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Effect of Micronutrients on Growth and Yield of Groundnut (*Arachis hypogaea* L.) Varieties

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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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Original Research Article

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ABSTRACT

During the summer season of 2022, a field experimental trail on groundnut was performed at Crop Research Farm (CRF), Department of Agronomy, SHUATS, Prayagraj (U.P.) to evaluate the impact of micronutrients on the growth and yield of groundnut (*Arachis hypogea* L.) varieties. The experimental plot's soil was sandy loam in texture, virtually neutral in soil reaction (pH 7.7), low in organic carbon (0.44%), available N (171.48 kg/ha), available P (27.00 kg/ha), and available K (291.20 kg/ha). The experiment was designed in the Randomized Block Design (RBD) method, with nine treatments repeated three times. According to this trial, the treatments are zinc (0.5%), boron (0.2%), zinc+ boron (0.5%+0.2%) as foliar spray, and varieties. (Kadiri 6, Kadiri 9, Kadiri Amaravati). The treatment combinations are, T1-0.5% Zinc (foliar) + Kadiri 6, T2- 0.5% Zinc (foliar)

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+ Kadiri 9, T3- 0.5% Zinc (foliar) + Kadiri Amaravati, T4- 0.2% Boron (foliar) + Kadiri 6, T5- 0.2% Boron (foliar) + Kadiri 9, T6- 0.2% Boron (foliar) + Kadiri Amaravati, T7- (0.5% + 0.2%) Zn+ B (foliar) + Kadiri 6, T8- (0.5% + 0.2%) Zn+ B (foliar) + Kadiri 9, T9- (0.5% + 0.2%) Zn+ B (foliar) + Kadiri Amaravati. (0.5% + 0.2%) Zn + B (foliar) application with variety Kadiri 6 resulted in greater Plant height (26.60cm), Nodules/plant (49.14), and Plant dry weight (6.56 g/plant). Maximum number of pods per plant (27.87), kernels per pod (2.66), seed index (40.13 g), seed yield (2.48 t/ha), haulm yield (5.67 t/ha), and harvest index (30.44%). Thus, using (0.5% + 0.2%) Zn + B (foliar) in conjunction with the variety Kadiri 6 could be a promising choice for increasing groundnut yield.

Keywords: Groundnut; zinc; boron; Kadiri 6; kadiri 9; Kadiri amaravati; growth; yield.

1. INTRODUCTION

An essential grain legume and oilseed, groundnut (*Arachis hypogaea*) is a legume. It is a member of the Leguminaceae family and is referred to as "The King of Oilseeds" because it is the third-most important source of vegetable protein and the fourth-most important source of edible oil. India ranks first in terms of groundnut output area and second in terms of production volume. In India, there will be a 40.12 lakh ha groundnut harvest in 2018–2019. Similar estimates place output at 37.70 lakh tonnes per ha [1]. It is India's top oil seed product and is also referred to as peanut, monkey nut, and manila nut. In the world, groundnuts are used for 12% seed purposes, 37% confectionery uses, and 50% oil extraction uses [2]. Approximately 46.70 percent of groundnuts are used for oil production, according to Satish et al*.* [3]. Because of its high food value, which is again a result of its greater amount of protein (22.0%), carbohydrates (10.0%), and minerals (3.0%), it is also consumed directly.

One of the most crucial nutrients for plant development is zinc. It functions as an enzyme activator in plants and is directly involved in the creation of growth factors like auxin, which results in the production of more plant cells and dry matter. Zinc is essential for the growth and evolution of plants. Additionally, zinc serves as an enzyme's metal activator and catalyzes the biosynthesis of indole acetic acid, which eventually boosts crop yield. Some researchers claimed that foliar zinc spraying could enhance groundnut growth, yield, and seed quality by resolving zinc deficiency. Zinc is necessary for the synthesis of chlorophyll, the operation of pollen, fertilization, and sprouting [4].

B deficiency is one of the nutrient deficiencies that has been identified as a major agricultural problem in more than 100 crops in 80 countries. It has been discovered that 18.3% of the 73,630 analysed soil samples gathered from all over India were B deficient. Therefore, India's lack of boron causes substantial crop losses in terms of both yield and quality of field crops. In groundnut, B shortage causes poor pollen viability, decreased peg formation, low pod filling, shriveled seeds, and hallows heart symptoms, which can result in a 20–40% yield loss [5]. Boron aids in the germination, growth, and development of pollen grains and tubes, enabling fertilization of plants and grain yield. In plants lacking in boron, the blooming time was prolonged. The element boron is crucial for the physiological processes that occur in plants, such as the control of carbohydrate metabolism, the production of protein, and seed development. In legumes and the peanut crop, boron played a crucial part in maintaining flowering and controlling fruit development [6].

The most crucial element in the creation of groundnuts is variety. The use of high yielding varieties has grown significantly in recent years, and the nation has almost achieved a level of groundnut sufficiency. In terms of growth habit, the varieties that might be appropriate for early kharif are quite distinct from the rest of the seasons. A given variety's optimal plant population with unit area per hectare in a given scenario not only lowers cultivation costs but also increases the cultivar's maximum yield potential [7]. Variety Kadiri 6 is released from the Agriculture Research Station, Kadiri Andhra Pradesh. Its parentage is JL24 x AH 316. It was released in the year 2002. The Crop duration 100-105 (kharif) 110-115 (rabi). Its average Yield in quintal /ha is 20-25 (kharif) and 40-45 (rabi). The Oil percentage is 48% and shelling is 74%. 100 Kernel weight (g) is 35-40g. The salient features are it is early variety, high yielding, spanish bunch, attractive kernel, and synchronous maturity.

2. MATERIALS AND METHODS

During the summer season of 2022, a field trial was performed at Crop Research Farm (CRF), Department of Agronomy, SHUATS, Prayagraj (U.P.), India, which is located at 25.40 N latitude, 81.85 E longitude, and 98 m altitude above mean sea level. (MSL). The experimental plot's soil was sandy loam in texture, virtually neutral in soil reaction (pH 7.7), low in organic carbon (0.44%), available N (171.48 kg/ha), available P (27.00 kg/ha), and available K (291.20 kg/ha). Urea, Single Super Phosphate, and Murate of Potash were used to meet the nitrogen, phosphorus, and potassium requirements, respectively. According to this trial, the treatments are zinc (0.5%), boron (0.2%), zinc+ boron (0.5%+0.2%) as foliar spray, and varieties. (Kadiri 6, Kadiri 9, Kadiri Amaravati). The treatment combinations are, T1- 0.5% Zinc (foliar) + Kadiri 6, T2- 0.5% Zinc (foliar) + Kadiri 9, T3- 0.5% Zinc (foliar) + Kadiri Amaravati, T4- 0.2% Boron (foliar) + Kadiri 6, T5- 0.2% Boron (foliar) + Kadiri 9, T6- 0.2% Boron (foliar) + Kadiri Amaravati, T7- (0.5% + 0.2%) Zn+ B (foliar) + Kadiri 6, T8- (0.5% + 0.2%) Zn+ B (foliar) + Kadiri 9, T9- (0.5% + 0.2%) Zn+ B (foliar) + Kadiri Amaravati. The experiment was designed in the Randomized Block Design (RBD) method, with nine treatments Replicated thrice. RDF of 20:40:40 NPK kg/ha was used as the basal dosage in all treatments, and the nutrients Zinc and Boron were applied as foliar spray according to the treatments. Manual seeding was done at a seed rate of 100 kg/ha at a depth of 4-5 cm and spacing of 30 cm X 10 cm. Plant growth parameters were documented at regular intervals from germination to harvest, and yield parameters were recorded after harvest. These factors were statistically analyzed using the Randomized Block Design analysis of variance (ANOVA). The treatment combinations are given in Table 1.

3. RESULTS AND DISCUSSION

3.1 Plant Height (cm)

The significantly taller plant height (26.60 cm) at 60 DAS was recoded in treatment 7 with (0.5% + 0.2%) Zn + B (foliar) with variety Kadiri 6. However, treatments with 0.5 % Zinc (foliar) + Kadiri 6 (26.10 cm) and (0.5 % + 0.2 %) Zn+ B (foliar) + Kadiri 9 (26.31 cm) were found to be statistically at par with (0.5 % + 0.2 %) Zn+ B (foliar) + Kadiri 6.

With the addition of boron and zinc, the plant height gradually increased. This could be attributed to improved vegetative growth, increased photosynthetic activity and chlorophyll synthesis, the development of new plant cells, an increase in IAA, the development of meristematic tissues, cell elongation and tissue differentiation, and sugar transportation. Over Kadiri 9 and Kadiri Amaravati, the Kadiri 6 variety beat the others and produced taller plants. The findings were found to be consistent with Mani et al*.* [8] and Suhathiya and Ravichandran's [9] research.

3.2 Number of Nodules per Plant

The significantly higher number of nodules/plant (49.14) at 60 DAS were recorded with the treatment 7 with (0.5% + 0.2 %) Zn+ B (foliar) + Kadiri 6. However, treatment with 0.5 % Zinc (foliar) + Kadiri 6 (48.66) and (0.5 % + 0.2 %) Zn+ B (foliar) + Kadiri 9 (48.89) which were found to be statistically at par with (0.5 % + 0.2 %) Zn+ B (foliar) + Kadiri 6.

In comparison to the Kadiri 9 and Kadiri Amaravati varieties, the Kadiri 6 variety reported more nodules. The genetic potential of the variety that has assisted in generating a larger number of nodules and the findings were similar to those of Jiotode et al*.* [10] may be the most likely explanation for this.

3.3 Plant Dry Weight (g)

The significantly maximum dry weight (6.56 g) at 60 DAS was recorded with treatment 7 with (0.5 % + 0.2 %) Zn+ B (foliar) + Kadiri 6. However, treatment with 0.5 % Zinc (foliar) + Kadiri 6 (6.32) and (0.5 % + 0.2 %) Zn+ B (foliar) + Kadiri 9 (6.44) which was found to be statistically at par with (0.5 % + 0.2 %) Zn + B (foliar) + Kadiri 6.

The Kadiri 6 variety showed the highest dry weight due to the higher growth and biomass accumulation compared to other varieties. Zinc and boron levels generally influence cell division and nitrogen absorption from the soil may enhance plant growth, which is reflected in terms of plant dry weight. These results are consistent with those attained by Shendage et al*.* [11] and Subasinghe et al*.* in [12].

3.4 Crop Growth Rate (g/m^2/day) and Relative Growth Rate (g/g/day)

Between 60-80 DAS Crop Growth Rate and Relative Growth Rate showed significant difference among the treatments.

Table 1. Treatment combinations

S No.	Treatment Combinations
1.	0.5 % Zinc (foliar) + Kadiri 6
2.	0.5 % Zinc (foliar) + Kadiri 9
3.	0.5 % Zinc (foliar) + Kadiri Amaravati
4.	0.2 % Boron (foliar) + Kadiri 6
5.	0.2 % Boron (foliar) + Kadiri 9
6.	0.2 % Boron (foliar) + Kadiri Amaravati
7.	(0.5 % + 0.2 %) Zn+ B (foliar) + Kadiri 6
8.	(0.5 % + 0.2 %) Zn+ B (foliar) + Kadiri 9
9.	(0.5 % + 0.2 %) Zn+ B (foliar) + Kadiri Amaravati

Table 2. Growth and growth attributes as influenced by micronutrients and varieties of groundnut

S No.	Treatment Combinations	60 DAS			60 DAS- 80 DAS	
		Plant Height (cm)	Number of Nodules per plant	Dry weight (g)	Crop Growth Rate ($g/m^2/day$)	Relative Growth Rate (g/g/day)
1.	0.5 % Zinc (foliar) + Kadiri 6	26.10	48.66	6.32	14.56	0.0486
2.	0.5 % Zinc (foliar) + Kadiri 9	25.64	47.72	6.04	14.48	0.0466
3.	0.5 % Zinc (foliar) + Kadiri Amaravati	24.34	46.83	5.61	14.72	0.0463
4.	0.2 % Boron (foliar) + Kadiri 6	25.80	48.10	6.23	14.82	0.0453
5.	0.2 % Boron (foliar) + Kadiri 9	24.66	47.08	5.78	15.18	0.0443
6.	0.2 % Boron (foliar) + Kadiri Amaravati	23.90	46.36	5.35	15.19	0.0440
7.	(0.5 % + 0.2 %) Zn+ B (foliar) + Kadiri 6	26.60	49.14	6.56	14.69	0.0456
8.	(0.5 % + 0.2 %) Zn+ B (foliar) + Kadiri 9	26.31	48.89	6.44	14.97	0.0446
9.	(0.5 % + 0.2 %) Zn+ B (foliar) + Kadiri Amaravati	25.18	47.54	5.93	15.19	0.0446
	F-test	S	S	S	NS	NS
	S.Em (±)	0.17	0.16	0.05	0.38	0.00
	CD (p=0.05)	0.52	0.48	0.14	-	-

Table 3. Yield and yield attributes as influenced by micronutrients and varieties of groundnut

S No.	Treatment Combinations	At Harvest					
		No. of pods per plant	No. of kernels per Pod	Seed Index (g)	Seed Yield (t/ha)	Haulm Yield (t/ha)	Harvest Index (%)
1.	0.5 % Zinc (foliar) + Kadiri 6	27.26	2.29	39.63	2.26	5.40	29.52
2.	0.5 % Zinc (foliar) + Kadiri 9	26.53	1.97	38.13	1.99	5.00	28.50
3.	0.5 % Zinc (foliar) + Kadiri Amaravati	25.54	1.84	37.38	1.70	4.14	29.08
4.	0.2 % Boron (foliar) + Kadiri 6	26.85	2.05	38.25	2.16	5.15	29.54
5.	0.2 % Boron (foliar) + Kadiri 9	25.72	1.87	37.50	1.74	4.51	27.85
6.	0.2 % Boron (foliar) + Kadiri Amaravati	25.28	1.76	37.30	1.45	3.93	26.99
7.	(0.5 % + 0.2 %) Zn+ B (foliar) + Kadiri 6	27.87	2.66	40.13	2.48	5.67	30.44
8.	(0.5 % + 0.2 %) Zn+ B (foliar) + Kadiri 9	27.51	2.49	39.94	2.38	5.54	30.01
9.	(0.5 % + 0.2 %) Zn+ B (foliar) + Kadiri Amaravati	26.19	1.91	37.89	1.87	4.84	27.90
	F-test	**S**	**S**	**S**	**S**	**S**	**S**
	S.Em (±)	0.25	0.13	0.33	0.08	0.09	0.39
	CD (p=0.05)	0.75	0.38	0.98	0.23	0.27	1.16

3.5 Yield Attributes

The significantly higher number of pods/plant (27.87), number of kernels per pod (2.66) and seed index (40.13 g) were found with treatment 7 (0.5% + 0.2%) Zn + B (foliar) with variety Kadiri 6. However, the treatments 0.5 % Zinc (foliar) + Kadiri 6(27.26) and (0.5 % + 0.2%) Zn+ B (foliar) + Kadiri 9 (27.51) which were found to be statistically at par with (0.5 % + 0.2 %) Zn+ B (foliar) + Kadiri 6 regarding number of pods/plant.

The beneficial effect of boron may be attributed to its important role in plant metabolism and in the synthesis of nucleic acid, and zinc also plays a significant role in the metabolism of plants by influencing the activity of growth enzymes. These enzymes are also involved in protein synthesis, carbohydrate metabolism, the regulation of auxin synthesis, and pollen formation. Tekale et al. s research yielded similar results [13]. Applying zinc and boron to crops had a positive impact on nutrient metabolism, biological activity, and growth parameters, which led to taller plants and higher enzyme activity, which in turn encouraged the production of more kernels/pods and pods/plant. El-Habbasha et al. have previously published findings that are similar [14]. Increase in this characteristic following foliar spraying may be attributable to zinc and boron's role in early stages of starch utilization, enzyme activation, membrane integrity, chlorophyll formation, and stomatal balance, which increased assimilate accumulation in the grains and led to heavier grains. The findings matched those of Jaiswal et al. [15].

3.6 Yield

Significantly higher seed yield (2.48 t/ha), haulm yield (5.67 t/ha) and harvest index (30.44%) were found in treatment 7 with (0.5% + 0.2%) Zn + B (foliar) with variety Kadiri 6. However, the treatments 0.5 % Zinc (foliar) + Kadiri 6 (2.26 t/ha) and (0.5 % + 0.2 %) Zn+ B (foliar) + Kadiri 9 (2.38 t/ha) which were found to be statistically at par with (0.5 % + 0.2 %) Zn+ B (foliar) + Kadiri 6 regarding seed yield.

In many physiological processes of plants, such as chlorophyll synthesis, stomatal control, and starch utilization that increases seed production, boron is involved. In addition to being essential for many physiological processes and plant development, nutrition is also important for boosting crop yields and quality. Zinc also helps increase crop production by converting ammonia to nitrate. These findings support the findings of Gowthami and Ananda [16]. In terms of pods/plant and kernels/pod, the Kadiri 6 cultivar outperformed others. The genetic makeup of the variety that has assisted in improving photosynthetic activity due to greater source capacity and effective photosynthesis translocation to the sink may be the most likely explanation for this. The outcomes were consistent with Dileep et al. [7]. Regarding seed yield, the performance of ground nut varieties was very positive and exhibited a comparable pattern to yield attributes. The fact that the variety Kadiri 6 produced more stover than other varieties may be attributable to its increased production efficiency and biomass accumulation, which have been mirrored in improvements in various yield-attributing characters. Rajpal Bochliya et al. found similar results [17].

4. CONCLUSION

As per my research trail, the use of (0.5% + 0.2%) Zn + B (foliar) with variety Kadiri 6 was discovered to be more effective. Although the results are based on a single season, more study is required to support the conclusions and their suggested solutions.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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