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IMPACT OF FOLIAR MICRONUTRIENT SPRAYS ON THE GROWTH AND YIELD OF LATE-PLANTED LENTIL (*LENS CULINARIS*) IN WESTERN UTTAR PRADESH INDIA

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ABSTRACT

A field experiment was carried out during 2023-24 and 2024-25 at the CRC, SVPUA&T, Meerut, India, to assess the impact of foliar application of micronutrients on lentil (*Lens culinaris* Medik) growth and yield. The pooled two-year results indicated that the foliar application of B @ 0.2% + Fe @ 0.5% significantly enhanced dry matter accumulation (113.4 g/m²), the number of nodules (30.6), and branches per plant (3.5). This treatment also led to an increase in the number of pods compared to the control (121.4 vs. 89.4). Additionally, the foliar spray of B @ 0.2% + Fe @ 0.5% resulted in a 38.6% increase in grain yield (1130 kg/ha), a 21.4% increase in stover yield (3713 kg/ha), a 3.4% rise in test weight (20.4 g), and a 35.4% improvement in harvest index (0.31) compared to the control (no spray). Under late-sown conditions, the application of B @ 0.2% + Fe @ 0.5% foliar spray proved effective in improving both growth and yield of the crop.

***Key words*: Nodules, Yield, Growth, Harvest index, Lentil.**

Introduction

Lentil is a nutritious legume, rich in carbohydrates, a valuable source of protein, and full of essential micronutrients. It is usually grown after the harvest of rainy season (kharif) crops, but its sowing is often delayed due to the late harvest of long-duration kharif crops or delays in field preparation caused by excess moisture (Singh *et al*., 2011; Visha *et al*., 2019). These delays in sowing can expose the crop to extreme cold during its early growth stages or heat and moisture stress in later stages, negatively impacting its growth and yield (Ramakrishna *et al*., 2000).

The foliar application of micronutrients facilitates faster nutrient translocation compared to soil application, making it especially effective in alleviating plant stress under late-sown conditions. Micronutrients such as zinc (Zn), iron (Fe), and boron (B) play critical roles in the reproductive development of plants. Zinc is essential for metabolic and regulatory functions, as well as for the reproductive phase of crops (Broadley *et al*., 2007). Iron is vital for numerous biochemical processes in plants (Rout and Sahoo, 2015; Briat *et al*., 2007). Boron plays a key role in reproductive growth, including pistil formation, pollination, and fertilization (Dear and Lipsett, 1987; Dell and Huang, 1997). Considering the frequent delays in lentil sowing in the alluvial zone, it is necessary to evaluate whether the foliar application of these micronutrients, either individually or in combination, can improve the growth and yield of lentil under late-sown conditions.

In light of this, the current study was conducted to examine the impact of foliar sprays of micronutrients—zinc, boron, and iron on the number of nodules, dry matter, and other growth and yield parameters of lentil.

Table 1: Growth parameters at maturity of lentil as influenced by micronutrient foliar spray (pooled data of 2 years).

Treatment	Plant height (cm)	Total dry matter ($g\ m^{-2}$)	No. of nodules/plant (60DAS)
No spray	44.6	105.1	23.6
Tap water	46.7	105.9	23.4
Zn @ 0.5%	47.7	108.8	24
Fe @ 0.5%	48.8	111.6	25.3
B @ 0.2%	50.8	110.9	27
Zn @ 0.5% +B @ 0.2%	50.9	112.8	27.4
Zn+Fe @ 0.5%	48.2	112.8	29
B @ 0.2% + Fe @ 0.5%	48.3	114.3	31.6
Zn @ 0.5% + Fe @ 0.5% +B @ 0.2%	50	110.5	33.4
CD (P=0.05)	**1.62**	**2.93**	**2.96**

Materials and Methods

The field experiment was conducted during the rabi seasons of 2023-24 and 2024-25 at CRC, SVPUA&T, Meerut, India. (Latitude 22º58´N, Longitude 88º32´E). The study site is situated at an elevation of 9.75 meters above mean sea level. Throughout the experiment, the crop received 149.5 mm of rainfall in 2023-24 and 105.8 mm in 2024-25. The maximum temperatures ranged from 22.2ºC to 35.5ºC, and the minimum temperatures varied between 7.8ºC and 25.5ºC during the rabi seasons of both years.

The soil at the experimental site is a well-drained Gangetic alluvial soil (order: Inceptisol) with a clayey loam texture, medium fertility, and a neutral pH of 7.4. The available nitrogen (alkaline permanganate-oxidizable) was found to be low at 138 kg/ha. The organic carbon content, determined using the wet-digestion method, was 0.52%. The levels of available zinc (DTPA-extractable), boron (Azomethine H), and iron (DTPA-extractable) were 0.40 ppm, 0.49 ppm, and 0.45 ppm, respectively, indicating medium availability. In contrast, the available phosphorus (P2O5) (Bray's P) and potassium (K2O) (NH4OAc-extractable) levels were high, with values of 30 kg/ha and 160 kg/ha, respectively.

The experiment was conducted using a randomized block design (RBD) with nine foliar spray treatments: no spray, tap water spray, Zn @ 0.5% ($ZnSO_4 \cdot 7H_2O$), Fe @ 0.5% ($FeSO_4 \cdot 7H_2O$), B @ 0.2% (borax 10.5%), Zn @ 0.5% + B @ 0.2%, Zn @ 0.5% + Fe @ 0.5%, B @ 0.2% + Fe @ 0.5%, and Zn @ 0.5% + Fe @ 0.5% + B @ 0.2%. Each treatment was replicated three times. Foliar sprays were applied at the flower initiation stage (45 DAS) and pod initiation stage (60 DAS).

The seeds of the widely cultivated variety "NDL 1" were sown in experimental plots measuring 5 m × 4 m with a row spacing of 30 cm on the first night of December. Standard crop management practices were followed, including a uniform fertilizer application of 20:40:40 kg ha^{-1} of N:P_2O_5 :K_2O, along with a single hand weeding at 25-30 DAS. The crop was grown using residual soil moisture with minimal precipitation during the rabi season, and no irrigation was provided.

Growth and yield attributes were recorded from ten randomly selected plants per plot, excluding the border rows. Analysis of variance (ANOVA) was performed according to the randomized block design (RBD), and treatment differences were evaluated using the critical difference (CD) at the 5% significance level (P=0.05), as outlined by Gomez and Gomez (1984). Since the data for both years were consistent, a pooled analysis was conducted and presented.

Results and Discussion

Growth parameters

The pooled data from two years showed that the foliar spray treatments of Zn @ 0.5% + B @ 0.2% and B @ 0.2% were statistically similar, both resulting in the highest plant height at harvest (50.9 cm and 50.8 cm, respectively). Dry matter (DM) accumulation consistently

Table 2: Yield attributes of lentil as influenced by micronutrient foliar spray (pooled data).

Treatment	No. of pods	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Test weight (g)	HI
No spray	82.3	701	2918	19.6	0.2
Tap water	88.9	714	3117	19.7	0.21
Zn @ 0.5 %	101.4	730	3396	20.1	0.21
Fe@ 0.5 %	106.3	812	3060	20.2	0.26
B @ 0.2 %	108.4	831	3441	20.2	0.24
Zn@0.5% +B@0.2%	114.2	905	3645	20.3	0.26
Zn+Fe@0.5%,	115.7	847	3494	20.3	0.24
B@0.2% +Fe@0.5%	122.3	1129	3714	20.4	0.31
Zn@0.5% +Fe@0.5% +B@0.2%	113.5	1035	3638	20.3	0.29
CD (P=0.05)	**5.05**	**87.52**	**43.31**	**0.15**	**NS**

increased as the crop progressed through its growth stages. However, only the data recorded at harvest is presented here, as the effects of the treatments were more evident in the later stages of the crop. The lentil crop treated with a foliar spray of B @ 0.2% + Fe @ 0.5% showed the highest dry matter accumulation (114.3 g/m²), significantly exceeding the control (105.1 g/m²), reflecting an approximate 9% increase compared to the untreated crop. These findings are in line with the results reported by Gill *et al*., (2012) in Punjab. While plant growth is mainly determined by varietal characteristics, the differences in dry matter accumulation among the treatments can be attributed to the contribution of specific micronutrients in promoting crop growth and development. The foliar spray of Zn @ 0.5% + Fe @ 0.5% + B @ 0.2% resulted in the highest number of nodules per plant (33.4), followed by the B @ 0.2% + Fe @ 0.5% treatment (31.6), both significantly higher than the control (23.6). However, the nodule count in this study was notably lower than in previous research, which can likely be attributed to the delayed sowing. Singh (2005) noted a reduction in nodule formation with delayed sowing from November to December in West Bengal. Additionally, the foliar application of micronutrients had no significant impact on the number of branches per plant. (Table 1).

Yield attributes

The foliar application of micronutrients significantly influenced the number of pods per plant, grain yield, stover yield, and test weight of lentil (Table 2). The treatment of B @ 0.2% + Fe @ 0.5% produced the highest grain yield (1129 kg/ha), which was significantly higher than the Zn @ 0.5% + Fe @ 0.5% + B @ 0.2% treatment (1035 kg/ha) (Table 2). A similar trend was observed for stover yield, with the B @ 0.2% + Fe @ 0.5% treatment yielding the highest stover production (3714 kg/ha), compared to 2918 kg/ha in the control.

The rise in both grain and stover yields can be linked to the direct foliar application of micronutrients, which efficiently supplies nutrients to the crop and minimizes losses due to leaching and other factors. This improved nutrient availability likely aided in the better movement of photosynthates to the sink, resulting in increased yields, as reported by Choudhary *et al*., (2015). However, no statistically significant differences were observed in the pooled data for the harvest index.

Conclusion

Based on the results, it can be concluded that the foliar application of B @ 0.2% + Fe @ 0.5% is recommended for achieving improved crop growth, establishment, and yield. Under late-sown conditions, this treatment proved effective in mitigating the adverse effects of heat and moisture stress caused by rising air temperatures. The foliar application of micronutrients significantly enhances crop growth and yield, making it a valuable practice for better crop performance in challenging conditions.

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