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Response of foliar application of Zn on growth, yield and quality production of Ber: A review

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Abstract
Ber is one of most important fruit cultivated all over the world and it belongs to family Rhamnaceae. It is a rich source of vitamin C. However, growth, yield and quality production of ber is declining due to several micronutrient deficiencies caused due to several reasons. Zinc is essential for energy transmission, nitrogen metabolism and oxidation reduction reactions. Zinc promotes synthesis of indole acetic acid through tryptophan which serves as a precursor for auxin synthesis and directly affects the growth and yield parameters. It also improves the chlorophyll contents of leaves and plays an important role in enzymatic activities and is also essential for growth and development of fruits. There are numerous ways to overcome Zinc deficiency under field conditions but the best and the easiest method is foliar application. The present review focuses on the response of foliar application of Zn on growth, yield and quality of ber fruit.

Keywords: Ber, micronutrient, tryptophan, yield

Introduction

Ber (*Ziziphus mauritiana* L.) is cultivated under wide range of climatic conditions in different states of India, i.e. Madhya Pradesh, Rajasthan, Gujarat, Punjab, Haryana, Uttar Pradesh, Maharashtra and to limited extent in several other states. It is a member of the Rhamnaceae family. This tetraploid species possesses a chromosome count of 2n = 4x = 48. Origin of ber is said to be India to South - Western Asia. It is a drought hardy and can grow under the most hazardous condition of soil, water and climate and thus it is highly recommended for the arid and desert area of India. Ber is quite popular due to high economic returns, low cost of cultivation and wide adaptability and ability to stand drought. It is popularly known as "King of arid fruits". Ber is a nutritious and delicious table fruit. The fruit is a rich source of ascorbic acid, vitamin B and minerals. It contains more protein, phosphorus, calcium and vitamin 'C' than an apple (Bakshi and Singh, 1974). The ber fruit contains carbohydrates (17.0 g/100 g), proteins (0.8 g/100 g), total sugars (5.4–10.4 g/100 g), reducing sugars (1.4–6.2 g/100 g), non-reducing sugars (3.2–8.0 g/100 g), calcium (25.6 mg/100g), phosphorus (26.8 mg/100 g), Iron (0.76–1.8 g/100 g), ascorbic acid content (65.8–76.0 mg/100 g), and carotene (0.02 mg/100 g) [Pareek and Dhaka (2008) [12], Pareek *et al.* (2009) [13]. It is popularly called as poor man's apple due to its high nutritional and medicinal value (Gajbhiya *et al.*, 2003) [3]. However, deficiency of Zn is one of the major micronutrient deficiency in crops and soil which reduce the yield and quality of production, ultimately either direct or indirect negative effects on human health (Cakmak, 2008) [2]. Zinc promotes synthesis of indole acetic acid through tryptophan which serves as a precursor for auxin synthesis and directly affected the growth parameters as well as yield parameters. It is also involved in regulating the protein and carbohydrate metabolism (Katiyar *et al.*, 2009) [5]. The maximum absorption of zinc would be possible when it is applied as foliar spray (Khanna *et al.*, 1969) [6]. Foliar application of Zn increases the biosynthesis of carotenoid and chlorophyll synthesis that are essential for proper performance of photosynthetic process (Mousavi, 2011) [8]. The present review focuses on the response of foliar application of Zn on growth, yield and quality of ber fruit.

Deficiency of Zinc

The deficiencies of micronutrients are general due to alkaline pH, low organic matter and calcareous nature of soil (Rashid *et al.*, 1997) [14]. Deficiencies of nutrients are turning healthy orchards into unproductive with low quality fruit. Zn deficiency is one of the major micro-nutrient deficiency in crops and soil which reduce the yield and quality of production; ultimately directly or indirectly cause negative effects on human health (Cakmak, 2008) [2].

Availability of Zn is inversely associated to pH of soil and its shortage is prominent on calcareous soils having pH > 8.0 (Srinivasa *et al*., 2008) [17]. Moreover, Soils with high percentage of phosphorous and silicon are also estimated to cause Zn deficiency. Insufficient supply of Zn causes negative effects on plants by stopping the tillering process, stunting growth, delaying crop maturity, chlorosis in younger and older leaves, poor quality of harvested products and sterility of spikelet (Hafeez *et al*., 2013) [4].

Importance of foliar application of Zinc in ber

Ber (*Ziziphus mauritiana* Lam.) is an ancient fruit tree indigenous to India and belongs to family Rhamnaceae. The maximum absorption of zinc would be possible when it is applied as foliar spray (Khanna *et al*., 1969) [6]. Singh and Vashishtha (1997) [16] observed that tree sprayed with zinc sulphate had higher fruit retention, yield and quality and reduced fruit drop. Foliar application of nutrients significantly reduced fruit drop (Sharma *et al*., 2009) [15]. Foliar application is noticeably a perfect way of escaping the problems of nutrient availability. The growth and development of fruits, vegetables and grains are thought to require zinc. Micronutrients like zinc (Zn) is very essential for physiological, optimal plant growth and biochemical pathways in ber development. It is crucial for the production of chlorophyll and is hence helpful for photosynthetic processes. IAA is synthesized with the help of several enzymes that include zinc. Therefore, foliar application of Zn is very important for not only increasing plant vigour, but also for enhancing the yield.

Response of Zn on Growth, Yield and Quality of Ber

Zinc takes part in lots of physiological processes and its inadequate dose can affect crop growth and yield. Pandey *et al*. (2011) [11] executed an experiment to determine the influence of NAA, GA_3 and zinc sulphate on fruit drop, growth, yield and quality of ber cv. Banarsi Karaka. There were nine treatments comprising two levels each of NAA (10 and 20 ppm), GA_3 (20 and 40 ppm) and zinc sulphate (0.2 and 0.4%) and their combinations (NAA @ 10 ppm + GA_3 @ 20 ppm + $ZnSO_4$ @ 0.2% and NAA @ 20 ppm + GA_3 @ 40 ppm + $ZnSO_4$ @ 0.4%) along with one control, replicated thrice in Randomized Block Design. Single plant was used as a Unit. Spray was done at fruit setting stage. From the present investigation it was found that the application of NAA @ 20 ppm + GA_3 @ 40 ppm + $ZnSO_4$ @ 0.4% proved to the most effective treatment for increasing fruit length (3.98 cm), width (2.99 cm), weight (20.13 g), yield (118.25 kg), weight of fruit pulp (19.02 g), TSS (14.20 °Brix), total sugars (10.71%), acidity (0.17%) and ascorbic acid (78.35 mg/100 g) content in ber cv. Banarsi Karaka. However, reduction in fruit drop (78.20%) and increase in fruit retention (21.81%) was also influenced by the combined spray of NAA @ 20 ppm + GA_3 @ 40 ppm + $ZnSO_4$ @ 0.4% during the present investigation. Laishram and Baruah (2020) conducted a research to evaluate the effect of different sources and concentration of zinc on growth, yield and quality of ber. There were total seven treatments *viz*. T_1 0.3% ($ZnSO_4$), T_2 0.4% ($ZnSO_4$), T_3 0.5% ($ZnSO_4$), T_4 0.3% (chelated zinc chelamin), T_5 0.4% (chelated zinc chelamin), T_6 0.5% (chelated zinc chelamin) and T_0 Control (Without zinc) which were taken into experiment for evaluation of different parameters of ber and each treatment was replicated three times. The age of ber plants taken were of about 3 years and spacing was 2.5 m apart from other plants. The plants selected were free from pest and diseases and all the plants were with normal growth. The highest leaf area (18.06 cm^2), the highest RWC (89.85%) and highest chlorophyll content (1.24 mg/g) of leaves were recorded in 0.5% chelated treatment. Similarly, the nitrogen and zinc contents were significantly affected by application of chelated treatment. The highest N content (3.12%) and Zn content (28.80%) was recorded in 0.5% chelated treatment. The quality attributing characters *viz*., Total Soluble Solids (11.73°B) was found highest in 0.5% chelated treatment, titratable acidity and ascorbic acid was found highest in control i.e. (0.55%) and (74.61 mg/100g), TSS/ acid ratio (51.01%), total sugar (11.04%), reducing sugar (4.84%), non reducing sugar (6.23%), thickness of pulp (23.60 mm) and weight of the pulp (66.51 g) were increased in 0.5% chelated treatment. Maximum fruit juice per volume (cc) (52.52), number of flower per plant (18277.02), no. of fruit per plant (1395.04), weight of the fruit (70.53 g), volume of the fruit (75.05 cc), yield (123.43 kg/plant), fruit length (6.07 cm) and girth (6.08 cm) were recorded in 0.5% chelated zinc treatment. Chelated zinc 'Chelamin' at the concentration of 0.5% has favourably influenced the growth, flowering, fruit set, yield attributing characters and yield and fruit quality of ber. Pal *et al*. (2021) [9] investigated the effect of foliar feeding on chemical attributes of ber (*Ziziphus mauritiana* L.) under sodic soil. The experiment comprised of total 10 treatments. One plant was taken as a unit and total number of plants selected were 30 with a spacing of 6 x 6 meter. Three sprays were done i.e. first spray at 20^{th} September, second at 5^{th} November and third at 20^{th} December. The foliar feeding of urea (2.0%), zinc sulphate (0.50%), borax 0.50% and K_2SO_4 0.50% at peak flowering, peanut size of fruit and second growth phase significantly increased the fruit quality characteristics T.S.S. (20.86°Brix), total sugars (9.58%), reducing sugars (6.68%), non- reducing sugars (2.90%), acidity (0.25%), ascorbic acid (95.66 mg/100 g pulp), fruit yield per plant (33.63 kg/plant) and fruit yield (9.37 t/ha.) over control. The treatment T_{10} was observed best with the feeding of Urea 2.0% + $ZnSO_4$ 0.50% + Borax 0.50% + K_2SO_4 0.50%. However, treatment T_{10} was observed best with the combination of Urea 2.0% + $ZnSO_4$ 0.50% + Borax 0.50% + K_2SO_4 0.50% in improving fruit quality of ber (*Ziziphus mauritiana* L.) under sodic soil. Pandey and Kumar (2022) [10] conducted an experiment to examine the effect of $ZnSO_4$, borax and GA_3 on quality and yield of ber (*Ziziphus mauritiana* Lamk.) fruits cv. gola. Single plant was used as a Unit. Two sprays were done i.e. the first spray was done in first week of September (just before flowering) and second spray was done after fruit setting in the month of November. There were total five treatments T_1: $ZnSO_4$ 0.5%, T_2: Borax 0.5%, T_3: GA_3 100 ppm, T_4: $ZnSO_4$ 0.5% + borax 0.5% + GA_3 100 ppm and T_5: Control. The application of $ZnSO_4$, borax and GA_3 on the growth and yield of ber fruits was studied and it was found that highest T.S.S. (19.36°B), ascorbic acid (86.32 mg/100 g), reducing sugars (6.10%), non-reducing sugars (8.00%), total sugars (14.10%), organoleptic quality (8.6) and lowest acidity (0.22%) was recorded with foliar application of $ZnSO_4$ 0.5% + borax 0.5% + GA_3 100 ppm and the minimum was found under the control. Tripathi *et al*. (2022) [18] conducted research on influence of foliar application of NAA, GA_3 and zinc sulphate on fruiting and yield attributes of ber (*Ziziphus mauritiana*

Lamk.). The experiment comprised of 9 treatments i.e. T_0 Control (water spray), T_1 (GA_3 @ 0 ppm), T_2 (GA_3 @ 20 ppm), T_3 (NAA @ 30 ppm), T_4 (NAA @ 40 ppm), T_5 ($ZnSO_4$ @ 0.4%), T_6 ($ZnSO_4$ @ 0.6%), T_7 (GA_3 @ 10ppm + NAA 30 ppm + $ZnSO_4$ 0.4%), T_8 (GA_3 @ 20 ppm + NAA @ 40 ppm + $ZnSO_4$ @ 0.6%). Nine trees of ber were taken and on each tree three unique branches were selected and used as one unit (for one treatment). So 27 units were selected on 9 ber trees. The yield attributes were improved by the foliar application of $ZnSO_4$ @ 0.6% and GA_3 @ 20 ppm + NAA @ 40 ppm + $ZnSO_4$ @ 0.6%. NAA, GA_3 and micronutrient Zn was found very effective in hastening fruiting and yielding attributes.

Conclusion

Our review has demonstrated that Zn is the most important factor limiting ber crop production but negative effects of ber deficiency can be minimized by the foliar application of Zn. Moreover, foliar application of zinc significantly improves growth, yield, production and quality of ber.

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