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Effect of Foliar Application of GA_3, NAA and Urea on Fruit Quality Attributes of Ber (*Zizyphus mauritiana* Lamk.) cv. Banarasi Karaka

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ABSTRACT: The present investigation was carried out in the Horticulture Garden Department of Fruit Science, College of Horticulture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during October 2018-march 2019. The Ber (*Zizyphus mauritiana* Lamk.), a significant indigenous fruit of China and India, has long been associated with Indian culture. The strong economic benefits, low cultivation costs, wide range of adaptation, and drought resistance of ber make it a popular crop. In this context, plant growth regulators are important. For enhancing blooming, fruit set, fruit drop, size, and quantity of fruit, many types of plant regulators like NAA, 2,4-D, 2,4,5-T, GA_3, and TIBA are utilized. Fruit quality, including total soluble solids, ascorbic acid, total sugar, and acidity, was dramatically increased by foliar application of GA_3, NAA, and urea. Over the control, application of the urea and plant growth regulators mentioned above had an impact on the biochemical components of fruit. The foliar spray of T_8 (GA_3 20 ppm + NAA 40 ppm + urea 1.5%) is advised to have a maximum total soluble solids concentration of 17.88°Brix. In terms of the ascorbic acid content of the ber fruit, there was a significant difference with the application of gibberellic, naphthalene acetic acid, and urea; all three treatments were determined to be significant compared to the control. The treatment of T8 resulted in the highest ascorbic acid level ever measured (101.05 mg/100g). Application of above plant growth regulators and urea influenced biochemical constituents of fruit over the control. The combined treatments of GA_3 20 ppm + NAA 40 ppm + urea 1.5% maximized the overall fruit quality.

Keywords: GA_3, NAA, Urea, PGR, Ber and Quality.

INTRODUCTION

Zizyphus mauriatiana, commonly known as Ber, is a tropical fruit tree that belongs to the Rhamnaceae family and is also referred to as the Chinese date, Chinese apple, Jujube, Indian plum, Regipandu, Indian jujube, Dunks (in Barbados), and Masau. Long associated with Indian culture is the ber (*Zizyphus mauritiana* Lamk.), a prominent indigenous fruit of China and India. Ber is used in the Puranas, the Vedas, and other literary works including the Kautilya Arthasastra, Charak Samitha, and others. Ved Vyas, the sage and author of "Purana" and "Mahabharat," really made one of the Ber tree's primary fruits his residence, earning him the epithet "Badrayan" (A person living in a forest of Ber tree).

In the tropics, it may be discovered in both domesticated and wild forms up to a height of 1500 meters above mean sea level. It can be successfully cultivated even in the most fragile settings of the subtropics and tropics. Ber is frequently utilized because of its high economic returns, low cultivation expenses, wide range of adaptability, and ability to withstand drought.

The Indian jujube is a native of Afghanistan, Malaysia, and Queensland, Australia, which are all in the Yunnan region of southern China. Ber has been used in India for nearly 4,000 years. Even though it frequently escapes cultivation and develops into a pest, it is planted to some amount across its natural habitat, but mostly in India where it is produced for commercial purposes. Examples of locations where specimens may be found include the Bahamas, Colombia, Venezuela, Guatemala, Belize, the arid West Indies, and southern Florida. The tree has established itself as a native species in Barbados, Jamaica, and Puerto Rico where it grows in thickets in untamed areas. It grows both in

cultivation and a wild or semi-wild condition in nearly every area of India. The states that are growing the quickest include Uttar Pradesh, Bihar, Madhya Pradesh, Punjab, Haryana, Rajasthan, Gujarat, Maharashtra, and Andhra Pradesh. Major Ber-growing areas in Uttar Pradesh include Varanasi, Aligarh, Faizabad, Agra, and RaeBareli district. It comes from India and is one of the most well-known and historically significant sub-tropical fruits. It is often cultivated in a range of soil types and climatic circumstances, including drought, because to its resilience and capacity for weight. The relationship between nutrition and finances is not widely known. It has a tremendous lot of promise.

It is an 8–10 m tall, small tree or shrub with stipular spines, a spreading crown, and a lot of drooping limbs. A 40 cm diameter minimum is present in the trunk. Variables exist in the fruit's shape and size. It can be up to 2.5 cm (1 inch) long and have a variety of shapes, such as oval, ovulate, or round, depending on the kind. There is crisp white flesh. When it is little underripe and a little damp, this fruit has a beautiful aroma. The skin of the fruit is smooth, lustrous, slender, and tight.

The development of the fruit is affected by a variety of genetic, physiological, nutritional, hormonal, and environmental factors. Plant growth regulators play a key role in this situation. These are used for fruit and flower thinning, vegetative propagation, artificially inducing seedlessness, increasing fruit production, preventing preharvest fruit drop, controlling blooming, suppressing growth, and controlling preharvest fruit drop. Numerous types of plant regulators including NAA, 2,4-D, 2,4,5-T, GA_3, and TIBA are used to improve fruit set, fruit drop, size, and quantity of fruit (Bonnar, 1950; Van Overbreak, 1959). NAA (Auxin) also stops fruit drop by suffocating the pedicle. It is now easier to see the fruit pedicle. Auxin levels that are high in the abscission zone prevent the fruit from dropping (Brigs and Leopide, 1958; Addicot and Lynch 1955). Ber is also included in this strategy, despite the fact that different scientists have periodically experimented on diverse fruit crops. But they fell short in this regard.

Gibberellins are mostly used for regulating physiological processes, but they may also be commercially used to improve the fruit quality of crops including apples, grapes, citrus, grapefruit, and berries. Three physiological processes—the lengthening of rachis cells, the thinning of flowers, and the growth of berries in grapes—have all been impacted. Citrus has also benefited from the influence of GA_3's ability to postpone fruit senescence, and more recent study suggests that GA_3 may even encourage apple flowering. GA_3 has been reported to promote fruit set and minimize fruit drop in Ber, according Gill and Bal (2013).

MATERIAL AND METHODS

The present investigation was carried out in the Horticulture Garden Department of Fruit Science, College of Horticulture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during October 2018-March 2019.

Banarasi Karaka Ber cultivar trees that were uniform, healthy, and well-established were chosen for the experiment's goal. The trees, which were around 47 years old, were maintained in good condition by adhering to the recommended fertilizer doses and other horticultural practices. Throughout the research, the entire orchard was kept orderly and consistently maintained. Three unique branches from each of the nine cut Ber trees were selected and utilized as a single unit (for one treatment). As a consequence, 27 units were selected on 9 Ber trees, and the experiment proceeded as planned. The experiment included nine treatments, each of which included foliar sprays of GA_3, NAA, Urea and control. The treatments are as follows- T_0 Control (water spray), T_1 (GA_3 @10 ppm), T_2 (GA_3 @20 ppm), T_3 (NAA @20 ppm), T_4 (NAA @40 ppm), T_5 (Urea @1.0%), T_6 (Urea @1.5%), T_7 (GA_3 @10 ppm + NAA @20 ppm + Urea @1.0%), T_8 (GA_3 @20 ppm + NAA @40 ppm + urea @1.5%). In the early morning, foot sprayers with various concentrations of the aforementioned solutions were used to thoroughly soak a few selected branches. Only water spray is authorized as a form of control. A homogenous spray of plant growth regulators and urea was applied to the leaves of each treatment on November 27, 2018, when the fruit-setting stage was in progress. This was done to cover the whole Ber plant treatment.

(a) Total soluble solids (^{0}Brix): Sample fruits of each plant were crushed to form a homogenized sample and then the juice was extracted through muslin cloth. The extract was used for determination of T.S.S. in 0Brix by hand refractometer.

(b) Ascorbic acid (mg/100g): Ascorbic acid was extracted from the pulp by macerating 5g of sample with 3% metaphosphoric acid (MPA) solution. The extract was filtered and volume made to 25 ml in volumetric flask. Two ml of the aliquot was taken and titrated against standardized blue dye till the light pink color appeared which was taken as the end point.

(c) Acidity (%): 20 ml fruit juice solution was taken by pipette and transferred into a 100 ml flask and then distilled water was added to make up the volume up to 100 ml. It was shaken well to dissolve. 0.25 ml of diluted fruit juice which was taken by pipette and transferred into a 250 ml beaker, and then 3 drops of Phenophthalene indicator were added in this solution. The burette was filled with N/10 NaOH solution and juice was titrated with alkali solution, drop by drop with constant stirring till the pink end point was reached. End point readings were recorded and the percentage acidity was calculated by the formula and expressed in terms of citric acid.

Total acidity per cent = 0.128 × titer value

(d) Total sugars (%): For the estimation of total sugars, 20 ml of ber juice solution was taken in a beaker and 5ml of concentrated HCL was added and then the solution was boiled on water bath for five minutes for the hydrolysis to convert the non-reducing sugar in to reducing sugars. After cooling, the excess of acid was neutralized by sodium carbonate solution. The solution was transferred in a 100ml volumetric flask and volume was made up to mark by adding distilled water. This

solution was taken in a burette and titrated with the Fehling 's solution A and B similar as was done in reducing sugars. The total sugars in percentage were calculated with the help of following formula.

Total sugars (%) = (0.25/Burette reading) × 100

RESULTS AND DISCUSSION

Fruit quality, including total soluble solids, ascorbic acid, total sugar, and acidity, were dramatically enhanced by foliar application of GA_3, NAA, and Urea. The biochemical components of fruit were changed over the control by the application of the aforementioned plant growth regulators and urea.

Total soluble solids (°Brix): The foliar spray of T_8 (GA_3 20 ppm + NAA 40 ppm + urea 1.5%) showed the highest total soluble solids (17.88°Brix), which was significant in this experiment. The plants that were left untreated showed the lowest total soluble solids (13.17°Brix) (control). Total soluble solids ranged from 13.17 to 17.88°Brix, with treatment T8 (GA_3 20 ppm + NAA 40 ppm + urea 1.5 %) being applied over control resulting in a maximum of 35.76 %. This increase in total soluble solids of treated juice may be the result of a rise in plant hormone-mediated mobilization of carbohydrates from the source to sink fruit. In addition, these growth regulators stimulated enzymatic activity, converted carbohydrates into simple sugar, and released nitrogen, which strengthened the fruit juice and increased the amount of total soluble solids in the berry fruit. These conclusions with those made in the papers of Kale *et al.* (1999); Yadav and Singh (2001); Rajpal *et al.* (2001); Singh *et al.* (2001); Katiyar *et al.* (2010); Singh *et al*. (2010) in Ber and Singh and Singh (2015) in Aonla.

Ascorbic acid (mg/100g): The results of the experiments revealed a substantial difference in the ascorbic acid content of the Ber fruit when gibberellin, naphthalene acetic acid, and urea were applied; all of the treatments were determined to be significantly different from the control. The treatment of T_8 (GA_3 20 ppm + NAA 40 ppm + urea 1.5 %) resulted in the highest ascorbic acid concentration (101.05 mg/100g) that could be produced. The control treatment (T_0) had an impact on the lowest ascorbic acid concentration (81.26 mg/100g). Regarding, a further improvement of 24.35 % was shown with the use of T_8 (GA_3 20 ppm + NAA 40 ppm + urea 1.5 %) spray therapy. The increase in ascorbic acid content has been demonstrated due to metabolic activities involving specific enzymes and metabolic ions under the influence of plant growth regulators and urea. The ascorbic acid content improvement may be attributable to the actual synthesis of glucose-6 phosphate during fruit growth and development, which is thought to be a precursor to ascorbic acid (vitamin C). With the use of plant growth regulators like GA_3 and NAA as well as the strengthening of the nitrogen nutrient, it may have occurred rather frequently (urea). These results are consistent with the reports of Singh and Shukla (1978); Masalkar and Wavhal (1991); Singh *et al.* (2001) in Ber, Kher *et al.* (2005); Singh *et al.* (2010) in guava, and Singh and Singh (2015) in Aonla.

Acidity (%): The data scenario showed that urea and growth regulators reduced the acidity of Ber fruit. Treatment of T_3 and T_1 displayed 0.37 and 0.36 % acidity content, respectively, whereas treatment of control (T_0) substantially indicated a maximum acidity content of 0.39 % in Ber fruit. In this regard, throughout the research, the plants treated with T_8 (GA_3 20 ppm + NAA 40 ppm + urea 1.5%) reported 0.15 % considerably lower acidity. The range of the acidity content was, correspondingly, 0.15 to 0.39 %. The treatment of T_8 (GA_3 20 ppm + NAA 40 ppm + urea 1.5%) resulted in a reduction of 61.53 % in the acidity content of Ber fruit. It indicates that under the influence of growth regulators, acid content may have been either quickly transformed into sugars and their derivatives by a mechanism involving the reverse glycolytic pathway or may have been employed in respiration, or both. It clearly functioned under the impact of GA_3 and NAA in particular, which strengthened the nitrogen phenomenon (urea). These results are consistent with the reports of Shukla and Singh (1998); Masalkar and Wavhal (1991); Singh *et al.* (2001) in Ber, Kher*et al.* (2005); Singh *et al.* (2010) in guava, and Singh and Singh (2015) in Aonla.

Total sugars (%): The total sugar percentage of Ber fruit was strongly and consistently altered by the effects of plant growth regulators and urea concentrations. According to this theory, sprays of treatment T_8 (GA_3 20 ppm + NAA 40 ppm + urea 1.5 %) increased the amount of total sugar in Ber fruit by 9.85 %. Control plants, or untreated plants, had a considerably lower 8.15 % total sugar percentage in Ber fruit. 8.15 to 9.85 % of total sugar was noted. As a result, sprays of treatment T_8 (GA_3 20 ppm + NAA 40 ppm + urea 1.5 %) above control showed the greatest improvement in total sugar percentage at 20.85%. Fruit sweetness may have improved as a result of increased photosynthetic activity, increased carbohydrate content production, and enhanced carbohydrate translocations with the fruits. Sugars are crucially transformed into their compounds by reactions involving numerous glycolytic pathways under the control of growth regulators. Nitrogen significantly strengthened the activity in this phenomenon. The reports by Kale *et al.* (1999); Yadav and Singh (2001); Bhati and Yadav (2003); Katiyar *et al*. (2010) in Ber, and Singh and Singh (2015) in Aonla are all in agreement with these findings.

Numerous researches on different fruit crops, including Ber, have been conducted. Many scientists have sometimes studied on this topic. They failed, nevertheless, in this regard. Gibberellins are commercially used to improve the fruit quality of crops including apples, grapes, citrus, grapefruit, and berries. Gibberellins have mostly been used to change a variety of physiological processes. Grapes have undergone modifications to three physiological processes, including rachis cell elongation, floral thinning, and berry enlargement. The capacity of GA_3 to delay fruit senescence has also been utilized by citrus, and more recent study suggests that GA_3 may even promote apple blossoming. According to research by Godara *et al*. (2001); Kale *et al.* (1999) and Gill and Bal (2013).

Table 1: Effect of Foliar Application of GA_3, NAA and Urea on Total soluble solid (^oBrix), Ascorbic acid (mg/100g), Acidity (%), Total sugar (%).

Sr. No.	Treatments	Total soluble solid (^oBrix)	Ascorbic acid (mg/100g)	Acidity (%)	Total sugar (%)
1.	T_0 Control (water spray)	13.17	81.26	0.39	8.15
2.	T_1 GA310 ppm	14.12	94.12	0.36	8.85
3.	T_2 GA3 20 ppm	13.71	97.33	0.32	9.25
4.	T_3 NAA 20 ppm	15.42	96.61	0.37	8.80
5.	T_4 NAA 40 ppm	16.03	92.88	0.33	8.98
6.	T_5 Urea 1.0 %	16.46	90.91	0.24	8.81
7.	T_6 Urea 1.5 %	16.68	93.67	0.22	9.48
8.	T_7 GA310 ppm + NAA 20 ppm + Urea 1.0 %	16.94	99.72	0.17	9.77
9.	T_8 GA3 20 ppm + NAA 40 ppm + Urea 1.5 %	17.88	101.05	0.15	9.85
SEM (±) C.D. at 5%		0.3864 0.82	1.0886 2.29	0.0258 0.05	0.1183 0.25

CONCLUSION

The administration of plant growth regulators, especially GA_3, NAA, and urea, as well as their combination treatments, changed a number of parameters in this study. The combined treatments of (GA_3 20 ppm + NAA 40 ppm + urea 1.5 %) increased total soluble solids content, ascorbic acid, and total sugar and decreased acidity content. The second effective medication in the current investigation was identified as Treatment (GA_3 10 ppm + NAA 20 ppm + urea 1%). The combined therapy of GA_3 (20 ppm + NAA 40 ppm + urea 1.5) percent was shown to be more effective in the current trial, according to the finding's scenario. Therefore, in order to boost production and increase income, it is advised that researchers, orchardists, farmers, and students spray this medication on Ber trees.

FUTURE SCOPE

Ber was best grown in an ecologically friendly manner with the use of plant growth regulator and urea, which also reduces production costs and maintains productivity.

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Conflict of Interest. None.

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