" was conducted during *Rabi* season of 2025 at Crop Research Farm Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The soil of experimental plot was sandy loam in texture. nearly neutral in soil reaction (pH 7.3), low in organic carbon (0.60%), available nitrogen (178.48 kg/ha), available phosphorus (41.3 kg/ha) and available potassium (244.6 kg/ha). The experiment was laid out in a Randomized Block Design with ten treatment which are replicated thrice. The treatment combinations are T_1 - Spacing 30 x 30 cm along with Boron 200 ppm, T_2 - Spacing 30 x 30 cm along with Boron 300 ppm, T_3- Spacing 30 x 30 cm along with Boron 400 ppm, T_4- Spacing 45 x 30 cm along with Boron 200 ppm, T_5 - Spacing 45 x 30 cm along with Boron 300 ppm,T_6 - Spacing 45 x 30 cm along with Boron 400 ppm, T_7 - Spacing 60 x 30 cm along with Boron 200 ppm, T_8 - Spacing 60 x 30 cm along with Boron 300 ppm, T_9 Spacing 60 x 30 cm along with Boron 400 ppm, T_{10} - Control (RDF)-N:P: K -60:45:45 kg/ha. The result showed that the significant and higher Plant height (139.26), Plant dry weight (30.35 g), Number of seeds/capitulum (125.53), Test weight (46.64 g), Seed yield (1440.20 kg/ha), Stover yield (2429.62 kg/ha) were recorded in treatment 7 (Spacing 60 x 30 cm along with Boron 200 ppm), Maximum Gross return (107698.63 ₹/ha), Net return (73658.63 ₹/ha) and B:C ratio (2.16) was also recorded in treatment 7 (Spacing 60 x 30 cm along with Boron 200 ppm).

Keywords: Spacing, boron, growth, yield, economics, Sunflower (DRSHI)

Introduction

Sunflower (*Helianthus annuus* L.) is one of the four most important annual oilseed crops cultivated worldwide. In India, sunflower is grown on approximately 0.9 million hectares, producing 0.63 million tonnes annually with an average productivity of 696 kg ha^{-1} (2011-12). Under rainfed conditions, the crop has the potential to yield at least 1,000 kg ha^{-1}, and under assured rainfall or irrigated conditions, yields may reach up to 1,500 kg ha^{-1}. Karnataka accounts for nearly half of the total sunflower-growing area in the country and ranks first in both area and production, followed by Andhra Pradesh and Uttar Pradesh. Uttar Pradesh reports the highest productivity, while Tamil Nadu records the lowest (Abhishek *et al*., 2024) [1].

Sunflower, which belongs to the family *Compositae*, originated in Mexico and Peru and was introduced into India in the 16th century. It is considered one of the most important edible oilseed crops due to its premium-quality oil, which is rich in polyunsaturated fatty acids (PUFA), especially linoleic acid, and contains almost no linolenic acid. Sunflower oil contains about 64% linoleic acid, which helps reduce cholesterol deposition in coronary arteries, making it beneficial for heart health. Its oil is widely used in cooking, vanaspati manufacturing, and industries such as paint, soap, and cosmetics. The oil cake, containing 40-44% high-quality protein, serves as an excellent feed ingredient for poultry and livestock. Although sunflower cultivation in India gained prominence only in the last three decades, its contribution to achieving self-sufficiency in edible oils and supporting the "Yellow Revolution" has been significant (Mangala Rai, 2002) [12]. Sunflower seed oil content is typically estimated using solvent extraction methods in a Soxhlet apparatus.

Plant spacing is a critical agronomic factor influencing sunflower productivity. Optimal row and plant spacing ensure proper plant population, which directly affects seed yield and oil quality. Research indicates that narrow row planting systems have considerable potential to enhance yields, particularly in oilseed hybrids (Rauf *et al*., 2012) [17]. Since sunflower plants do not exhibit branching or tillering, they cannot compensate for gaps in plant stands. Therefore, maintaining an optimal plant population is essential for maximizing resource utilization and achieving higher yields (Kumar *et al*., 2011) [8].

Boron (B) plays a crucial role in sunflower production, as sunflower is highly sensitive to B deficiency. One of the major causes of low productivity in sunflower is poor seed setting and a high percentage of chaffy seeds in the central portion of the capitulum. Micronutrients, especially boron, significantly improve seed-setting percentage by enhancing growth and yield attributes. Boron is essential for cell wall synthesis, root elongation, glucose metabolism, nucleic acid synthesis, lignification, and tissue differentiation (Karthikeyan *et al*., 2008) [6]. Sunflower has a particularly high requirement for boron and, depending on soil conditions, may also require other micronutrients. Nutrient uptake by sunflower roots is greatly influenced by soil properties, especially soil pH, and the availability of micronutrients in the soil (Prabhakar *et al*., 2021) [16].

Sunflower productivity can be substantially improved by optimizing agronomic practices, among which plant spacing and boron nutrition are two critical factors that significantly influence growth, seed setting, yield, and oil quality.

Materials and Methods

An experiment was rigorously performed during the *Rabi* season of 2025 at the Crop Research Farm, an integral part of the Department of Agronomy at Naini Agricultural Institute, itself a component of Sam Higginbottom University of Agriculture, Technology and Sciences, situated in Prayagraj, to investigate the effects of spacing and boron treatments, both individually and in combination, on crop performance. The soil at the experimental site was characterized as sandy loam, exhibiting a pH of 7.3, indicating near neutrality, alongside a deficiency in organic carbon (0.60%), as well as low available levels of Nitrogen (178.48 Kg/ha), Phosphorus (41.3 Kg/ha), and Potassium (244.6 Kg/ha), which are essential macronutrients for plant growth and development, suggesting a need for nutrient supplementation to optimize crop yields. To ensure statistical validity and minimize the impact of environmental variability, the experiment was meticulously designed following a Randomized Block Design, incorporating a total of 10 treatment combinations, each replicated thrice. The treatment combinations are T_1 - Spacing 30 x 30 cm along with Boron 200 ppm, T_2 - Spacing 30 x 30 cm along with Boron 300 ppm, T_3- Spacing 30 x 30 cm along with Boron 400 ppm, T_4- Spacing 45 x 30 cm along with Boron 200 ppm, T_5 - Spacing 45 x 30 cm along with Boron 300 ppm,T_6 - Spacing 45 x 30 cm along with Boron 400 ppm, T_7 - Spacing 60 x 30 cm along with Boron 200 ppm, T_8 - Spacing 60 x 30 cm along with Boron 300 ppm, T_9 Spacing 60 x 30 cm along with Boron 400 ppm, T_{10} - Control (RDF)-N:P: K -60:45:45 kg/ha. Data recorded on different aspects of crop, *viz.*, plant height (cm), plant dry weight (g), seeds/capitulum, test weight (g), seed yield (t/ha), stover yield (t/ha) and harvest index were statistically analysed by analysis of variance method as described by Gomez and Gomez (1976) [7]. Economics were also calculated, *viz.*, Cost of cultivation, Gross return, Net return and benefit-cost ratio.

Chemical analysis of soil

A composite soil sample was collected before laying out the experiment to determine the initial soil characteristics. The soil sample was taken from a depth of 0-15 cm, air-dried in the shade, ground with a wooden pestle and mortar, filtered through a 2 mm sieve, and used for analysis. Organic carbon availability and the black technique were according to Jackson (1973) [4], available nitrogen was determined by the alkaline permanganate method by Subbiah and Asija (1956), and phosphorus availability was measured using Olsen's colorimeter method as described by Olsen *et al*. (1954) [15].

Statistical analysis

The experimental data gathered underwent a statistical analysis of variance (ANOVA) as described by Gamez and Gomez (1984). Analysis of variance (ANOVA), as it relates to randomized block design, was used to statistically examine the observed data of ten treatments. Critical Difference (CD) values were computed, and the 'F' test was significant at the 5% level Mohan *et al.*

Results and Discussions

Growth parameter

Plant Height

Significantly higher plant height (139.26 cm) was recorded with spacing 60cm x 30 cm along with Boron 200 ppm. However, spacing 30cm x 30cm along with Boron 300 pp was found to be statistically at par with spacing 60cm x 30cm along with Boron 200 ppm. Plant height, leaves/plant, stem girth, leaf area index and dry weight/plant were superior under medium spacing, due to better resource availability and reduced interplant competition in the community. The poor yield at 30 cm × 30 cm, corresponding to 1.1 lakh plant/ha might be ascribed to more congestion and severe competition for light, space and nutrients Kumar *et al*. (2011) [8]. Both boron and nitrogen were found to interact positively to improve the growth parameters suggesting enhanced assimilation of nitrogen in the presence of sufficient boron contents Jagadala *et al*. (2020) [5].

Plant Dry weight

Significantly highest dry weight (30.35 g/plant) was recorded with 60cm x 30cm along with Boron 200 ppm at 100 DAS. However, spacing 60cm x 30cm along with Boron 400 ppm were found to be statistically at par with spacing 60cm x 30cm along with Boron 200 ppm. Higher green forage yield with 30 cm row spacing might be due to the higher values of plant height, number of leaves per plant, leaf length, leaf width, green leaf weight per plant, green stem weight per plant and green forage yield per plant**.**

The dry matter and seed yields of sunflower and mustard crops increased with increasing levels of boron and Sulphur. The interaction effect between B and S significantly and synergistically influenced the dry matter yield of sunflower, Karthikeyan *et al.* (2008) [6]

Yield attributes

Number of seeds/capitulum

In number of seeds/capitulum significantly highest number of seeds/capitulum (125.53) was recorded with spacing 60cm x 30cm along with Boron 200 ppm. However, spacing 60 x 30 cm along with Boron 400 ppm was found to be statistically at par with spacing 60cm x 30cm along with

Boron 200 ppm. Application of boron increased seed diameter, which may be due to greater Anthes pollen production capacity and pollen grain viability. Sunflower seed yield was enhanced by the role of boron in enhancing pollen viability and stigma susceptibility, which increases seed quantity and increases photosynthetic transfer to sink, which increases seed yield Kumar *et al.* (2024) [1]. positive interaction between B and S might synergistically enhance the dry matter and seed yields, Ravikumar *et al.* (2021) [20].

Test weight (g)

Test weight (g) recorded at harvest stage, is presented in Table 4.5. The data shown that significantly highest test weight (46.64 g) was observed with Spacing 60 x 30 cm along with Boron 200 ppm. However, spacing 45 x 30 cm along with Boron 200 ppm was found to be statistically at par with Spacing 60 x 30 cm along with Boron 200 ppm.

Seed Yield (kg/ha)

The treatment consisting of 60 cm × 30 cm spacing combined with 200 ppm boron recorded the significantly highest seed yield (1440.20 kg ha^{-1}). The treatment with 60 cm × 30 cm spacing + 300 ppm boron was found to be statistically at par with this highest-yielding treatment. The superior performance under wider spacing may be attributed to better plant distribution across the field, which allows for improved interception of solar radiation and more efficient utilization of available resources. This enhanced light penetration and reduced intra-specific competition encourage vigorous growth, greater biomass accumulation, and improved yield attributes, ultimately leading to higher seed yields in sunflower (Kumar *et al*., 2011) [8].

Stover Yield (kg/ha)

A significantly higher stover yield of 2429.62 kg ha^{-1} was obtained with 60 cm × 30 cm spacing + 200 ppm boron. Treatment T_8 (60 cm × 30 cm + 300 ppm boron) was statistically at par with T_7 (60 cm × 30 cm + 200 ppm boron). Wider spacing facilitates sufficient light interception, which enhances photosynthetic efficiency and promotes greater accumulation of dry matter. In contrast, narrow spacing with a dense plant population results in increased competition for sunlight, moisture, and nutrients, leading to lower yield attributes. The reduction in yield at higher plant densities can be attributed to intense competition for photosynthates and solar radiation. Wider spacing reduces inter-plant competition, providing each plant adequate space for optimal growth and biomass development (Sandhi *et al*., 2014) [21].

Economics

The economics like Gross returns, Net returns and Benefit cost ratio were significantly influenced due to different treatments.

Cost of Cultivation (INR/ha)

The cost of cultivation was calculated according to the crop. The maximum cost of cultivation (34600.00 ₹/ha) was recorded with spacing30cm x 30cm along with Boron 400 ppm.

Gross Returns (INR/ha)

The maximum gross return (107698.63 ₹/ha) was recorded with spacing 60cm x 30cm along with Boron 200 ppm and the minimum gross return (80553 ₹/ha) was recorded with spacing 30 x 30 cm along with Boron 200 ppm.

Net returns (INR/ha)

The maximum net return (73658.63) was recorded with spacing 60cm x 30cm along with Boron 200 ppm and the minimum net return (46039.24) was recorded with spacing 30 x 30 cm along with Boron 200 ppm.

Benefit cost ratio (B:C)

The maximum benefit cost ratio (2.16) was recorded with spacing 60cm x 30cm along with Boron 200 ppm and the minimum benefit cost ratio (1.33) was recorded with spacing 30 x 30 cm along with Boron 200 ppm.

Higher gross return, net return and benefit cost ratio was recorded with spacing 60cm x 30cm along with Boron 200 ppm.

Table 1: Influence of Spacing and Boron on Growth attributes of Sunflower.

S. No.	Treatments	Plant height (cm)	Dry weight (g)
		100 DAS	100 DAS
1	Spacing 30 x 30 cm + Boron 200 ppm	136.10	29.71
2	Spacing 30 x 30 cm + Boron 300 ppm	138.74	28.87
3	Spacing 30 x 30 cm + Boron 400 ppm	136.10	27.43
4	Spacing 45 x 30 cm + Boron 200 ppm	134.38	26.02
5	Spacing 45 x 30 cm + Boron 300 ppm	132.75	26.26
6	Spacing 45 x 30 cm + Boron 400 ppm	131.61	27.07
7	Spacing 60 x 30 cm + Boron 200 ppm	139.26	30.35
8	Spacing 60 x 30 cm + Boron 300 ppm	133.52	26.68
9.	Spacing 60 x 30 cm + Boron 400 ppm	134.46	29.46
10	Control (RDF)-N:P: K -60:45:45 kg/ha	132.12	25.23
SEm(±)		1.73	0.873
CD (P= 0.05)		5.13	2.18

Table 2: Influence of Spacing and Boron on yield attributes and yield of Sunflower.

S.no Treatment combination	At harvest			
	Number of Seeds/ Capitulum	Test weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)
1. Spacing 30 x 30 cm + Boron 200 ppm	116.27	41.71	1071.89	1946.63
2. Spacing 30 x 30 cm + Boron 300 ppm	120.13	42.36	1134.49	2022.50
3. Spacing 30 x 30 cm + Boron 400 ppm	121.47	43.84	1159.56	2106.45
4. Spacing 45 x 30 cm + Boron 200 ppm	120.07	44.67	1212.27	2230.69
5. Spacing 45 x 30 cm + Boron 300 ppm	122.80	44.00	1282.69	2244.28
6. Spacing 45 x 30 cm + Boron 400 ppm	123.00	44.44	1366.14	2182.23
7. Spacing 60 x 30 cm + Boron 200 ppm	125.53	46.64	1440.20	2429.62
8. Spacing 60 x 30 cm + Boron 300 ppm	121.27	45.33	1391.82	2363.82
9. Spacing 60 x 30 cm + Boron 400 ppm	124.67	42.45	1306.44	2126.89
10. Control (RDF)-N:P: K -60:45:45 kg/ha	115.73	40.57	1233.54	1869.26
F - Test	S	S	S	S
S.Em (±)	2.07	1.09	58.88	102.74
CD (p= 0.05)	6.16	3.25	174.94	305.27

Table 3: Influence of Spacing and Boron on Economics of Sunflower.

S. no	Treatment combination	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C ratio
1.	Spacing 30 x 30 cm + Boron 200 ppm	34520	80559.24	46039.24	1.33
2.	Spacing 30 x 30 cm + Boron 300 ppm	34560	85000.66	50440.66	1.46
3.	Spacing 30 x 30 cm + Boron 400 ppm	34600	86938.12	52338.12	1.51
4.	Spacing 45 x 30 cm + Boron 200 ppm	33920	90932.54	57012.54	1.68
5.	Spacing 45 x 30 cm + Boron 300 ppm	33960	96041.01	62081.01	1.83
6.	Spacing 45 x 30 cm + Boron 400 ppm	34000	101976.71	67976.71	2.00
7.	Spacing 60 x 30 cm + Boron 200 ppm	34040	107698.63	73658.63	2.16
8.	Spacing 60 x 30 cm + Boron 300 ppm	34080	104024.97	69944.97	2.05
9.	Spacing 60 x 30 cm + Boron 400 ppm	34120	97580.38	63460.38	1.86
10.	Control (RDF)-N:P: K -60:45:45 kg/ha	31500	92227.39	60727.39	1.93

Conclusion

It can be concluded that sunflower sown at a spacing of 60 × 30 cm combined with an application of200 ppm boron (Treatment 7) resulted in significantly superior performance in terms of growth parameters, yield and yield attributes, gross returns, net returns, and benefit-cost ratio compared to all other treatments. This combination proved to be the most effective and economically viable option for maximizing sunflower productivity under the given experimental conditions.

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References

1. Abhishek Kumar, *et al*. Influence of sulphur and boron on growth and yield of zaid sunflower. J Exp Agric Int. 2024;46(5):884-887.
2. Gomez KA, Gomez AA. Statistical procedures for agricultural research. New York: John Wiley and Sons; 1984.
3. Mohammed MHSM, Ali Khan MS, Syed MM. Remote work culture: the impact of digital transformation on workforce productivity. J e-Sci Lett. 2023;4(1):01-01.
4. Jackson ML. Soil chemical analysis. Englewood Cliffs (NJ): Prentice Hall; 1962.
5. Jagadala K, Bhol R, Sahoo JP. Effect of boron on growth and yield parameters of sunflower in acid soil. J Pharmacogn Phytochem. 2020;9(4):215-218.
6. Karthikeyan K, Shukla LM. Effect of boron-sulphur interaction on their uptake and quality parameters of mustard (*Brassica juncea* L.) and sunflower (*Helianthus annuus* L.). J Indian Soc Soil Sci. 2008;56(2):225-230.
7. Parvin K. Emerging perspectives on polyphenols and their role in food quality and human health. J Food Biotechnol. 2024;5(1):30-30.
8. Kumar S, Tewari SK, Singh SS. Effect of sources and levels of sulphur and spacing on the growth, yield and quality of spring sunflower (*Helianthus annuus*). Indian J Agron. 2011;56(3):242-246.
9. Gupta S, Yusuf AA, Sridhar A, Suthar MB, Lakineni PK, Bhor HN. International review of advanced learning and teaching technologies. J e-Sci Lett. 2024;5(2):01-01.
10. Manjulatha G, Rajanikanth E. Emerging strategies in climate change mitigation and adaptation. Environ Rep. 2022;4(2):06-06.
11. Parvin K. Anthocyanins and polyphenols in fruits and beverages: comparative stability, bioavailability, and antioxidant mechanisms. J Food Biotechnol. 2023;4(2):24-24.
12. Mangala R. Oilseeds in India. Andhra Pradesh Agric Res J. 2002;20:13-15.
13. Murari M, Umesha C, Sahi VP, Rai PK, Ranjan S, Priya P. Comparison of sorghum (*Sorghum bicolor* (L.) Moench) genotypes grown in Indo-Gangetic plain of Prayagraj, U.P. Ann Agric Res. 2024;45(3):67-75.
14. Chawla R, Mondal K, Pankaj MS. Mechanisms of plant stress tolerance: drought, salinity, and temperature extremes. Plant Sci Arch. 2022;4(8):1-10.
15. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soil by extraction with sodium bicarbonate. USDA. 1954;93(9):1-9.
16. Prabhakar K, *et al*. Effect of boron foliar application at critical growth stages on sunflower (*Helianthus annuus*

L.) seed yield and oil yield. Pharma Innov J. 2021;10:910-913.
17. Rauf A, *et al*. Yield and oil content of sunflower (*Helianthus annuus* L.) as influenced by spacing and reduced irrigation condition. Crop Prod. 2012;1(1):41-45.
18. Mishra TSU, Shubhalakshmi BS. Nonlinear finite element analysis of retrofitting of RCC beam-column joint using CFRP. Int J Eng Technol. 2010;2(5):459-459.
19. Baro J, Vinayaka KS, Chaturvedani AK, Rout S, Sheikh IA, Waghmare GH. Probiotics and prebiotics: the power of beneficial microbes for health and wellness. Microbiol Arch. 2019;1(1):1-1.
20. Ravikumar C, *et al*. Effect of sulphur, zinc and boron on the growth and yield enhancement of sunflower (*Helianthus annuus* L.). J Appl Nat Sci. 2021;13(1):1-6.
21. Sandhi SJ, Patel JG, Desai CK. Effect of spacing and nutrient management on growth and yield of sunflower (*Helianthus annuus* L.) under south Gujarat condition. 2014;360-364. *(Journal name missing — please provide for completion)*
22. Sen T, Reddy HJ, Shubhalakshmi BS. Shear strength study of RC beams retrofitted using vinyl ester bonded GFRP and epoxy bonded GFRP. Civil Environ Res. 2012;2(2):23-33.
23. Subbiah BV, Asija GL. A rapid procedure for the estimation of available nitrogen in soils. Curr Sci. 1956;25:259-305.