**Effect of foliar application of micronutrients and PGRs on quality attributes of Bael (*Aegle marmelos* L.) cv. NB-9 under sodic soil conditions**

**Abstract**

The present experiment was undertaken at Post Harvest Laboratory and Main Experiment Station, Department of Fruit Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya . The experiment was conducted in Randomized Block Design (RBD), with eight treatments, replicated thrice. The treatments were T0 – Control , T1 - CuSO4 @ 0.6% ,T2 - Borax @ 0.6% ,T3 - NAA @50 ppm, T4 - CuSO4 @ 0.3% + Borax @ 0.3% ,T5 - CuSO4 @ 0.6% + NAA @ 50ppm, T6 - Borax @ 0.6% + NAA @ 50ppm, and T7 - CuSO4 @ 0.3% + Borax @ 0.3% + NAA @25ppm . From the present investigation it is found that treatment T7 (CuSO4 @ 0.3% + Borax @ 0.3% + NAA @25ppm) was found superior in respect of chemical attributes of bael i.e, Total Soluble Solids, Acidity, Ascorbic Acid ,Reducing Sugar, Non- Reducing Sugar and Total Sugar as well as physical attributes of bael such as Fruit Length and width followed by T6 (Borax @ 0.6% + NAA @ 50ppm) and minimum was recorded in treatment T0 in all the parameters.

Keywords: Bael , Foliar spray, NAA , Borax and quality.

**Introduction**

Bael (*Aegle marmelos*) is one of the most important medicinal fruits of India. It is highly rich in nutrients and hold a significant importance from therapeutic point of view. The bael fruit possess excellent flavour and contains many functional compounds such as phenolics, carotenoids, alkaloids, coumarins, flavonoids, terpenoids and has many medicinal uses (Karunanayake *et al.* 1984; Nagaraju and Rao 1990). Bael (*Aegle marmelos* L.) belongs to family Rutaceae and it is commonly known as Bengal quince, Stone apple , bel, Sriphal in Hindi in India (John and Stevenson, 1979). Inside the fruit there is yellow or orange coloured mucilaginous pulp which is soft with numerous seeds. Bael fruit contains 28-39 % total soluble solids, 19-21 % carbohydrates, 11-17 % sugar, 1 % protein, 0.2 % fat and 7-21 mg/100g vitamin C.It is also rich source of vitamin A (186 IU/100g pulp). Bael is known to be one of the richest source of riboflavin and provides minerals and vitamins (Barthakur and Arnolds, 1989). All parts of bael tree from stem, bark, root, leaves and fruit at all stages of maturity have medicinal value and have been used as medicine since antiquity. Rind(outer part) is used to cure acute and amoebic dysentery, it reduces pain in the loins and works wonders for constipation and gastric issues .

Foliar application of fertilizer is beneficial over soil application. It helps in uniform distribution of fertilizers, low application rates and quick and positive response to applied nutrients (Kumar *et al*., 2015).These micronutrients help in uptake of major nutrients and play active roles in the of plant like Development of cell wall, photosynthesis, Formation of chlorophyll , activity of enzyme, fixing nitrogen as well as in oxidation-reduction reaction. Copper is one of the important micronutrients needed in very small quantities by plants. Copper activates certain enzymes in plants which are involved in synthesis of lignin. It is also crucial in the process of photosynthesis and helps plants in metabolism of carbohydrates and proteins.

Boron is a heavy non-metal micronutrient. It is absorbed by plant in the form of boric acid (H3BO3). It plays vital role for translocation of sugar . Its has been observed that it also plays role in hormone movement and active salt absorption. It plays important role in fruit quality. Boron has an effect on cell wall structure and also has a major effect on cell elongation (pollen tube) and root growth (Meena *et al.,* 2008) Borax response was positive due to boron which plays an important role in translocation of sugars and carbohydrates, auxin synthesis . These physiological activities improve width length of fruit which ultimately increase the yield of fruit (Singh and Bramhachari, 1999). NAA is an important growth promoter of auxin group, which helps to decrease fruit drop and to improve fruit set and quality. By the application of NAA, Total Soluble Solids and ascorbic acid content of fruit crops are increased and acidity is reduced. NAA reduces the number of seed content of the fruits. NAA induces heavier fruiting and promotes flowering (Sharma and Tiwari, 2015).

**Material and Methods**

The present investigation entitled “Response of foliar application of micronutrients and PGRs on fruit cracking in bael (*Aegle marmelos* L.) cv. NB-9 under sodic soil” was undertaken at Main Experiment Station and Post Harvest Laboratory, Department of Fruit Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya .The experiment was conducted in Randomized Block Design (RBD), with 8 treatments, replicated thrice. Total number of treatments were Eight *viz*. T0 – Control , T1 - CuSO4 @ 0.6% ,T2 - Borax @ 0.6% ,T3 - NAA @50 ppm, T4 - CuSO4 @ 0.3% + Borax @ 0.3% ,T5 - CuSO4 @ 0.6% + NAA @ 0.50ppm, T6 - Borax @ 0.6% + NAA @ 50ppm, and T7 - CuSO4 @ 0.3% + Borax @ 0.3% + NAA @25ppm .

**Climatic Condition of the Experimental Site**

The experimental site is located 45 km away from Ayodhya head quarter on Ayodhya- Raebareli road. The main experiment station is established in Department of Fruit Science, ANDUAT, Kumarganj, Ayodhya which lies under eastern district of Uttar Pradesh. The soil of experimental site is sodic having poor soil structure, texture and fertility. The site comes under sub-tropical region comprising of three distinct seasons viz. summer, rainy and winter and situated at 26.47o North latitude, 82.12o F longitude and on altitude of 113 meters from mean sea level. The summer season occurring from March to June is characterized by temperature ranging from 25 to 45o C and hot desiccating winds from March to June. Rainy season started from July to September having an average annual rainfall of 1200 mm while winter season occurs from November to March having average temperature range of 10 to 25 0C.

**Result and Discussion**

The present investigation entitled “Response of foliar application of micronutrients and PGRs on fruit cracking in bael (*Aegle marmelos* L.) cv. NB-9 under sodic soil” was undertaken at Main Experiment Station and Post Harvest Laboratory, Department of Fruit Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya . The results of the present investigation regarding the quality attributes of Bael, have been discussed and interpreted in the light of previous research work done in India and abroad. The experiment was conducted in Randomized Block Design with 8 treatments and three replications. The results of the experiment are summarized below:

**Total Soluble Solids (o Brix)**

In terms of Total soluble solids, the lowest TSS of (35.29 0Brix) was observed in treatment T0 (Control) ,whereas the maximum TSS(37.820Brix) was observed in treatment T7 (CuSO4 @ 0.3% + Borax @ 0.3% + NAA @25ppm) followed by T6(Borax @ 0.6% + NAA @ 50ppm) with 37.310Brix (Table 1) . An increase in total soluble solids content of Bael may possibly be due to due to foliar application of NAA as resulted in increase of total soluble solids. The adequate amount of borax and NAA improve the auxin content that acted as catalyst in oxidation process. T.S.S. of bael fruits probably due to difference in rate of accumulation of food materials and hydrolysis of polysaccharides into sugars. The finding is supported by Kaushik *et al.* (2002) and Shrivastava and Jain (2006) in mango.

**Acidity(%)**

In terms of Acidity %, the lowest score of Acidity (0.21%) in treatment T7(CuSO4 @ 0.3% + Borax @ 0.3% + NAA @25ppm) followed by T6(Borax @ 0.6% + NAA @ 50ppm) with acidity % of 0.27 whereas the maximum score of acidity was observed in treatment T0 (Control) with (0.38 %) at the time of maturity(Table 1) . The decrease trend might be due to rapid utilization of organic acids and conversion of organic acids into their salts and sugars (Ruffner *et al*., 1975). The findings are supported by other workers who have reported that titrable acidity of fruits was decreased with growth in bael (Kaushik *et al*., 2002), (Nidhi and Gehlot, 2007).

**Ascorbic Acid**

In terms of Ascorbic acid, the maximum Ascorbic acid (20.51 mg/100g) was observed in treatment T7 (CuSO4 @ 0.3% + Borax @ 0.3% + NAA @25ppm), followed by treatment T6(Borax @ 0.6% + NAA @ 50ppm) with (19.53 mg/100 g) whereas the minimum ascorbic acid was observed in treatment T0 (Control) with (16.68 mg/100 g) (Table 1). Results indicated that there increased ascorbic acid content in bael fruit was due to increase in the synthesis of catalytic activity by enzymes and coenzymes, which are represented in ascorbic acid synthesis. The adequate amount of borax improves the auxin content and also acts as catalyst in oxidation process. Fruit quality improvement due to NAA application was also noted by Ghosh et al. (2009) in pomegranate. Similar with the results of Pal *et al.* (2008) in guava cv. Sardar, Ghosh *et al.* (2009) in aonla cv. NA-10.

**Reducing Sugar**

In terms of Reducing sugar, the maximum reducing Sugar (4.53) was observed in treatment T7(CuSO4 @ 0.3% + Borax @ 0.3% + NAA @25ppm), followed by treatment T6 (Borax @ 0.6% + NAA @ 50ppm) with (4.51) whereas the least reducing sugar was observed in treatment T0(Control) with (36.27) (Table 2) . The increase in reducing sugars content of fruits might be due to conversion of starch into sugars during growth and development of fruits. The observations are in conformity with the findings of Molla *et al.* (2007).

**Non-Reducing Sugar**

In terms of Non-Reducing sugar, the maximum (11.18) was observed in treatment T7(CuSO4 @ 0.3% + Borax @ 0.3% + NAA @25ppm), followed by treatment T6 (Borax @ 0.6% + NAA @ 50ppm) with (10.75) whereas the least reducing sugar was observed in treatment T0(Control) with (8.99) (Table 2) might be due to availability of starch amount to hydrolyze into sugars. The results are in line with the findings of Ram and Singh (2003) and Mukhopadhyay *et al.* (2002) in bael fruits and sunberry (Patel *et al.,* 2011) fruits.

**Total Sugar**

In terms of Total Sugar, the maximum (15.69) was observed in treatment T7(CuSO4 @ 0.3% + Borax @ 0.3% + NAA @25ppm), followed by treatment T6 (Borax @ 0.6% + NAA @ 50ppm) with (15.03) whereas the least total sugar was observed in treatment T0(Control) with (12.46) (Table 2) .The increase in total sugars content might be due to an increase in reducing and non-reducing sugars resulting from the conversion of starch into sugars. The results are similar to Mukhopadhyay et al. (2002), Ram and Singh (2003), Pandey et al. (2008) and Molla et al. (2007) in bael fruits, and Abu-Goukh et al. (2010) in papaya fruits. The increase in total sugars content may be due to the NAA works as stimulator of amino acids and seems to be helpful in the process of photosynthesis and accumulation of photosynthates which ultimately help in the translocation of more sugar and TSS in the fruits. It has been reported that there is a greater conversion of starch into sugar (source to sink) in the presence of these plant growth regulators and micronutrient similar findings with Ghosh *et al.* (2009)

**Fruit Size(Length and Width )**

In terms of Fruit size, the maximum length of fruit (14.48cm) and width of fruit(10.82cm) was observed in treatment T7(CuSO4 @ 0.3% + Borax @ 0.3% + NAA @25ppm), followed by treatment T6 (Borax @ 0.6% + NAA @ 50ppm) with length and widhth(13.56 cm ,10.55cm respectively ) whereas the least length and width of fruit was observed in treatment T0(Control) with (12.64 cm 9.21 cm respectively) (Table 1) . It is clearly noticed that during early stages of fruit development, rapid increase in fruit size was noticed which might be due to rapid division and enlargement of cells influenced by endogenous levels of nutrients and metabolites. The increase might be due to beneficial role of boron as it synthase auxin and NAA significantly increased fruit length, diameter and fruit weight and ultimately crop yield Maurya and Singh (1981). NAA produced maximum fruit length and breadth Uniyal *et al* (2015).

**Table 1 Effect of micronutrients and PGRs on on Total Soluble Solids (oBrix), Acidity (%), Ascorbic Acid (mg/100 g) of fruit at the time of maturity in bael cv. NB-9**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatment Symbol** | **Treatment Details** | **Fruit Size** | **TSS(oBrix)** | **Acidity(%)** | **Ascorbic Acid(mg/100 g)**  |
|  |  | **Fruit Length(cm)** | **Fruit Width(cm )** |  |
| T0 | T0 – Control | 12.64 | 9.21 | 35.29 | 0.38 | 16.68 |
| T1 | T1– CuSO4 @ 0.6% | 13.16 | 9.8 | 36.3 | 0.35 | 19.22 |
| T2 | T2 - Borax @ 0.6% | 13.32 | 10.49 | 35.73 | 0.33 | 18.77 |
| T3 | T3 - NAA @50 ppm | 12.81 | 10.1 | 36.37 | 0.32 | 18.86 |
| T4 | T4 – CuSO4 @ 0.3% + Borax @ 0.3% | 13.78 | 10.4 | 36.27 | 0.32 | 19.5 |
| T5 | T5 – CuSO4 @ 0.6% + NAA @ 50ppm | 12.99 | 10.11 | 36.91 | 0.33 | 19.27 |
| T6 | T6 - Borax @ 0.6% + NAA @ 50ppm | 13.56 | 10.55 | 37.31 | 0.27 | 19.53 |
| T7 | T7 – CuSO4 @ 0.3% + Borax @ 0.3% + NAA@25ppm | 14.48 | 10.82 | 37.82 | 0.21 | 20.51 |
| SEm± | 0.18 | 0.15 | 0.69 | 0.04 | 0.51 |
| C.D. at 5% | 0.54 | 0.45 | 2.10 | 0.11 | 1.54 |

**Table 2 Effect of micronutrients and PGRs on Reducing Sugar (%) , Non Reducing Sugar (%) and Total Sugar of fruit at the time of maturity in bael cv. NB-9**

|  |  |  |
| --- | --- | --- |
| **Treatment Symbol** | **Treatment Details** | **Sugar Content** |
|  |  | **Reducing** | **Non- Reducing** | **Total Sugar** |
| T0 | T0 – Control | 3.47 | 8.99 | 12.46 |
| T1 | T1– CuSO4 @ 0.6% | 4.17 | 9.26 | 13.1 |
| T2 | T2 - Borax @ 0.6% | 4.36 | 10.14 | 14.67 |
| T3 | T3 - NAA @50 ppm | 3.82 | 10.31 | 14.13 |
| T4 | T4 – CuSO4 @ 0.3% + Borax @ 0.3% | 3.59 | 10.39 | 13.98 |
| T5 | T5 – CuSO4 @ 0.6% + NAA @ 50ppm | 4.04 | 10.64 | 14.34 |
| T6 | T6 - Borax @ 0.6% + NAA @ 50ppm | 4.53 | 10.75 | 15.03 |
| T7 | T7 – CuSO4 @ 0.3% + Borax @ 0.3% + NAA@25ppm | 4.51 | 11.18 | 15.69 |
| SEm± | 0.22 | 0.49 | 0.59 |
| C.D. at 5% | 0.67 | 1.49 | 1.78 |

**Conclusion**

Based on findings of the present experiment it is concluded that treatment T7 (CuSO4 @ 0.3% + Borax @ 0.3% + NAA@25ppm) followed by T6 (Borax @ 0.6% + NAA @ 50ppm) was found superior in respect of the Total Soluble Solids, Acidity, Ascorbic acid, Reducing Sugar, Non Reducing Sugar, Total Sugar, Fruit length and Width and minimum was recorded in treatment T0 (Control) in all the parameters. So inorder to obtain quality production of bael CuSO4 @ 0.3% + Borax @ 0.3% + NAA@25ppm can be recommended.

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