Foliar application of micronutrients to reduce fruit drop and enhance quality and yield attributes in ber (*Ziziphus mauritiana* Lamk.) cv. Gola

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Receipt: 11.11.2024 *Revised: 10.12.24* *Acceptance:12.12.24*
DOI: 10.53552/ijmfmap.10.2.2024.129-135
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ABSTRACT

A field experiment was conducted in Narendra Deva University of Agriculture and Technology Kumarganj, Faizabad (U.P.) during the years 2023-24 to evaluate the performance of micro-nutrient on fruit setting, retention, physical characteristics, and yield of ber fruit cv. Gola. Seven treatment of micronutrient and their combination were used with included a control (water spray).Results indicated that treatment T_5(Zinc sulphate @ 0.5% + Borax @ 0.3%) was most effective in achieving the highest fruit retention (38.42 %), and minimal fruit drop (61.58 %) leading to the maximum yield (131.00 q/ha).Additionally, Treatment T_7 with the combination of $ZnSO_4$ at 0.5%, $FeSO_4$ at 0.5%, and Borax at 0.3% resulted in highest fruit weight (18.59g), largest fruit dimensions (length-3.34cm and width-2.29cm), volume (19.83cc), and specific gravity (1.11) over control. Treatment- T_7 also enhanced fruit quality parameters, including higher percentages of total soluble solids (TSS-15.44 ^{0}B), ascorbic acid (84.85 mg/100g), reducing sugar (5.43%), non-reducing sugar (5.87%) and total sugar (11.30%), and the lowest acidity (0.31%).Thus the investigation concluded that treatment T_5- Zinc sulphate @ 0.5% + Borax @ 0.3% is most favourable to reduce fruit drop, enhance retention and yield attributes while treatment T_7- Zinc sulphate @ 0.5% + ferrous sulphate @ 0.5% + Borax @ 0.3% produced most favourable result among all treatment in physico-chemical parameters.

Keywords: Ber, borax, fruit drop, yield, zinc sulphate,

INTRODUCTION

The Indian jujube, also referred as ber (*Zizyphus mauritiana* Lamk), holds significant importance as a fruit tree cultivated across a wide range of tropical, subtropical, and dry land areas. It belongs to the Rhamnaceae family, which includes approximately 50 species, with 18-20 of them originating from India. Ber thrives both in wild habitats and cultivated environments across warmer regions, reaching as high as 1500 feet above sea level (Yadav *et al*., 2021). Its ability to withstand various conditions has made it a commercially viable option in several countries, including South Africa, the Indo Malayan region, the Middle East, Australia, Iran, the USA, Syria, as well as specific regions of Spain and Italy. In India, commercial cultivation of this crop is widespread across states like Haryana, Punjab, Maharashtra, Uttar Pradesh, Rajasthan, Madhya Pradesh, Bihar, Andhra Pradesh, and Tamil Nadu. In India, ber cultivation spans across an area of 54,000 hectares, yielding approximately 596,000 MT (Anonymous, 2021-22). Ber yields high-quality produce, demonstrating remarkable productivity even in constrained environments. Its resilience allows it to thrive in challenging conditions such as extreme heat and drought. Ber fruit contain elevated levels of key nutrients per 100 grams of pulp, including ascorbic acid (69 mg), protein (1.2 g), energy (79 kcal),

carbohydrates (20.2 g), and fats (0.2 g). Typically consumed fresh, ber is renowned for its rich content of ascorbic acid, carbohydrates, and vital minerals (Pareek *et al.*, 2009). Nutrients play a crucial role in various physiological processes such as vegetative propagation, induction of seedlessness, increasing fruit set, preventing pre-harvest fruit drop, regulating flowering, and managing fruit size and thinning and Nutrients like iron (Fe), potassium (K), borax, zinc (Zn), and calcium (Ca) are essential for enhancing flowering, fruit set, size, quality, and yield in many tree crops (Singh *et al.*, 2016). Borax in particular, is widely used to manipulate physiological events and improve fruit quality. Given the increasing importance of micronutrients in modern agriculture, their foliar application has emerged as a crucial strategy. This method allows for the direct delivery of nutrients to the leaves, ensuring timely availability during critical growth phases. Thus, it is vital to assess the effects of various micronutrients and their combinations on plant growth, yield, and fruit quality in ber cultivation. This research is essential not only to enhance the productivity and quality of ber but also to ensure its sustainable cultivation, thereby supporting local economies and food security.

MATERIALS AND METHODS

The present experiment was conducted at main experiment station, Department of Horticulture, ANDUA&T, Kumarganj, Ayodhya during the year 2023–2024 on Gola variety of ber. Its geographic co-ordinates are 26.470 N latitude, 82.120 E longitude, and 113 m above mean sea level. This location is in the Eastern Uttar Pradesh Indo-Gangetic Plains, a typical saline-alkaline zone. The experiment was laid out in randomized block design with three replications. The treatment consisted two foliar applications of Zinc sulphate, Iron sulphate and borax which were consisted T_0 (Control- water spray), T_1 (Zinc sulphate @ 0.5%), T_2 (Ferrous sulphate @ 0.5%), T_3 (Borax @ 0.3%), T_4 (Zinc sulphate @ 0.5% + Ferrous sulphate @ 0.5%), T_5 (Zinc sulphate @ 0.5% + Borax @ 0.3%), T_6 (Ferrous sulphate @ 0.5% + Borax @ 0.3%) and T_7 (Zinc sulphate @ 0.5% + Ferrous sulphate @ 0.5% + Borax @ 0.3%). The foliar sprays of micro-nutrient were applied two times. The first foliar spray was applied in the third week of October at the fruit set stage, followed by a second spray in the third week of November during the active growth phase, using a foot sprayer. Physical parameters like Fruit size (length and width) measured by Vernier calliper, Fruit Weight (g) is measured by Digital weighing machine and Biochemical parameters like Total soluble solids (TSS ^{0}Brix), Acidity (%), Ascorbic acid (mg/100g pulp), Reducing sugar (%), Non reducing sugar (%), Total sugars (%) and Total invert sugar (%) were analyzed by AOAC(1995) method in the Post Graduate Laboratory, Department of Fruit Science CHF, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.) during 2023-24. The data is subjected to two way ANOVA and analyzed as per method suggested by Punse and Sukhatme (1995).

RESULTS AND DISCUSSION

Fruit drop and fruit retention

The micro-nutrients in general were effective in increasing fruit setting significantly in comparison to control. Data collection occurred at seven specific intervals (Table 1). The combined application of $ZnSO_4$ @ 0.5% and $FeSO_4$ @ 0.5% which is treatment (T_5) resulted in the lowest fruit drop with only 61.58% followed by Treatment T_7 (64.67%) with foliar application of $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% + Borax @ 0.3% over control and at par with all the mentioned treatments. Adhikary *et al.* (2019) in reported in ber that a very heavy fruit drop occurred immediately after fruit set and fruit drop was reduced as fruit development advanced. It was observed that maximum fruit retention (38.42%) was observed in T_5 (Zinc sulphate @ 0.5% + Borax @ 0.3%). Involvement of Zn in auxin synthesis and B in translocation of starch to fruit resulted into better photosynthesis. Presence of borax and zinc stimulates auxin production and postponing the development of

the abscission layer in the initial phases of fruit growth. The increase in fruit retention seen with borax sprays implies that these treatments may have influenced the balance of auxin, thereby preventing fruit drop (Kumar and Shukla (2010) in ber) and Yadav *et. al.*, (2017) in guava cv. Lalit.

Physical parameter

The maximum fruit size in terms of maximum fruit length (3.34 cm) and width (2.29 cm) was revealed with combined spray of Zinc sulphate @ 0.5% + Ferrous sulphate @ 0.5% + Borax @ 0.3% (T_7) expressed in Table 2. Treatment T_7 shows significant difference over control in fruit length but in fruit width there is no significant difference between T_7 and T_5. This effect is might be due to Zinc improves quality in many fruit crops as well as Borax helps in cell wall synthesis and elongation of so it's application can influence fruit diameter (Tripathi *et al.*, 2018). Result is closely related with the Mishra *et al*. (2017) in aonla, Meena *et al.* (2008) worked in ber trees. The improvement in volume of fruit (Table 2) and specific gravity (19.83 cc and 1.11) was recorded respectively with the combined spray of Zinc sulphate @ 0.5% + Ferrous sulphate @ 0.5% + Borax @ 0.3% (T_7) followed by treatment (T_5) whereas minimum recorded in control plants. Specific gravity (Table 2) shows significant difference among treatment and also at par with the rest of treatments. Meena *et al.* (2008) also reported favourable effects of potassium, boron and ferrous sulphate on various constituents of ber fruits and these findings also closely align with Majumder *et al*. (2017) in ber.

Biochemical parameters

Data on biochemical parameters like TSS, ascorbic acid, acidity, ascorbic acid, reducing sugar, non-reducing sugar and total sugars are presented in Table 2. Increased TSS and minimum acidity content was estimated in treatment T_7 ($ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% + Borax @ 0.3%) (15.44 ^{0}B and 0.31% respectively) followed by T_5-$ZnSO_4$ @ 0.5% + Borax @ 0.3% (13.80 ^{0}B and 0.32%) and decreased TSS and increased acidity were seen over control (11.44 ^{0}B and 0.38%). All the treatment were showed significance difference over control but in acidity there is no significance difference among all the treatments. Borax stimulates the functioning of number of enzymes in the physiological process which probably cause an increase in T.S.S. content. Pandey and Kumar (2022), Pal *et al*. (2021) reported highest TSS in ber cv. Gola and Kumar *et al*. (2024) in papaya. Likewise similar results were obtained by Singh *et al.* (2012) with the spray of zinc sulphate to reduce the acidity of aonla fruit, cv. Banarasi due to transformation of organic acids into sugars during ripening and their derivative by the reaction involving reversal of glycolytic path way. The highest levels of ascorbic acid (84.85 mg/100g,) reducing (5.43%), non-reducing (5.87%), and total sugars (11.30%) were recorded by the treatment T_7 with foliar application of Zinc sulphate 0.5% + Ferrous sulphate 0.5% + Borax 0.3% followed by treatment T_5 (81.35 mg/100g, 4.98%, 5.56% and 10.54% respectively) with foliar application of Zinc sulphate 0.5% + Borax 0.3 and least content were observed in control. Treatment T_7 was found significant and at par with rest of the treatment. Borax also stimulates the functioning of number of enzymes in the physiological process resulting increased ascorbic acid content and iron also act as catalyst in oxidation process. These finding has close conformity with by Pal *et al*. (2021) and Pandey and Kumar (2022) in ber cv. Gola and Majumdar *et al.* (2017) in ber. Increased in sugar level in fruits may be due to effectiveness of boron which facilitating sugar translocation within the fruits and boost the sugar level to increase (Pandey and Kumar, 2022 and Pal *et al*., 2021 in ber).

Yield parameter

The results revealed that the effect of foliar spray of different micronutrients alone and in combination influenced the overall yield (Table 3). The application of treatment T_7-$ZnSO_4$@ 0.5% + $FeSO_4$ @ 0.5% + Borax @ 0.3% gained maximum weight (18.59 g per fruit) followed by T_5 (18.52g per fruit) while

T_5 ($ZnSO_4$ @ 0.5% + Borax @ 0.3%) treatment gave the maximum yield 83.97 kg/per tree and 131.00 q/ha as compared to other treatments. Cumulative effect of zinc and boron help to increase the fruit retention per centage as well as minimise fruit drop per centage and thereby increasing the fruit yield. Kumar and Shukla (2010) noted impacts of zinc and borax on fruit yield, Bhatt *et al.* (2012) in mango, Gurjar *et al*. (2015) in mango, Chaudhary *et al*. (2018) in aonla, Kumar *et al*. (2024) in papaya and Yadav *et al.* (2017) reported in guava cv. Lalit.

Conclusion

The current study's findings, which involved a 24-year-old ber cv. Gola plant, indicated that the treatment T_5, which received $ZnSO_4$ @ 0.5% + Borax @ 0.3%, was the most suitable nutrient dose for sodic soil conditions in order to maximize fruiting, yield and minimize fruit drop. Whereas after analysing the impacts of each treatment on different parameters, it was determined that treatment T_7 (receiving $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% + Borax @ 0.3%) found the best in terms of physical and chemical attributes of ber.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Table 1: Effect of specific micro nutrient on periodical fruit drop (%), total fruit drop (%) and fruit retention (%) of ber cv. Gola.

Treatments	1st week of Nov.	2nd week of Nov.	3rd week of Nov.	3rd week of Dec.	3rd week of Jan.	3rd week of Feb.	At Harvest	Total Fruit drop (%)	Fruit retention (%)
T_0	8.59	9.17	11.42	12.73	20.59	7.23	8.94	78.67	21.33
T_1	8.92	6.89	11.18	10.08	20.16	7.05	8.20	72.48	27.52
T_2	7.27	8.28	10.63	14.75	19.72	6.73	7.89	75.27	24.73
T_3	7.81	10.31	11.24	11.25	17.56	5.37	7.29	70.83	29.17
T_4	9.30	5.09	10.28	11.22	16.19	5.06	9.21	66.35	33.65
T_5	7.03	5.13	7.02	10.64	19.68	5.04	7.04	61.58	38.42
T_6	7.29	6.44	9.41	12.38	18.50	6.12	8.36	68.50	31.50
T_7	6.39	6.26	11.08	13.09	17.40	4.34	6.11	64.67	35.33
S. Em±	**0.14**	**0.14**	**0.17**	**0.21**	**0.31**	**0.10**	**0.16**	**0.61**	**0.49**
CD @ 5%	**0.41**	**0.43**	**0.51**	**0.64**	**0.94**	**0.30**	**0.48**	**1.86**	**1.48**

T_0-Control- water spray, T_1-Zinc sulphate @ 0.5%, T_2- Ferrous sulphate @ 0.5%, T_3- Borax @ 0.3%, T_4- Zinc sulphate @ 0.5% + Ferrous sulphate @ 0.5%, T_5- Zinc sulphate @ 0.5% + Borax @ 0.3%, T_6- Ferrous sulphate @ 0.5% + Borax @ 0.3% and T_7-Zinc sulphate @ 0.5% + Ferrous sulphate @ 0.5% + Borax @ 0.3%

Table 2: Effect of specific micro nutrient on physical and biochemical characters of ber cv. Gola.

Treatments	Fruit length (cm)	Fruit width (cm)	Fruit volume (cc)	Specific gravity	TSS (^{0}Brix)	Acidity (%)	Ascorbic acid (mg/100g)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)
T_0	2.23	1.91	16.70	0.82	11.44	0.38	68.01	3.71	3.78	7.49
T_1	2.80	2.13	18.10	0.93	13.44	0.36	73.82	4.17	4.23	8.40
T_2	2.56	2.03	17.60	0.90	12.91	0.37	72.55	3.93	4.11	8.04
T_3	2.61	2.07	18.10	0.93	13.56	0.35	75.00	4.32	4.53	8.85
T_4	3.17	2.19	18.30	1.00	13.77	0.33	79.16	4.77	5.34	10.11
T_5	3.19	2.25	18.40	1.05	13.80	0.32	81.35	4.98	5.56	10.54
T_6	3.06	2.17	18.20	0.95	13.61	0.34	77.27	4.56	5.02	9.58
T_7	3.34	2.29	19.83	1.11	15.44	0.31	84.85	5.43	5.87	11.30
S. Em±	**0.03**	**0.04**	**0.24**	**0.03**	**0.20**	**0.01**	**1.34**	**0.07**	**0.07**	**0.08**
C.D. at 5%	**0.10**	**0.11**	**0.73**	**0.10**	**0.60**	**0.02**	**4.06**	**0.22**	**0.22**	**0.23**

T_0-Control- water spray, T_1-Zinc sulphate @ 0.5%, T_2- Ferrous sulphate @ 0.5%, T_3- Borax @ 0.3%, T_4- Zinc sulphate @ 0.5% + Ferrous sulphate @ 0.5%, T_5- Zinc sulphate @ 0.5% + Borax @ 0.3%, T_6- Ferrous sulphate @ 0.5% + Borax @ 0.3% and T_7-Zinc sulphate @ 0.5% + Ferrous sulphate @ 0.5% + Borax @ 0.3%

Table 3: Effect of specific micro nutrient on yield attributes of ber cv. Gola.

Treatments	Fruit weight (g)	yield per (kg/plant)	yield (q/ha)
T_0	16.27	65.74	102.56
T_1	16.80	71.61	111.71
T_2	16.47	68.24	106.46
T_3	16.95	73.77	115.08
T_4	18.01	80.85	126.12
T_5	18.52	83.97	131.00
T_6	17.25	76.02	118.58
T_7	18.59	83.80	130.73
S. Em±	**0.29**	**0.91**	**0.20**
C.D. at 5%	**0.87**	**2.76**	**0.60**

T_0-Control- water spray, T_1-Zinc sulphate @ 0.5%, T_2- Ferrous sulphate @ 0.5%, T_3- Borax @ 0.3%, T_4- Zinc sulphate @ 0.5% + Ferrous sulphate @ 0.5%, T_5- Zinc sulphate @ 0.5% + Borax @ 0.3%, T_6- Ferrous sulphate @ 0.5% + Borax @ 0.3% and T_7-Zinc sulphate @ 0.5% + Ferrous sulphate @ 0.5% + Borax @ 0.3%