

Effect of Foliar Application of Micronutrients on Growth and Yield of Onion (*Allium cepa* L.)

Hari Dayal Choudhary*, Baldev Jayani and Brajesh Choudhary

Dr. B.R. Choudhary Agricultural Research Station, Mandor (Jodhpur), Agriculture University, Jodhpur

Abstract

An investigation was made to determine the effect of foliar application of micronutrients on the growth and yield of onion cv. NHRDF Red-4. The research was conducted at Dr. B.R. Choudhary Agricultural Research Station, Mandor, Jodhpur during Rabi seasons of 2022-23 and 2023-24. The experiment was laid out in a randomized block design with eight treatment combinations and three replications. The experiment consisted eight micronutrient treatments. The results indicated that the treatment T₈ (ZnSO₄ 0.5% + FeSO₄ 0.5% + Boron 0.25%) significantly improved growth and yield parameters over other treatments. T₈ exhibited the highest plant height, number of leaves, neck thickness, bulb dimensions, bulb weight, TSS and bulb yield. This treatment recorded the highest net profit (₹2,06,621/ha) with the most favorable benefit-cost ratio (3.76). In the present study, Treatment T₈ exhibited 28.14% increase in yield and 36.83% increase in net return over the control.

Keywords: Onion, foliar application, micronutrients, growth, yield, quality and economics.

*Correspondence

Author: Hari Dayal Choudhary
Email: haridayal.choudhary@gmail.com

Introduction

Onion (*Allium cepa* L.) is one of the most important bulb crops cultivated worldwide. It belongs to the family Alliaceae and is commonly referred to as the “Queen of the Kitchen” due to its indispensability in culinary use. It is an essential component of daily diets and has significant economic importance in India, especially in states like Maharashtra, Karnataka, Madhya Pradesh, and Rajasthan. Onion is rich in bioactive compounds such as quercetin, anthocyanins, and organosulfur compounds, which contribute to its antioxidant, anti-inflammatory and antitumor properties [1].

Despite the importance of onion, its productivity is often hampered by imbalanced nutrient supply, particularly deficiencies of micronutrients in soils with low fertility or alkaline pH. Micronutrients such as zinc (Zn), iron (Fe) and boron (B) are essential for key physiological functions, including chlorophyll formation, enzyme activation, carbohydrate metabolism and reproductive development [2]. Deficiencies of these nutrients adversely affect plant growth and significantly reduce bulb yield and quality.

Foliar application is considered an effective method of supplying micronutrients during critical growth stages, as it ensures quick absorption and utilization. It is especially beneficial in correcting deficiencies that may not be addressed efficiently through soil application due to nutrient fixation or poor mobility in the soil. According to [3], foliar sprays of boron and zinc at appropriate concentrations significantly improved onion growth parameters and bulb yield. Similarly, [4] demonstrated that foliar application of zinc and iron enhanced vegetative growth, neck thickness and marketable yield in onion. Given the proven benefits of micronutrient foliar feeding, the present investigation was undertaken to evaluate the effect of foliar application of zinc, iron and boron on growth and yield of onion under the agro-climatic conditions of western Rajasthan.

Material and Methods

The experiment was conducted during Rabi 2022–23 and 2023–24 at Dr. B.R. Choudhary Agricultural Research Station, Mandor, under Agriculture University, Jodhpur. The experiment was conducted using the onion cultivar 'NHRDF Red-4' as the test material. The trial was laid out in a Randomized Block Design (RBD) with eight treatments and three replications. Each plot measured 2.8 m in width and 3.0 m in length with an inter-row spacing of 15 cm and intra-row spacing of 10 cm between plants. The treatments consisted of foliar applications of zinc sulphate (ZnSO₄·H₂O), ferrous sulphate (FeSO₄·7H₂O) and boron (Borax) alone and in combinations, as treatments details viz. T₁: Control, T₂: ZnSO₄ 0.5%, T₃: FeSO₄ 0.5%, T₄: Boron 0.25%, T₅: ZnSO₄ 0.5% + FeSO₄ 0.5%, T₆: ZnSO₄ 0.5% + Boron 0.25%, T₇: FeSO₄ 0.5% + Boron 0.25% and T₈: ZnSO₄ 0.5% + FeSO₄ 0.5% + Boron 0.25%. Foliar sprays were

applied at three critical growth stages: 30, 60 and 90 days after transplanting (DAT). A spray solution at the rate of 500 litres of water per hectare was used for micronutrient application. Spraying was performed in the early morning to reduce evaporation losses and improve nutrient absorption. Standard agronomic practices, including timely irrigation at 10 day intervals, two hand weeding's at 30 and 45 days after transplanting (DAT) and pest management using Malathion 50 E.C. 1 ml/L were uniformly applied across all plots as per requirement to avoid confounding effects. The data were recorded on various growth and yield parameters namely plant height, number of leaves per plant and neck thickness at 30, 60 and 90 days after transplanting, polar and equatorial diameter of bulb (mm), fresh weight of bulb (g), total soluble solids ($^{\circ}$ Brix) and bulb yield (q ha^{-1}). For each treatment, ten plants were randomly selected from each replication for data collection, ensuring representativeness. The recorded data from both years were pooled and subjected to statistical analysis. The analysis of variance (ANOVA) technique as described by [5] was used to assess the significance of differences among treatments. Treatment means were compared using the least significant difference (LSD) test at a 5% significance level.

Results and Discussion

Growth parameters

Plant Height (cm)

Foliar application of micronutrients had a significant effect on plant height at all growth stages (30, 60 and 90 DAT) as presented in **Table 1**. The maximum plant height at 30 DAT (19.02 cm), 60 DAT (51.82 cm) and 90 DAT (56.92 cm) was recorded in treatment T_8 (ZnSO_4 0.5% + FeSO_4 0.5% + Boron 0.25%) followed by T_6 (18.02, 50.87 and 56.30 cm) and T_5 (17.63, 49.73 and 55.30 cm). The maximum plant height under combined application of Zn, Fe and B (T_8) may be attributed to the synergistic effect of these micronutrients on cellular elongation and metabolic activities. The minimum plant height was recorded under control (T_1) 14.94, 45.45 and 49.87 cm at 30, 60 and 90 DAT, respectively. Similarly, better efficacy of micronutrient mixture was reported by [6] and [7] in onion.

Table 1 Effect of foliar application of micronutrient on growth attributes of onion (Pooled data of two years)

Treatments	Plant height (cm)			Number of leaves			Neck Thickness (mm)		
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
T_1	14.94	45.45	49.87	4.88	6.48	7.75	6.05	7.82	9.36
T_2	17.10	48.42	53.75	5.70	7.42	8.63	7.71	8.69	10.46
T_3	15.90	47.15	52.25	5.12	7.18	8.22	6.50	8.81	9.66
T_4	16.69	47.92	53.00	5.27	6.98	8.43	7.42	8.99	10.03
T_5	17.63	49.73	55.30	6.03	7.67	9.70	8.25	9.70	11.44
T_6	18.02	50.87	56.30	6.25	7.78	10.30	8.54	9.84	11.88
T_7	17.43	48.95	54.25	5.88	7.48	9.07	7.93	9.56	11.03
T_8	19.02	51.82	56.92	6.53	8.55	11.15	9.16	10.73	12.63
SEm $\pm$	0.72	1.01	1.24	0.22	0.25	0.28	0.48	0.48	0.61
CD at 5%	2.08	2.93	3.58	0.64	0.71	0.80	1.38	1.39	1.75
CV (%)	7.29	3.59	3.97	6.73	5.73	5.23	10.71	8.96	9.70

(T_1 : Control, T_2 : ZnSO_4 0.5%, T_3 : FeSO_4 0.5%, T_4 : Boron 0.25%, T_5 : ZnSO_4 0.5% + FeSO_4 0.5%, T_6 : ZnSO_4 0.5% + Boron 0.25%, T_7 : FeSO_4 0.5% + Boron 0.25% and T_8 : ZnSO_4 0.5% + FeSO_4 0.5% + Boron 0.25%)

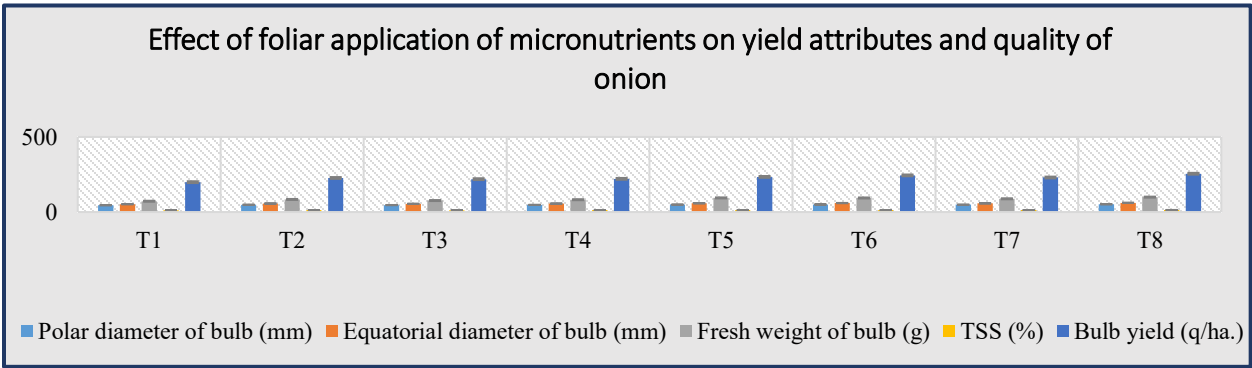


Figure 1 Effect of foliar application of micronutrients on yield attributes and quality of onion

Number of Leaves per Plant

A significant improvement in the number of leaves per plant was observed due to foliar application of micronutrients (Table 1). The maximum number of leaves at 30, 60 and 90 DAT was recorded under T₈ (6.53, 8.55 and 11.15) which was significantly higher than all other treatments. It was followed by T₆ (6.25, 7.78 and 10.30) and T₅ (6.03, 7.67 and 9.70). Whereas the minimum number of leaves was recorded in T₁ (4.88, 6.48 and 7.75) at 30, 60 and 90 DAT. The probable reason for the increased number of leaves could be the promotive effect of micronutrients on vegetative growth which ultimately enhances photosynthetic activity. These findings are in agreement with the findings of [4, 8].

Neck Thickness (mm)

Neck thickness showed a significant effect of foliar application of micronutrients (Table 1). The thickest neck at all growth stages was observed in T₈ (9.16, 10.73 and 12.63 mm) which was significantly superior to other treatments. It was followed by T₆ (8.54, 9.84 and 11.88 mm) and T₅ (8.25, 9.70 and 11.44 mm). While the minimum neck thickness was recorded in the control (T₁) 6.05, 7.82 and 9.36 mm at 30, 60 and 90 DAT, respectively. These similar findings are obtained by [2, 6].

*Yield parameters and economics**Polar and Equatorial Diameter of Bulb (mm)*

Foliar application of micronutrients significantly influenced bulb dimensions (Table 2). The maximum polar and equatorial diameter of bulb was obtained with T₈ (51.78 and 61.42 mm, respectively) followed by T₆ (50.21 and 59.68 mm) and T₅ (49.27 and 58.30 mm). The lowest polar and equatorial diameter (45.44 and 52.26 mm) was recorded in the control (T₁). The significant increase in bulb dimensions under foliar application of micronutrient mixture can be attributed to better metabolic efficiency and assimilate translocation. Improved enzymatic and photosynthetic activity supports cell expansion and bulb development. These findings are close conformity with the findings of [7-9].

Table 2 Effect of foliar application of micronutrients on yield attributes, quality and Economics of onion
(Pooled data of two years)

Treatments	Polar diameter of bulb (mm)	Equatorial diameter of bulb (mm)	Fresh weight of bulb (g)	TSS (%)	Bulb yield (q/ha.)	Gross Return/ha (Rs)	Net Return/ha (Rs)	B : C ratio
T ₁	45.44	52.26	71.90	11.69	199	219861	150991	3.19
T ₂	48.38	56.45	83.85	12.68	227	251139	178331	3.45
T ₃	46.28	54.92	76.57	12.20	219	242500	169543	3.32
T ₄	47.71	56.23	82.20	12.61	221	244306	171479	3.35
T ₅	49.27	58.30	94.15	12.92	234	258639	184744	3.50
T ₆	50.21	59.68	93.75	13.10	244	269889	196125	3.66
T ₇	48.82	57.73	88.22	12.85	230	254278	180364	3.44
T ₈	51.78	61.42	99.32	13.68	255	281472	206621	3.76
SEm+	1.23	1.32	3.63	0.46	6.19	6938	-	-
CD at 5%	3.55	3.82	10.51	1.34	17.94	20097	-	-
CV (%)	4.38	4.00	7.28	6.32	4.69	4.75	-	-

(T₁: Control, T₂: ZnSo₄ 0.5%, T₃: FeSo₄ 0.5%, T₄: Boron 0.25%, T₅: ZnSo₄ 0.5% + FeSo₄ 0.5%, T₆: ZnSo₄ 0.5% + Boron 0.25%, T₇: FeSo₄ 0.5% + Boron 0.25% and T₈: ZnSo₄ 0.5% + FeSo₄ 0.5% + Boron 0.25%)

Fresh Weight of Bulb (g)

The data revealed significant variations in fresh weight of bulb among all treatments (Table 2). The highest fresh weight of bulbs was recorded in T₈ (99.32 g) which was significantly superior to all treatments. It was followed by T₅ (94.15 g) and T₆ (93.75 g), whereas the lowest fresh weight of bulb (71.90 g) was observed in control (T₁). The supply of food is directly proportional to the rate of bulb growth and development. Zinc enhances photosynthetic activity and facilitates the translocation of photosynthates to the developing onion bulbs, thereby positively influencing bulb weight. Similarly better efficiency of micronutrient toward bulb weight was recorded by [10, 11].

Total Soluble Solids (°Brix)

The total soluble solids of bulbs were significantly influenced by micronutrient treatments (Table 2). The highest TSS

was recorded in T₈ (13.68 °Brix) followed by statistically at par performance of T₆ (13.10 °Brix) and T₅ (12.92 °Brix). The lowest TSS (11.69 °Brix) was recorded in the control (T₁). The improvement in TSS content of onion bulbs following foliar application of mixer of micronutrients may be attributed to enhanced metabolic processes involved in the biosynthesis of total soluble solids including carbohydrates, amino acids, organic acids and other inorganic constituents. This increase is likely due to the elevated production of carbohydrates during photosynthesis. The results are conformity with the findings of [1, 4, 7].

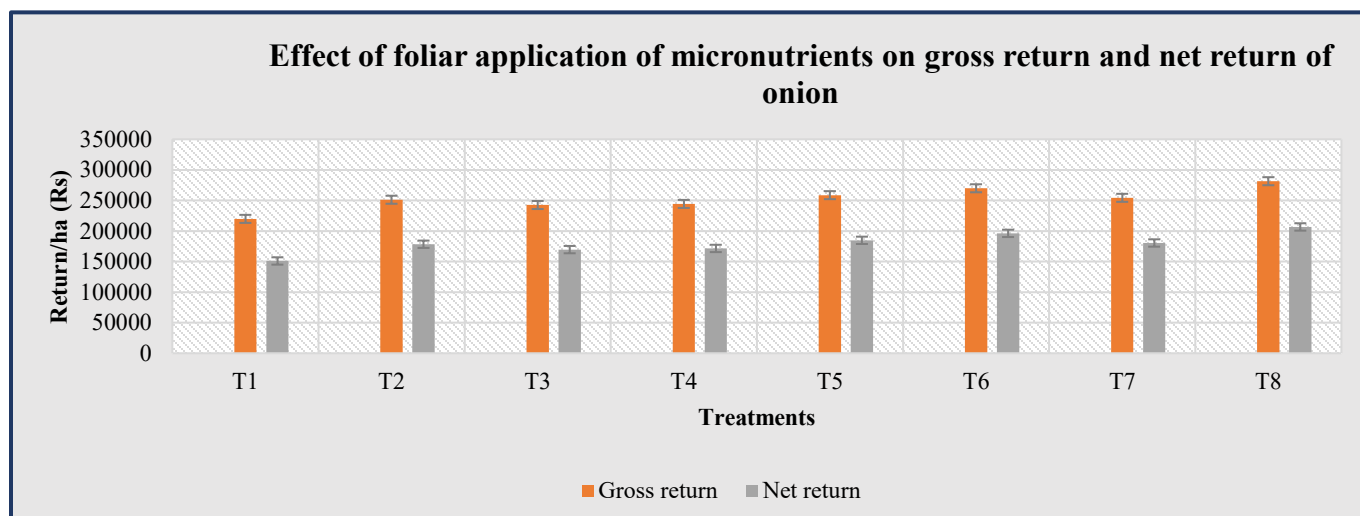


Figure 2 Effect of foliar application of micronutrients on gross return and net return of onion

Bulb Yield ($q\ ha^{-1}$)

Bulb yield was significantly affected by foliar application of micronutrients (Table 2). The maximum bulb yield was recorded in T₈ (255 q ha⁻¹), which was significantly higher than all other treatments. This was followed by T₆ (244 q ha⁻¹) and T₅ (234 q ha⁻¹). The lowest bulb yield (199 q ha⁻¹) was recorded in the control (T₁). The improvement in bulb yield may be attributed to enhanced vegetative growth of onion plants and increased photosynthetic assimilate accumulation in bulbs which contribute to higher individual bulb weight and larger bulb diameter which collectively increasing the overall bulb yield. The results are similar with findings of [6, 9, 11].

Economics

Economic analysis (Table 2) revealed that the highest gross return (₹2,81,472 ha⁻¹) and net return (₹2,06,621 ha⁻¹) were obtained in treatment T₈ (ZnSO₄ 0.5% + FeSO₄ 0.5% + Boron 0.25%) with the maximum benefit-cost ratio (3.76). This was followed by T₆ (₹2,69,889 and ₹1,96,125 with B:C ratio 3.66) and T₅ (₹2,58,639 and ₹1,84,744 with B:C ratio 3.50). The economic analysis confirmed that foliar application of mixture of Zn, Fe and B was not only agronomically beneficial but also economically viable. The lowest economic returns were occurred in the control with gross return of ₹2,19,861, net return of ₹1,50,991 and B:C ratio of 3.19. These findings are in line with [12], who reported that foliar application of micronutrients enhances profitability in onion cultivation.

Conclusion

In this experiment, it was observed that the foliar spray with a combination of ZnSO₄ 0.5%, FeSO₄ 0.5% and Boron 0.25% (T₈) consistently outperformed other treatments across all measured parameters, including plant growth, yield, bulb characteristics and economic returns in onion production. This indicates that T₈ is the most effective treatment overall for optimizing both agronomic performance and economic returns in onion bulb production.

The findings suggest that adopting either T₈ or T₆ (ZnSO₄ 0.5% + Boron 0.25%) would be beneficial for maximizing yield and economic returns in onion bulb production, making them the recommended treatments for achieving optimal results.

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