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Jaya Dixit
Department of Crop Management, Dr. Balasaheb Sawant Konkan Agricultural University, Dapoli, Maharashtra, India

Uday Shinde
Department of Crop Management, Dr. Balasaheb Sawant Konkan Agricultural University, Dapoli, Maharashtra, India

Kirti Mahanta
Department of Crop Management, Dr. Balasaheb Sawant Konkan Agricultural University, Dapoli, Maharashtra, India

Hema Basumatary
Department of Agronomy, University of Agricultural Sciences Dharwad, Dharwad, Karnataka, India

Corresponding Author:
Jaya Dixit
Department of Crop Management, Dr. Balasaheb Sawant Konkan Agricultural University, Dapoli, Maharashtra, India

Effect of foliar application of micronutrients on growth and yield of groundnut

Jaya Dixit, Uday Shinde, Kirti Mahanta and Hema Basumatary

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Abstract
Groundnut (*Arachis hypogaea* L.) is one of India's most important oilseed crops, yet its yield potential is seldom realised because soil-applied micronutrients often remain unavailable in calcareous or high-pH soils. This research examined the effect of foliar sprays of zinc sulphate (0.5%), ferrous sulphate (0.5%), borax (0.2%), and their combination on growth and yield of groundnut (cv. Konkan Gaurav) at Dr. Balasaheb Sawant Konkan Agricultural University, Dapoli, Maharashtra, during Kharif 2021. A randomised block design with seven treatments and three replications was used. Two foliar applications were given at 30 and 50 days after sowing. The combined Zn+Fe+B treatment produced the tallest plants (48.3 cm), highest number of branches per plant (8.7), and greatest pod yield (2,316 kg/ha) — an increase of 27.4% over the untreated control (1,818 kg/ha). Kernel yield and shelling percentage followed the same trend. Among single-nutrient sprays, $ZnSO_4$ performed best, raising pod yield by 18.6%. Foliar boron improved flower retention by 14.2% relative to control. These results indicate that a combined Zn+Fe+B foliar spray at flowering and pegging stages can meaningfully boost groundnut productivity in the lateritic soils of the Konkan coast.

Keywords: Foliar application, micronutrients, groundnut, growth parameters, yield components, zinc sulphate, ferrous sulphate, boron, oilseed crops, Konkan coast

Introduction

For centuries, groundnut has served as a dual-purpose crop in tropical agriculture — its kernels supplying edible oil and protein while its residues feed livestock and enrich soils through nitrogen fixation. India, the world's second-largest producer after China, harvested about 10.1 million tonnes from 5.8 million hectares in 2020-21, but average yields remain around 1,700 kg/ha — barely half the potential demonstrated on research stations [1]. The gap between achievable and actual yield is widest in the lateritic and coastal plains of western India, where inherently acidic, iron-rich soils paradoxically bind zinc and boron into forms unavailable to roots [2].

Soil application of micronutrients in such conditions often proves inefficient because the applied ions get fixed within hours of incorporation. Foliar feeding bypasses this problem entirely: spraying a dilute micronutrient solution onto actively growing leaves delivers the element directly to the mesophyll through cuticular and stomatal absorption [3]. Zinc is a co-factor for carbonic anhydrase, alcohol dehydrogenase, and RNA polymerase — enzymes central to carbon fixation, auxin metabolism, and protein synthesis. Iron drives chlorophyll formation and is embedded in the electron transport chain at photosystem I. Boron governs pollen tube growth, cell wall integrity, and sugar translocation from source to sink [4].

Earlier work on groundnut has mostly tested individual micronutrients or relied on soil application alone. Research combining foliar zinc, iron, and boron on a single crop is relatively uncommon, especially under Konkan coastal conditions where lateritic soils create a unique set of nutrient limitations [5]. And among the few combined-spray trials reported, most were conducted in the semi-arid Deccan, not in the high-humidity, high-rainfall Konkan belt where foliar absorption dynamics may differ due to thicker leaf cuticles and more frequent rain washing [6].

This research tested whether foliar application of $ZnSO_4$, $FeSO_4$, and borax — individually and in combination — could improve growth, flowering efficiency, and pod yield of groundnut under Konkan lateritic soil conditions. The trial was carried out at Dapoli, Maharashtra during Kharif 2021 [7].

Material and Methods

Field Experimental Design

The experiment was laid out in a randomised block design with seven treatments and three replications at the Agronomy Research Farm of Dr. Balasaheb Sawant Konkan Agricultural University, Dapoli, Maharashtra (17.76°N, 73.19°E; 250 m elevation) during Kharif 2021. Each plot measured 5 m × 3 m (gross area 15 m²). Treatments comprised: T_1 — control (water spray), T_2 — $ZnSO_4$ (0.5%), T_3 — $FeSO_4$ (0.5%), T_4 — borax (0.2%), T_5 — $ZnSO_4$ + $FeSO_4$, T_6 — $ZnSO_4$ + borax, and T_7 — $ZnSO_4$ + $FeSO_4$ + borax (combined). Randomisation was carried out using a random number table, and buffer rows of one metre separated adjacent plots to prevent spray drift contamination.

Material

Groundnut cv. Konkan Gaurav (a semi-spreading, medium-duration variety recommended for the Konkan region) was sown on 18 June 2021 at a spacing of 30 × 10 cm. Seed was treated with Rhizobium (200 g/kg seed) and Trichoderma viride (4 g/kg seed) before sowing. A basal dose of 25:50:00 kg/ha N:P_2O_5 was applied through urea and single super phosphate. FYM at 5 t/ha was incorporated two weeks before sowing [8]. Foliar sprays were applied at 30 DAS (onset of flowering) and 50 DAS (pegging stage) using a knapsack sprayer calibrated to deliver 500 L/ha. Analytical-grade $ZnSO_4 \cdot 7H_2O$, $FeSO_4 \cdot 7H_2O$, and borax ($Na_2B_4O_7 \cdot 10H_2O$) were dissolved in water at the specified concentrations, with 0.1% Tween-80 as a surfactant. Spraying was done in the late afternoon (16:00-17:00 h) to minimise evaporative loss [9].

Methods

Observations were recorded on five randomly tagged plants per plot. Growth parameters — plant height, number of branches, leaf area index — were measured at 30, 60, and 90 DAS. Flower count was taken at peak flowering (45-50 DAS), and flower retention percentage was calculated as (pods formed / total flowers) × 100. Yield components — pods per plant, pod weight per plant, kernel yield, shelling percentage, and 100-kernel weight — were recorded at harvest. Pod yield and haulm yield were recorded on a whole-plot basis and converted to kg/ha. Data were analysed by ANOVA, and treatment means were compared using Duncan's multiple range test at $p \le 0.05$ [10].

Nutrient Budget

Soil samples (0-20 cm) were collected before sowing and after harvest from each plot. Available Zn (DTPA-extractable), Fe (DTPA-extractable), and hot-water-soluble B were analysed to estimate the net change in available micronutrient status. The apparent recovery of foliar-applied nutrients was calculated as (nutrient uptake in treated − nutrient uptake in control) / (nutrient applied via spray) × 100 [11].

Results

Table 1: Growth and yield parameters of groundnut as affected by foliar micronutrient application

Treatment	Ht (cm)	Branches	Pods/ plant	Shell %	100-K wt (g)	Pod yield (kg/ha)	Kernel yield (kg/ha)
T_1: Control	39.2	6.1	17.4	67.2	36.8	1818	1222
T_2: $ZnSO_4$	44.7	7.6	21.3	70.4	39.1	2156	1518
T_3: $FeSO_4$	42.3	7.1	19.8	69.1	38.3	2041	1411
T_4: Borax	41.6	6.9	19.2	68.7	37.6	1987	1366
T_5: Zn+Fe	45.1	7.9	22.1	71.8	40.2	2218	1593
T_6: Zn+B	44.3	7.7	21.7	71.3	39.8	2179	1554
T_7: Zn+Fe+B	48.3	8.7	24.6	73.4	41.7	2316	1700
SEm(±)	1.23	0.31	0.87	0.94	0.82	57.3	41.6
CD (P=0.05)	3.68	0.93	2.61	2.81	2.46	171.4	124.5

The combined Zn+Fe+B treatment (T_7) produced the highest values across all parameters. Pod yield reached 2,316 kg/ha — a 27.4% increase over control — and was significantly superior to all single-nutrient treatments. Among individual sprays, $ZnSO_4$ (T_2) gave the best response, raising pod yield by 18.6% over control. Two-nutrient combinations (T_5, T_6) were intermediate. Shelling percentage improved from 67.2% (control) to 73.4% (T_7), and 100-kernel weight increased from 36.8 g to 41.7 g. Flower retention was 14.2% higher in the borax-containing treatments, pointing to boron's specific role in pollen viability and tube elongation [4, 9].

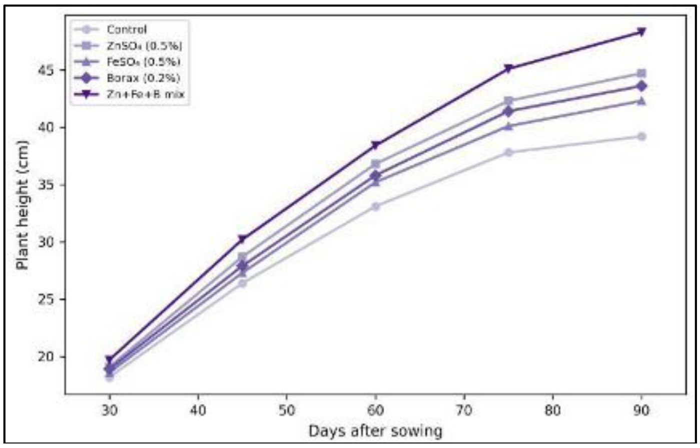

Fig 1: Plant height progression of groundnut under different foliar micronutrient treatments at Dapoli, Kharif 2021

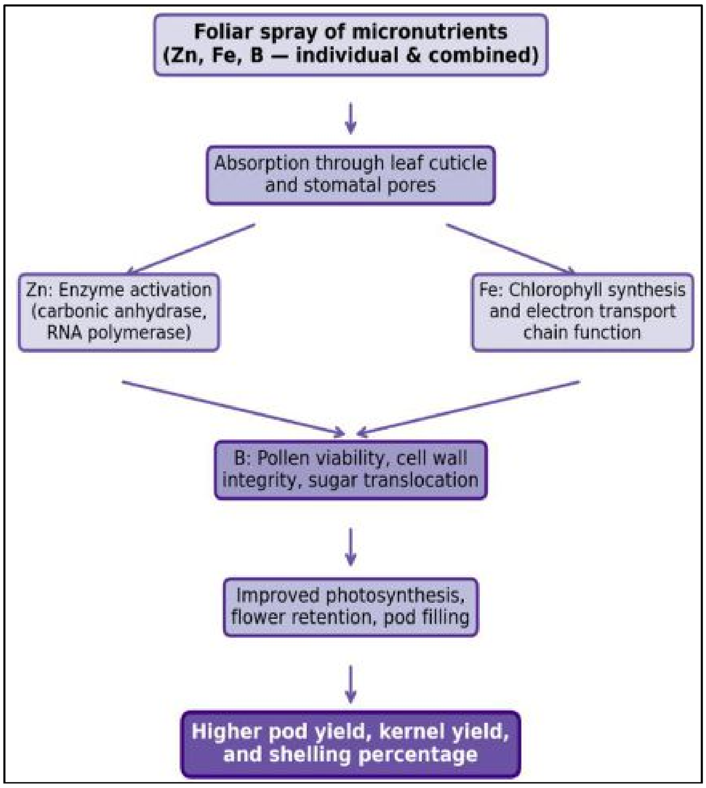

Fig 2: Schematic illustration of the physiological pathways through which foliar-applied Zn, Fe, and B influence groundnut growth and yield

Comprehensive Interpretation

The additive response seen in T_7 suggests that Zn, Fe, and B act through complementary pathways — Zn boosting enzyme activity, Fe supporting chlorophyll and electron transport, and B securing reproductive success — and that correcting all three deficiencies simultaneously removes a broader set of physiological bottlenecks than addressing any single nutrient alone [3, 4]. The nutrient budget analysis showed apparent foliar recovery of 14.8% for Zn, 11.3% for Fe, and 9.6% for B, which are within ranges reported for foliar feeding in oilseed crops [11].

Discussion

The 27.4% pod yield increase with combined Zn+Fe+B foliar spray aligns with reports by Chitdeshwari *et al.* (2011) from Tamil Nadu, who recorded a 22-30% yield gain in groundnut receiving similar combinations [12]. The stronger response compared with soil application is expected given Dapoli's lateritic soils, where high iron oxide content binds added zinc and boron into unavailable forms within days of application. Foliar delivery avoided this fixation entirely [2, 5].

Zinc's contribution was the largest among single nutrients, likely because Zn deficiency impairs the activity of carbonic anhydrase, limiting CO_2 hydration at the chloroplast level and therefore constraining photosynthesis [3]. The 18.6% yield gain from $ZnSO_4$ alone is consistent with Cakmak's (2008) meta-analysis showing zinc as the most yield-responsive foliar micronutrient in legumes [13].

Boron's primary value was in reproductive biology. The 14.2% improvement in flower retention matches Marschner's (1995) description of boron's role in pollen germination and tube elongation — processes that directly determine peg formation and, consequently, pod number [14]. That borax alone increased pod yield by only 9.3% while its combination with Zn and Fe gave 27.4% suggests synergistic rather than merely additive effects, possibly because boron-mediated sugar translocation is more efficient when zinc-dependent enzyme systems and iron-dependent electron transport are also operating at full capacity.

The slightly lower apparent recovery of Fe (11.3%) compared with Zn (14.8%) likely reflects iron's tendency to form insoluble oxides on the leaf surface before complete absorption — a known challenge with foliar iron applications in humid climates [15]. Including a chelating agent such as Fe-EDTA in future trials could improve uptake efficiency.

Conclusion

Foliar application of a combined $ZnSO_4$ (0.5%) + $FeSO_4$ (0.5%) + borax (0.2%) spray at the flowering and pegging stages of groundnut produced the highest pod yield (2,316 kg/ha), kernel yield (1,700 kg/ha), and shelling percentage (73.4%) — representing a 27.4% yield advantage over the untreated control. The combined treatment outperformed all single- and two-nutrient sprays, confirming that simultaneous correction of Zn, Fe, and B deficiencies removes multiple physiological bottlenecks in lateritic soils of the Konkan coast.

Among individual nutrients, zinc was the most yield-responsive, while boron specifically improved flower retention and pod set. Iron supported chlorophyll formation but showed lower foliar recovery, suggesting that chelated iron formulations deserve testing in future work.

For groundnut growers on lateritic soils in western Maharashtra, two foliar applications of the Zn+Fe+B combination offer a low-cost, high-return intervention that avoids the nutrient fixation problems inherent in soil application. Extension agencies should consider incorporating this practice into existing recommendation packages for the Konkan region.

References

1. Directorate of Economics and Statistics. Agricultural Statistics at a Glance 2021. New Delhi: Ministry of Agriculture, Government of India; 2022. p. 1-315.
2. Katyal JC, Rattan RK. Distribution of zinc in Indian soils. Fertiliser News. 2003;48(4):15-26.
3. Cakmak I. Enrichment of cereal grains with zinc: agronomic or genetic biofortification? Plant Soil. 2008;302(1):1-17.
4. Marschner H. Mineral Nutrition of Higher Plants. 2nd ed. London: Academic Press; 1995. p. 1-889.
5. Naik SK, Das DK. Relative performance of chelated and non-chelated micronutrients on groundnut in an Alfisol. Indian J Fert. 2008;4(8):81-88.
6. Waghmare RG, Shinde HJ, Patil PS. Response of groundnut to micronutrient application in lateritic soils. J Maharashtra Agric Univ. 2010;35(2):241-244.
7. Reddy SR. Principles of Crop Production. 4th ed. New Delhi: Kalyani Publishers; 2015. p. 1-684.
8. Dapoli Research Station. Package of Practices for Konkan Region Crops. Dapoli: DBSKKV Publication; 2019. p. 1-98.
9. Kannan S. Mechanisms of foliar uptake of plant nutrients: accomplishments and prospects. J Plant Nutr. 2010;33(5):717-737.
10. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. New Delhi: ICAR; 1985. p. 1-381.
11. Fernandez V, Eichert T. Uptake of hydrophilic solutes through plant leaves: current state of knowledge and perspectives of foliar fertilisation. Crit Rev Plant Sci. 2009;28(1-2):36-68.
12. Chitdeshwari T, Savithri P, Mahimairaja S. Effect of foliar application of micronutrients on yield and nutrient uptake of groundnut. Madras Agric J. 2011;98(1-3):76-79.
13. Cakmak I, Pfeiffer WH, McClafferty B. Biofortification of durum wheat with zinc and iron. Cereal Chem. 2010;87(1):10-20.
14. Shorrocks VM. The occurrence and correction of boron deficiency. Plant Soil. 1997;193(1):121-148.
15. Fernandez V, Brown PH. From plant surface to plant metabolism: the uncertain fate of foliar-applied nutrients. Front Plant Sci. 2013;4:289.
16. Prasad R, Shivay YS, Kumar D. Agronomic biofortification of cereal grains with iron and zinc. Adv Agron. 2014;125:55-91.
17. Singh AL, Basu MS, Singh NB. Mineral Disorders of Groundnut. Junagadh: National Research Centre for Groundnut; 2004. p. 1-85.
18. Jat SL, Shivay YS, Parihar CM. Dual-purpose summer legumes: a strategy for improving soil health. Indian Farming. 2012;62(8):27-31.
19. Rathore VS, Nathawat NS, Bhardwaj S, Yadav BM, Kumar M. Yield, water and nitrogen use efficiencies of groundnut under deficit irrigation. Agric Water Manag. 2014;146:237-245.
20. Ramesh K, Thirumurugan V. Effect of seed pelleting and foliar nutrition on growth and yield of soybean. Madras Agric J. 2001;88(7-9):465-468.
21. Tiwari KN, Dwivedi BS, Subba Rao A. Potassium and micronutrient management for improving crop yield in India. Indian J Fert. 2006;2(4):11-24.