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Effect of plant bio- regulators and micro-nutrients on chemical attributes of mango (*Mangifera indica* L) cv Amrapali

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Abstract

The present investigation entitled “Effect of plant bio-regulators and micronutrients on growth, yield, and quality of mango (*Mangifera indica* L.) cv. Amrapali” was conducted at Main Experiment Station, Department of Fruit Science, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) during 2022-23. The treatments consisted of GA₃ @ 20, 40, and 60 ppm; NAA @ 15, 20, and 25 ppm; borax @ 0.2%, 0.4%, and 0.6%; along with a control (water spray). The experiment was laid out in a Randomized Block Design (RBD) with three replications, comprising ten treatments. The results revealed that foliar application of GA₃ @ 20 ppm significantly improved fruit quality parameters, including total soluble solids (TSS), reducing sugars, non-reducing sugars, total sugars, and ascorbic acid content, while it also resulted in the lowest fruit acidity. Based on the findings, foliar application of GA₃ @ 20 ppm applied twice during the second fortnight of March and April, is recommended for mango growers of Eastern Uttar Pradesh to improved chemical characteristics in mango cv. Amrapali.

Keywords: Mango, GA₃, NAA, Borax and Quality

Introduction

Mango (*Mangifera indica* L.) is one of the oldest and most extensively cultivated fruit crops in tropical and subtropical regions of the world. It is grown in more than 100 countries and is recognized as the second most widely cultivated tropical fruit and the sixth most important fruit crop globally (Ahmad *et al.*, 2018^[2]; Masroor *et al.*, 2016^[15]; UNCTAD, 2016). Owing to its adaptability to diverse agro-climatic conditions and its resilience to changing climatic scenarios, mango continues to be a highly sustainable fruit crop (Munir *et al.*, 2015)^[16].

Mango is widely appreciated for its attractive appearance, unique flavor, pleasant aroma, and exceptional nutritional value. The fruits are rich in carotenoids and vitamins such as vitamin C, A, E, and B-complex, including riboflavin, niacin, and thiamine. In addition, they contain appreciable amounts of phenolic compounds, carbohydrates, and essential mineral nutrients such as iron (Fe), phosphorus (P), calcium (Ca), and potassium (K), making mango an important component of a healthy and balanced diet (Maldonado *et al.*, 2019)^[14]. Because of its high nutritional and economic value, mango plays a significant role in ensuring food and nutritional security.

Despite its commercial importance, mango production is often constrained by several factors, including micronutrient deficiencies, physiological disorders, poor fruit retention, and inadequate fruit quality, which collectively reduce productivity and limit export potential (Elsheery *et al.*, 2020)^[7]. The judicious application of plant growth regulators and micronutrients has emerged as an effective strategy to overcome these constraints and improve both yield and fruit quality (Zargar *et al.*, 2019)^[25]. Among the plant growth regulators, Naphthalene Acetic Acid (NAA) has been reported to promote flowering when applied at concentrations ranging from 50 to 100 ppm (Davenport, 2007) [5]. It also reduces flower and fruit drop, enhances fruit set, improves fruit size, and ultimately increases yield and fruit quality. Similarly, GA₃ application has been shown

to significantly enhance fruit retention per panicle, resulting in increased fruit size and fruit weight in mango as well as in several other fruit crops (Kumar *et al.*, 2018) ^[12]. Boron, an essential micronutrient, plays a crucial role in reproductive development by promoting ovule formation, pollen germination, pollen tube growth, and fruit set. It also contributes significantly to improving the physical and biochemical quality of mango fruits. Therefore, pre-harvest foliar application of suitable plant growth regulators and micronutrients represents an effective management practice for reducing fruit drop and enhancing the yield as well as the overall quality of mango fruits.

Materials and methods

The present investigation was carried out during the 2022-2023 growing season at the Main Experiment Station, Department of Fruit Science, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya, Uttar Pradesh. The study was undertaken to assess the influence of Gibberellic acid (GA₃), Naphthalene Acetic Acid (NAA), and Borax on fruit quality of mango (*Mangifera indica* L.) cv. Amrapali. Thirty healthy, uniform, and bearing mango trees were selected for the experiment. The experiment was laid out in a Randomized Block Design (RBD) comprising ten treatments with three replications. The treatments included foliar viz., T₁-GA₃ @20 ppm, T₂-GA₃ @40 ppm, T₃-GA₃ @60 ppm, T₄-NAA @15 ppm, T₅-NAA @20 ppm, T₆-NAA @25 ppm, T₇-Borax @0.2 ppm, T₈-Borax @0.4 ppm, T₉-Borax @0.6 ppm and T₁₀-Control (water spray). Foliar sprays were applied twice during the experimental period, with the first application in the second fortnight of March and the second application in the second fortnight of April, following fruit set. Observations were recorded at 15-day intervals until harvest. The study focused on evaluating the effects of the treatments on the chemical quality attributes of the fruits, including total soluble solids (TSS), ascorbic acid, reducing sugars, non-reducing sugars, total sugars.

Total soluble solids percentage: The total soluble solids (TSS) content of the fruit was determined using a hand refractometer with a measurement range of 0-32°Brix. For analysis, a small portion of fruit pulp was wrapped in a muslin cloth and gently squeezed to extract the juice. Before taking the measurements, the prism of the refractometer was cleaned thoroughly with a moist muslin cloth. A few drops of the extracted juice were then placed on the prism, and the TSS reading was recorded. The observed values were corrected to the standard temperature of 20°C using the temperature correction table recommended by A.O.A.C. (1980). The TSS content was expressed as a percentage.

Ascorbic acid (Vitamin C): The ascorbic acid content of the fruit pulp was estimated by homogenizing 5 g of fresh pulp with 3.0% metaphosphoric acid, which served as the extracting and stabilizing solution. The homogenate was filtered, and the filtrate volume was made up to 100 ml with the same solution. An aliquot of 5 ml of the extract was titrated against a standard 2,6-dichlorophenol indophenol dye solution until the appearance of a light pink endpoint. The ascorbic acid content was calculated and expressed as milligrams per 100 g of fresh fruit pulp (mg 100 g⁻¹ pulp).

Ascorbic acid (mg/ 100 g)

$$= \frac{\text{titrate value} \times \text{Dyefactor} \times \text{Volume made up}}{\text{Aliquot taken} \times \text{Weight of sample taken}} \times 100$$

Reducing sugar (%): To estimate the reducing sugar content, 100 g of fruit pulp was crushed with distilled water, filtered through a muslin cloth, and the volume was adjusted to 100 ml. A 5 ml aliquot of the extract was mixed with 5 ml each of Fehling's 'A' and 'B' solutions and titrated against a 1.0% glucose solution under boiling conditions, using Methylene Blue as an indicator. A blank sample containing 5 ml each of Fehling's 'A' and 'B' solutions was also prepared. The results were expressed as a percentage of reducing sugars.

Reducing sugars (%)

$$= \frac{(\text{Blank titrate value} - \text{sample titre value}) \times \text{Volume made up}}{\text{Aliquot taken} \times \text{Weight of sample taken}}$$

× 100

Non reducing sugar (%): To determine the non-reducing sugar content, the value of reducing sugars was subtracted from the total sugar content, and the result was multiplied by 0.95. The following formula was used for the calculation of non-reducing sugars (AOAC, 1980):

$$\text{Non-reducing sugar} = (\text{Total sugar \%} - \text{Reducing sugar \%}) \times 0.95$$

Total sugars (%): The sum of reducing and non-reducing sugars was expressed as total sugars. Total sugars (%) = Reducing sugar (%) + Non-reducing sugar (%)

Results and discussion

Total soluble solids (°Brix)

The data presented in Table 1 revealed that the highest total soluble solids (18.4°Brix) content in mango fruits was recorded at GA₃ @ 20 ppm, followed by the NAA treatment (18.3 °Brix), whereas the lowest TSS (16.2°Brix) was observed in the control. The increase in total soluble solids (TSS) may be attributed to the enhanced photosynthetic activity and carbohydrate accumulation induced by micronutrients. Gibberellins play an important role in the breakdown of sucrose and starch by enhancing the activity of the enzyme invertase, which converts sucrose into glucose and fructose (Majumder *et al.*, 2017) ^[13].

Ascorbic acid content

The data presented in Table 1 revealed that the highest ascorbic acid (37.5 mg/100 g pulp) observed in GA₃ @ 20 ppm, closely followed by NAA @ 25 ppm (37.1 mg/100 g pulp), whereas the lowest ascorbic acid (29.2 mg/100 g pulp) was recorded at control. The increase in ascorbic acid content may be attributed to the role of micronutrients such as boron and zinc, which activate several enzymes involved in physiological and biochemical processes. These findings are in agreement with those reported by Gill and Bal (2013) ^[8] in mango, Bankar and Prasad (1990) ^[3] in ber, Kaur *et al.* (2009) in guava, and Singh and Singh (2015) ^[19] in aonla following the application of GA₃, NAA, and other growth regulators. Similar results were reported by Tripathi and Shukla (2010) ^[22], who observed an increase in ascorbic acid content in strawberry following GA₃ application.

Table 1: Effect of foliar Spray of micro-nutrients and plant growth- regulators on TSS and Ascorbic acid of mango cv. Amrapali.

Treatment	TSS (°Brix)	Ascorbic acid (mg/100 g pulp)
T ₁ - GA ₃ 20 ppm	18.4	37.5
T ₂ - GA ₃ 40 ppm	17.5	36.5
T ₃ - GA ₃ 60 ppm	17.5	35.4
T ₄ - NAA 15 ppm	17.3	35.1
T ₅ - NAA 20 ppm	17.6	35.2
T ₆ - NAA 25 ppm	18.3	37.1
T ₇ - Borax 0.2 ppm	16.9	33.3
T ₈ - Borax 0.4 ppm	17.0	33.6
T ₉ - Borax 0.6 ppm	17.1	34.5
T ₁₀ - Control (Water Spray)	16.2	29.2
SEm±	0.3	0.7
CD at 5%	1.0	2.1

Reducing sugars (%)

The findings presented in Table 2 reveal that maximum reducing sugar (4.66%) recorded GA₃ at 20 ppm, closely followed by NAA at 25 ppm (4.38%), while minimum reducing sugar (3.64%) recorded at control. The increase in reducing sugar content may be attributed to the conversion of organic acids into sugars during fruit ripening. These findings are consistent with the reports of Hammam *et al.* (2001)^[9], Singh *et al.* (2003)^[21], Patel and Valia (2004)^[17], Sarkar and Ghosh (2004)^[18], Singh and Banik (2011)^[20], and Yadav *et al.* (2011)^[24].

Non reducing sugars (%)

The data presented in Table 2 shows significant differences among the treatments. The highest non-reducing sugar content (8.90%) was observed in GA₃ @ 20 ppm, followed by NAA at 25 ppm (7.40%). The lowest non-reducing sugar content (7.40%) was recorded in the water spray (T₁₀) treatment. The present findings are in close agreement with those reported by Singh *et*

al. (2003), Patel and Valia (2004)^[17], Bhowmick and Banik (2011)^[4], Moazzam *et al.* (2011), and Yadav *et al.* (2011)^[24] and Kaur *et al.* (2015).

Total sugars

The data presented in Table 2 indicate that highest total sugar content (14.12%) was recorded with the foliar application of GA₃ @20 ppm followed by NAA @ 25 ppm (13.28%) whereas, the lowest total sugar content (11.04%) was observed at control. The higher total sugar content may be due to the enhanced conversion of organic acids into sugars, coupled with improved nutrient absorption and the regulatory influence of plant growth regulators on carbohydrate synthesis and accumulation in the fruits. Results are agreed with the finding reported by Hammam *et al.* (2001)^[9], Dutta and Dhua (2002)^[6], Singh *et al.* (2003)^[21], Patel and Valia (2004)^[17], Sarkar and Ghosh (2004)^[18], Bhowmick and Banik (2011)^[4], Singh and Banik (2011)^[20], Yadav *et al.* (2011)^[24].

Table 2.: Effect of foliar Spray on micro-nutrients and plant growth- regulators on Reducing sugar, Non-reducing and total sugar of mango cv. Amrapali

Treatment	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)
T ₁ - GA ₃ 20 ppm	4.66	8.9	14.12
T ₂ - GA ₃ 40 ppm	4.25	8.63	12.88
T ₃ - GA ₃ 60 ppm	4.12	9.46	12.48
T ₄ - NAA 15 ppm	4.11	8.35	12.46
T ₅ - NAA 20 ppm	4.28	8.36	12.96
T ₆ - NAA 25 ppm	4.38	8.68	13.28
T ₇ - Borax 0.2 ppm	3.80	7.72	11.52
T ₈ - Borax 0.4 ppm	3.83	7.77	11.60
T ₉ - Borax 0.6 ppm	3.84	7.80	11.64
T ₁₀ - Control (Water Spray)	3.64	7.40	11.04
SEm±	0.08	0.16	0.25
CD at 5%	0.25	0.50	0.75

Conclusion

The present investigation concluded that foliar application of plant growth regulators and micronutrients significantly influenced the chemical quality attributes of mango (*Mangifera indica* L.) cv. Amrapali. Among the treatments, GA₃ at 20 ppm (T₁) proved to be the most effective, recording the highest total soluble solids (18.4 °Brix), ascorbic acid (37.5 mg 100 g⁻¹ pulp), reducing sugars (4.66%), non-reducing sugars (8.90%), and total sugars (14.12%). The NAA at 25 ppm (T₆) treatment ranked second for most of the quality parameters, whereas the control consistently recorded the lowest values. The improvement in fruit quality may be attributed to the beneficial effects of GA₃ on carbohydrate metabolism, sugar accumulation, and the synthesis of biochemical constituents during fruit development. Therefore,

foliar application of GA₃ at 20 ppm, applied twice during the second fortnight of March and April, can be recommended for improving the chemical quality of mango cv. Amrapali under the agro-climatic conditions of Eastern Uttar Pradesh.

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