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Effect of foliar application of plant growth regulators and micro-nutrient on physico-chemical characters of Ber (*Zizyphus mauritiana* Lamk.)

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Abstract
The present investigation was carried out to investigate the "Effect of foliar feeding of plant growth regulators and micro-nutrient on fruiting, yield and quality of ber (*Zizyphus Mauritiana* Lamk.) cv. Gola" during the year 2020-21. The experiment was conducted at the Main Experiment Station, Department of Horticulture, A. N. D. University of Agriculture and Technology Kumarganj, Ayodhya. The experiment on ber cv. Gola was conducted in Randomized Block Design (RBD) with seven treatments, comprise of difference plant growth regulators and micro-nutrient *viz*. NAA 20 ppm, NAA 40 ppm, GA_3 20 ppm, GA_3 40 ppm, $ZnSO_4$ 0.4% and $ZnSO_4$ 0.6% with control. The observations were recorded for quality aspects TSS, acidity, ascorbic acid and sugars were estimated. From the findings of present investigation, it can be inferred that the quality aspects (acidity, ascorbic acid, TSS and non-reducing sugar, reducing sugar and total sugars) were found maximum by the spray of NAA 40 ppm and can be used in increasing the quality in the ber fruit.

Keywords: Ber, Gola, NAA, GA_3, $ZnSO_4$

1. Introduction
Ber *(Zizyphus mauritiana* Lamk.), the popular arid fruit, also known as Indian jujube, is an important fruit crop of dry climate. It belongs to the family Rhamnaceae. The crop is originated in India and one of its related species *Z. jujube* is widely cultivated in the hills of Himalayas. This fruit crop is commonly grown in India and also in other countries *i.e.*, China, Afghanistan, Iran, Russia, Syria, Myanmar, Australia and USA. In India, ber is cultivated in various part of the country particularly in arid and semi-arid regions comprising of 50,000 ha area, producing 5.39 lakh MT of fruits (National Horticulture Board, 2018-19)[3]. The major ber growing regions are Rajasthan, Madhya Pradesh, Uttar Pradesh, Haryana, Punjab, Gujarat, Bihar, Maharashtra, Andhra Pradesh and Tamil Nadu. Ber is a nutritious and delicious table fruit. The fruit is a rich source of ascorbic acid, vitamin B and minerals. Ber is important because it is a hardy fruit crop that can be grown in a variety of soils, including deep sandy loam with neutral or slightly alkaline reaction. It can also flourish in soil with a pH of 9.2 or even higher. The fruits are usually consumed fresh, but they can also be dried, candied, and used to make other items such as squash/juice and ber butter. It also has remedial properties. The digestible, laxative, aphrodisiac, and invigorating ripe fruit has a cooling effect. It contains more protein, phosphorus, calcium, and vitamin 'C' than an apple (Bakshi and Singh, 1974) [4]. Growth regulators and micro-nutrient plays an important role in many physiological phenomena like vegetative propagation, induction of seedlessness, increase fruit set, prevention of pre-harvest fruit drop, regulation of flowering, fruit size, thinning of flower and fruits, quality of fruit as well as yield in many fruit crops. NAA is a synthetic auxin plant hormone that is routinely used greatly increase cellulose fiber formation in plant. Fruit drop is controlled by spraying of NAA at different concentration in different fruit crops. NAA also inhibits fruit drop by strengthening the pedicle. Gibberellic acids are diterpene plant hormones that are biosynthesized from geranyl diphosphate, which control diverse aspects of growth and development including seed germination, stem elongation, flowering, fruit development, and the regulation of gene expression in the cereal aleurone layer. Foliar sprays with Zn are widely practiced by fruit growers because this metal is an essential element for normal plant development. Large areas of agricultural soils are deficient in this element and soil applications are generally ineffective in correcting Zn deficiency in fruit crops.

2. Materials and Methods

The present investigation entitled "To study the effect of foliar application of plant growth regulators and micro-nutrient on physico-chemical characters of ber (*Zizyphus mauritiana* Lamk.)" was carried out at Main Experiment Station, Department of Fruit Science, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.) during the year 2020-21. Plants received uniform cultural operation throughout the experimental period. The details of the materials used, experimental procedures followed and techniques adopted during the course of investigation described briefly in this chapter. In the present study, plants of ber cultivar Gola, uniform in vigor and productivity were taken as experimental material to find out the effect of foliar spray of plant growth regulators and micro-nutrient on physico-chemical characters of ber fruits.

The experiment was layout in a Randomized Block Design to assess the effects of plant growth regulators and micro-nutrient on ber cv. Gola. The details of experimental plan employed in the present investigation are as follows with 7 treatments comprised of i.e., T_1: Control (Water spray), T_2: NAA 20 ppm, T_3: NAA 40 ppm, T_4: GA_3 20 ppm, T_5: GA_3 40 ppm, T_6: $ZnSO_4$ 0.4% and T_7: ZnSO4 0.6% in Randomized Block Design (RBD) with 3 replications.

2.1 Time and number of spraying

First spray of PGR and micro-nutrient was done on 15th October and second spray of PGR and micro-nutrient on 15th November.

Five fruits were randomly selected from each treatment and macerated in pestle and mortar for juice extraction. Total soluble solids (TSS) of the juice were determined by using a Hand Refractometer (Erma) of 0 to 32 ^{0}Brix range. The values were corrected at 20 ^{0}C and expressed as ^{0}Brix of the juice. Known quantity of the fruit pulp (5 g) was macerated and diluted in small amount of distilled water and filtered through muslin cloth. The volume was made up to 100 ml. 5 ml aliquot was taken for titration against 0.1N sodium hydroxide solution using phenolphthalein as indicator. The end point was marked by the appearance of light pink colour which persisted at least 15 second. Ascorbic acid content was estimated by crushing 5 g fruit pulp with 3 per cent metaphosphoric acid as buffer through pestle and mortal. The extracted was filtered and 100 ml volume was made up. 5 ml aliquot was titrated against, 2, 6- Dichlorophenol indophenol dye solution till the light pink colour appeared. The results were expressed as mg of ascorbic acid per 100 g of fruit pulp A.O.A.C., 1970 [1]. Sugar was estimated by using Fehling solution 'A' and 'B' as per method given by Lane and Eynon (1943). Five g fruit pulp was macerated with small amount of distilled water and filtered through muslin cloth and volume was made up to 100 ml. An aliquot of 5 ml diluted fruit juice was taken from 100 ml as above for titration and mixed with 5 ml of each Fehling solution 'A' and 'B'. This solution was titrated against 1.0% glucose solution in boiling the solution using methyl blue indicator. The appearance of light brick colour was marked as end point. A blank titration with 10 ml of Fehling solution 'A' and 'B' was also run. The results were expressed as per cent of reducing sugars. Non-reducing sugar was estimated by deducting quality of reduction sugars from total invert sugar and multiplied by factors 0.95. The results were expressed as per cent non reducing sugars. The estimated values were expressed in total sugars, reducing sugars and non-reducing sugar contents of fruits and expressed as Reducing sugars percentage + Non-reducing sugar percentage and expressed as percent total sugars.

3. Results and Discussion

The maximum total soluble solids (18.47%) was found with application of treatment T_3 (NAA 40 ppm), which was at par with T_2 (NAA 20 ppm) and minimum T.S.S. (15.92%) under T_1 (control). The increase in total soluble solids as a result of auxin spray may be ascribed to fact that application of these growth regulators probably improved the physiology of leaves, thereby causing better translocation of vital components in the fruit and assimilation of photosynthates by the developing fruit (Pandey, 1999) [6]. The above findings are in agreement with the Yadav *et al*. (2001) [8] concluded that TSS content of guava fruits can be improved with application of NAA. The minimum acidity (0.31%) was found with the application of treatment T_3 (NAA 40 ppm), which was at par with T_2 (NAA 20 ppm) and maximum (0.38%) with application of treatment T1 (water control). Different treatments significantly influenced the acidity percentage in ber cv. Gola. The decrease in fruit acidity owing to the application these treatments might be because of the acids that might have been quickly converted into sugars and its derivatives by the reaction of glycolytic pathway. The above findings are in agreement with the Ingle *et al*. (2001) [5] established that spray of NAA enhanced acidity and total yield in mandarin. It has been discovered that NAA treatment decreased the acidity in Umran ber. Maximum acidity (71.10 mg/ 100 g pulp) by the foliar spray of T_3 (NAA 40 ppm), which was at par with T_5 (GA_3 40 ppm) and T_7 ($ZnSO_4$ 0.6%) respectively. The minimum ascorbic acid (58.70 mg/ 100 g pulp) was recorded with the T_1. Ascorbic acid content was significantly influenced by foliar application of different plant growth regulators and micro-nutrient. This increased in ascorbic acid content of fruit juice was due to an increase in the synthesis of catalytic activity by the enzyme and coenzyme, which are represented in ascorbic acid synthesis. The above findings are in agreement with the Sawale *et al*. (2001) [7] revealed that with application of NAA fruit were rich in vitamin C.

Table 1: Effect of foliar spray of plant growth regulators and micro-nutrient on TSS, acidity and ascorbic acid in ber cv. Gola.

Treatments	TSS (%)	Acidity (%)	Ascorbic acid (mg/ 100 g pulp)
T_1:- Control (Water spray)	15.92	0.38	58.70
T_2:- NAA 20 ppm	18.30	0.35	63.30
T_3:- NAA 40 ppm	18.47	0.31	71.10
T_4:- GA_3 20 ppm	17.15	0.33	64.00
T_5:- GA_3 40 ppm	16.57	0.34	68.40
T_6:- $ZnSO_4$ 0.4%	16.60	0.32	61.00
T_7:- $ZnSO_4$ 0.6%	16.45	0.33	68.60
SEm±	0.39	0.01	1.63
CD at 5%	1.21	0.02	5.03

The maximum reducing sugars (6.45%) was found with the application of treatment T_3 (NAA 40 ppm), which was at par with T_7 (ZnSO4 0.6%) and T_2 (NAA 20 ppm) and minimum reducing sugars (5.20%) under T_1 (control). The maximum non-reducing sugar (5.82%) was found with the spray of treatment T_3 (NAA 40 ppm) and minimum non-reducing sugar was found (4.50%) with T_1 (control). The maximum total sugars (12.27%) were found with treatment T_3 (NAA 40 ppm), which was at par with T_7 ($ZnSO_4$ 0.6%) and T_2 (NAA 20 ppm) and minimum (9.70%) under T_1 (control). This increase in total soluble solids and total sugars content of fruits may be due to the fact that plant bio-regulators play an important role in the photosynthesis which results in the accumulation of carbohydrates and ultimately increase the sugars content. The above findings are in agreement with the Amoros *et al.* (2004) [2] recorded that NAA was helpful in improving fruit quality in terms total sugars and reducing sugars.

Table 2: Effect of foliar spray of plant growth regulators and micro-nutrient on reducing sugars, non-reducing sugar and Total sugars in ber cv. Gola.

Treatments	Reducing sugars (%)	Non-reducing sugar (%)	Total sugars (%)
T_1:-Control (Water spray)	5.20	4.50	9.70
T_2:- NAA 20 ppm	6.35	5.70	12.05
T_3:- NAA 40 ppm	6.45	5.82	12.27
T_4:- GA_3 20 ppm	6.00	5.50	11.50
T_5:- GA_3 40 ppm	5.55	5.20	10.75
T_6:- $ZnSO_4$ 0.4%	5.70	5.40	11.10
T_7:- $ZnSO_4$ 0.6%	6.27	5.67	11.94
SEm±	0.10	0.03	0.11
CD at 5%	0.31	0.09	0.34

4. Conclusion

From the findings of present investigation, it can be inferred that ascorbic acid, TSS and non-reducing sugar, reducing sugars and total sugars found maximum and minimum acidity by the spray of NAA 40 ppm.

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