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Response of Foliar Feeding of NAA, Urea, Nano-urea and Biofertisol on Fruit Quality of Mango (*Mangifera indica* L.) cv. Langra

Raushan Kumar [a], Rajnee Sharma [a], T. R. Sharma [b], C. S. Pandey [c], Deepak Singh [a*], Shikha Thakur [a] and Surya Pratap Singh [a]

[a] Department of Horticulture, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur- 482004, India.
[b] Directorate of Extension Services, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur- 482004, India.
[c] Department of Plant Physiology, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur- 482004, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A study was conducted during the season of 2022-23 at the fruit research station in Imalia, which is affiliated with the Department of Horticulture at the JNKVV in Jabalpur. The objective of the study was to evaluate the positive effect of foliar sprays containing NAA, Urea, Nano-urea, and Biofertisol on the fruit quality of mango (*Mangifera indica* L.) cv. Langra. The experiment was laid out in Randomized Block design in three replications and all the treatments were replicated thrice by using the single tree as a unit. Each treatment was carried out with one tree for each replication. At the full bloom and pea stage, the spraying of three different concentrations of NAA (20 ppm, 30

**Corresponding author: E-mail: dsingh.horticulture@gmail.com;*

ppm, and 40 ppm), Urea (2%, 3%, and 4%), Nano-urea (0.2%, 0.3%, and 0.4%) and Biofertisol (5 ml/l, 10 ml/l, and 15 ml/l) was compared with the control, which consisted of no spraying. According to the findings of the experiment, applying a foliar spray containing 40 ppm of NAA resulted in a significant improvement in the quality parameter, as measured by a maximum TSS value of 22.22 ^{o}Brix, a maximum TSS: acid ratio of 117.13, maximum ascorbic acid content of 26.70 mg/100g, a minimum acidity content of 0.19%, and reducing sugars of 6.74% and total sugars of 17. During the evaluation, it performed at the same level as T_3 (NAA 30 ppm), T_2 (NAA 20 ppm), and T_7 (Urea 4%).

Keywords: NAA; urea; nano-urea; TSS; physicochemical quality; mango; langra; ascorbic acid.

1. INTRODUCTION

Mango (*Mangifera indica* L.) belonging to the genus Mangifera, one of the 73 genera of the family Anacardiaceae, in order Sapindales, is among the most important tropical fruits of the world. It is also called as "King of the fruits" in India due to its historical and religious importance, attractive aroma, and capitative taste [1]. It is a staple fruit in many Latin American countries, and the quality of the fruit impacts its marketability and nutritional value (Olivares et al. 2022b; Hernandez et al. 2018). Mangoes are well-established commodities of international trade because of their high quality [2]. It occupies relatively the same position in the tropics as is enjoyed by the apple in temperate America or Europe [3].

India's mango crop had significant cultural, socio-economic, and religious importance since ancient times, making it the most important crop in the country. The mango fruit has a substantial nutritional profile and exhibits a significant dietary worth. The inclusion of [this particular food item] may serve a significant function in achieving dietary equilibrium for individuals. One mango has the potential to fulfill up to 40 percent of the recommended daily intake of dietary fiber, which is known to be effective in preventing heart disease, cancer, and high cholesterol levels. India is the foremost global producer of mangoes, with a remarkable 111 nations engaging in mango cultivation. Currently, there are around 1200 distinct cultivars of mango, yet only a select handful have significant economic value due to their widespread acceptance. The present area under Mango in India is 2339 thousand hectares with a production of 20336 thousand MT and a productivity of 15.3 MT/ha. In Madhya Pradesh area under Mango is 42.11 thousand hectares with a production of 526.23 thousand Tonnes. [4]. In Madhya Pradesh, it is grown in all districts and commercially cultivated in Hosangabad, Betul, Rewa, Satna and Bhopal. Generally, quality parameters are genetically controlled. Exposure of fruit trees to adverse climatic conditions may alter the quality parameters of fruit like color, flavor, TSS, acidity, sugars etc. up to a certain level. PGRs like NAA and Cytokinins are more prone to the retention of fruit i.e. minimizing fruit drop by increasing auxin level and had less or non-significant role in improving quality like TSS, acidity, sugars, etc. [5]. Similar results were observed by Pujari et al. [6] in Alphonso mango. NAA improves the size and quality of fruits in mango and other crops [7].

2. MATERIALS AND METHODS

The present experiment was conducted at the Fruit Research Station, Imalia, Department of Horticulture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during the year 2022-23 on 23 years old mango plants cv. Langra with spacing at 12 × 12 m. The different concentrations of NAA @ 20ppm, 30ppm and 40ppm; Urea @ 2%, 3% and 4%; Nano-urea @ 0.2%, 0.3% and 0.4%; Biofertisol @ 5ml, 10ml and 15 ml per litre spray along with control at full bloom and pea stage. Treatments are as follows, T_1 (Control or Water spray), T_2 (NAA @ 20 ppm), T_3 (NAA @ 30 ppm), T_4 (NAA @ 40 ppm), T_5 (Urea @ 2%), T_6 (Urea @ 3 %), T_7 (Urea @ 4%), T_8 (Nano urea @ 0.2%), T_9 (Nano urea @ 0.3%), T_{10} (Nano urea @ 0.4%), T_{11} (Biofertisol @ 0.5%), T_{12} (Biofertisol @ 1%) and T_{13} (Biofertisol @ 1.5%). The experiment was planned out in a randomized block design and each treatment was replicated three times. A unit of single tree per replication was taken. The quality parameters were estimated after the harvesting of fruit. Langra mango is harvested at mid-June to mid-July. After harvesting value related to different parameters were taken in lab conditions. A hand Refractometer was used for the determination of TSS. Before usage, the hand refractometer was set to zero with pure water. According to a method described by Ranganna [8], the titratable acidity of the samples was determined by titrating against 0.1N sodium hydroxide solution while using phenolphthalein

as an indicator. The TSS and acidity ratio of fruit was calculated by dividing the TSS by acidity.

$$\text{TSS: Acidity ratio} = \frac{\text{Average value of TSS}}{\text{Average value of Acidity}}$$

Ascorbic acid was estimated as per the assay method given by Ranganna [8]. The ascorbic acid content of a sample was calculated by using the following formula.

$$\text{Ascorbic acid } \left(\frac{\text{mg}}{100\text{g}}\right) =$$

$$\frac{\text{Titrated value} \times \text{dye factor} \times \text{volume made up}}{\text{Aliquot extract taken} \times \text{weight of sample}} \times 100$$

The sugar content of the sample was determined by the procedure described by Ranganna [8] by using the following formula:

Non reducing sugar (%) =
Total sugar (%) - Reducing sugar (%) × 0.95

$$\text{Reducing sugar}(\%) = \frac{0.25}{\text{Burette reading}} \times 100$$

$$\text{Total sugar } (\%) = \frac{1.25}{\text{Burette reading}} \times 100$$

2.1 Statistical Analysis

The statistical technique and data analysis in this study were conducted utilising the methodology proposed by Panse and Sukhatme [9] and the Duncan multiple range test (DMRT) developed by Duncan [10]. The R-Software was used for implementing these methodologies.

3. RESULTS AND DISCUSSION

3.1 Effect of NAA, Urea, Nano-urea and Biofertisol on TSS (°Brix), acidity (%) and ascorbic acid (mg/100g)

Data are shown in Table 1 that the maximum total soluble solids (22.22 ^{0}Brix) was recorded with T_4 (NAA 40ppm) which was statistically at par with T_2 (NAA 20ppm), T_3 (NAA 30ppm) and T_7 (Urea 4%) having 22.20 ^{0}Brix, 22.15 ^{0}Brix and 21.80 ^{0}Brix, respectively. Whereas the minimum total soluble solids (20.10 ^{0}Brix) were recorded with control (T_1). The increase in TSS content of fruits might be due to the application of NAA might have increased a'-amylase activity and thus there was conversion of starch into sugars and hence improved total soluble solids content and enhanced solubilization of insoluble starch and pectin present in the cell wall and middle lamella. These results were accordingly to previous findings of Bal and Randhawa [11], Ghosh [12], Singh et al. [13] Venu and Radhevputra [14] in mango. Foliar application of nano urea liquid results in more efficient nitrogen absorption, better physiological growth and allows fruit quality in diverse climates [15].

Data shown in Table 1 revealed that the minimum acidity (0.19%) was recorded with T_4 (NAA 40ppm) which is statistically at par with T_3 (NAA 30ppm) and T_7 (Urea 4%) having 0.20% and 0.20%, respectively and the maximum acidity percent (0.25%) was recorded with T_1 (control). The acidity percentage decreased might be due to increase in TSS and sugars of the fruits harvested from the treated trees which might be due to an increase in translocation of photosynthates (carbohydrates) and more metabolic conversion of acids to sugars by the reverse reaction of glycolytic pathway which is utilized in various physiological activities. The present study is supported by findings of Gupta and Brahmachari [16] on mango. Titratable acidity was similar to the previous results of Maurya et al. [17] and Mahajan et al. [18], in Papaya. The TSS Acidity ratio was also maximum with NAA @ 40ppm (117.13) these results harmony with Venu and Radhevputra [14] in mango.

As presented in Table 1 maximum ascorbic acid (26.70 mg/100g) was recorded under T_4 (NAA 40ppm) which was significantly at par with T_7 (Urea 4%) and T_3 (NAA 30ppm) having 26.50 and 26.36 mg/100g, respectively and the minimum ascorbic acid (19.83 mg/100g) was found with T_1 (control).

The elevation in the concentration of ascorbic acid could be attributed to the continuous production of glucose-6-phosphate throughout the maturation and progression of fruits, which is believed to serve as the precursor for vitamin C [19]. Previous studies conducted by Sharma et al. [20] and Sukhla [21] have similarly shown the application of NAA 40ppm to the leaves of mango cv. Langra resulted in the highest levels of ascorbic acid. These findings are consistent with the research conducted by Gattass et al. [22] and Yadav et al. [23] in the field. They also align with the results obtained in the current investigation.

Table 1. Effect of NAA, Urea, Nano-urea and Biofertisol on TSS (o Brix), acidity (%), ascorbic acid (mg/100g) and TSS-acidity ratio

Notation	Treatment	TSS (^{O} Brix)	Acidity (%)	Ascorbic acid (mg/100g)	TSS: Acidity ratio
T_1	Control (Water)	20.10 ^{e}	0.25 ^{b}	19.83 ^{d}	81.51 ^{j}
T_2	NAA @ 20 ppm	22.15 ^{a}	0.21 ^{ab}	25.61 ^{ab}	105.48 ^{c}
T_3	NAA @ 30 ppm	22.20 ^{a}	0.20 ^{ab}	26.36 ^{a}	111.18 ^{ab}
T_4	NAA @ 40 ppm	22.22 ^{a}	0.19 ^{a}	26.70 ^{a}	117.13 ^{a}
T_5	Urea @ 2%	20.67 ^{cd}	0.22 ^{ab}	22.83 ^{c}	94.06 ^{ef}
T_6	Urea @ 3 %	21.53 ^{b}	0.21 ^{ab}	24.65 ^{b}	102.62 ^{d}
T_7	Urea @ 4%	21.80 ^{ab}	0.20 ^{ab}	26.50 ^{a}	107.29 ^{b}
T_8	Nano urea @ 0.2%	20.32 ^{de}	0.23 ^{ab}	21.23 ^{cd}	88.33 ^{h}
T_9	Nano urea @ 0.3%	20.53 ^{cde}	0.23 ^{ab}	22.77 ^{c}	89.39 ^{gh}
T_{10}	Nano urea @ 0.4%	20.80 ^{c}	0.22 ^{ab}	22.17 ^{c}	94.67 ^{e}
T_{11}	Biofertisol @ 0.5%	20.23 ^{de}	0.24 ^{ab}	19.90 ^{d}	85.54 ^{i}
T_{12}	Biofertisol @ 1%	20.33 ^{de}	0.23 ^{ab}	20.20 ^{d}	89.72 ^{g}
T_{13}	Biofertisol @ 1.5%	20.50 ^{cde}	0.22 ^{ab}	20.27 ^{d}	91.80 ^{f}
	SE(m)±	**0.14**	**0.004**	**0.17**	**1.97**
	C. D. (*p=0.05*)	**0.42**	**0.013**	**0.50**	**5.75**
	C.V (%)	**1.19**	**3.53**	**1.29**	**3.52**

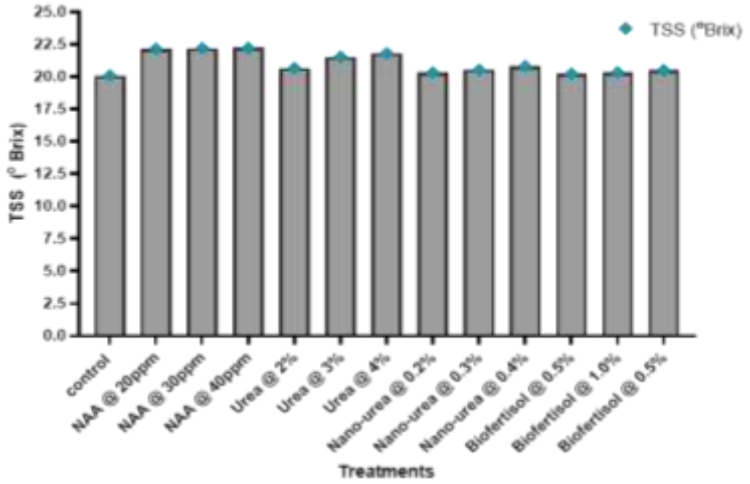

Fig. 1. Effect of NAA, Urea, Nano-urea and Biofertisol on TSS (° Brix)

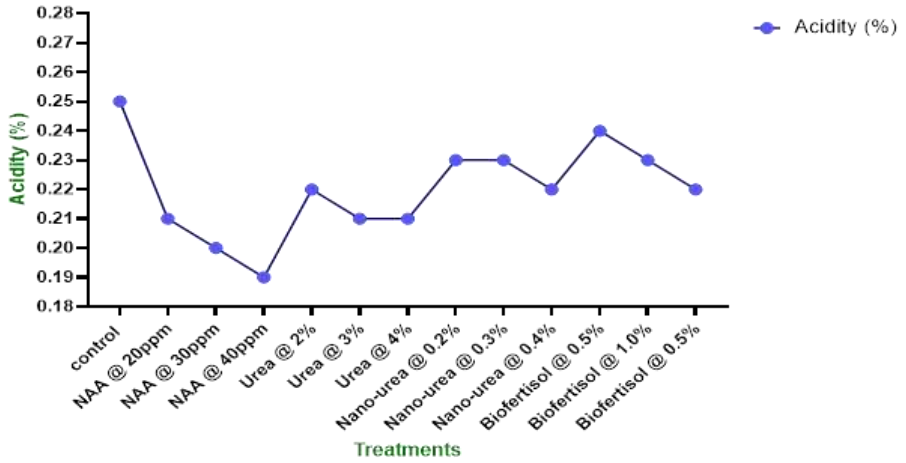

Fig. 2. Effect of NAA, Urea, Nano-urea and Biofertisol on acidity (%)

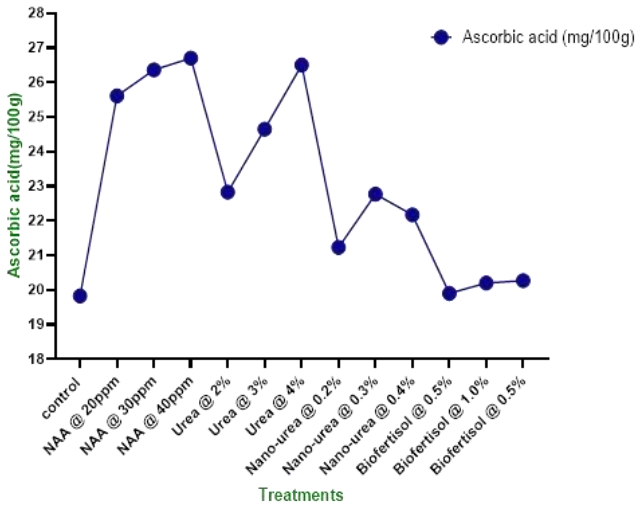

Fig. 3. Effect of NAA, Urea, Nano-urea and Biofertisol on Ascorbic acid (mg/100g)

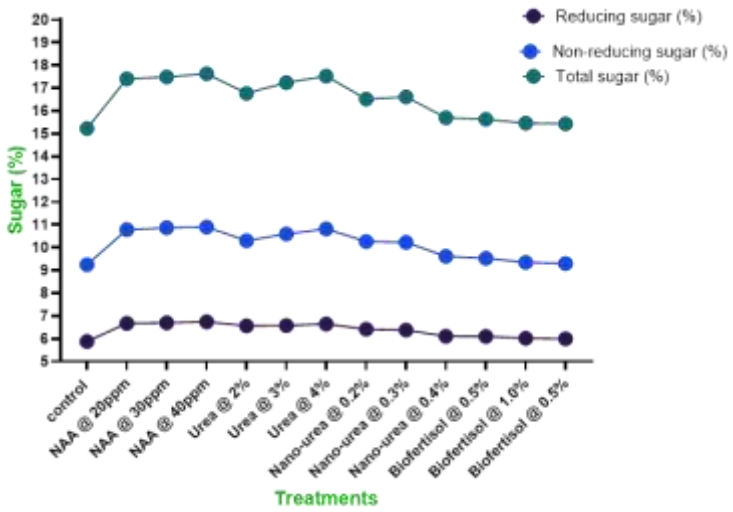

Fig. 4. Effect of NAA, Urea, Nano-urea and Biofertisol on total sugar (%), reducing and non-reducing sugar (%)

3.2 Effect of NAA, Urea, Nano-urea and Biofertisol on Total Sugar, Reducing Sugar and Non-reducing Sugar (%)

Maximum reducing sugar (6.74%), total sugar (17.63%) and minimum non-reducing sugar (9.25%) was recorded with the treatment T_4 (NAA at 40ppm) and presented in Table 2. The surge in overall sugar levels may be linked to the presence of NAA, which potentially enhances the conversion of starch and other polysaccharides into soluble forms of sugar, hence promoting an increase in sugar content [24]. The sugar content may be elevated as a result of the breakdown of polysaccharides into monosaccharides via metabolic processes, the conversion of organic acids into sugars, and the reduction of moisture, leading to an overall rise in total soluble solids. The findings align with previous studies conducted by Haidry et al. [25] and Shrivastava and Jain [26] in the case of cv. Langra, Narayanswamy et al. [27] in the context of Pomegranate cv. Bhagwa, and Tripathi et al. [28] in the case of ber. Finding can also shed light on the potential benefits of different foliar feeding methods, which may lead to improved agricultural practices and increased fruit quality [29]. Application of NAA overall boost nutritional level of fruit and access to high-quality fruit production which insure higher income and livelihoods for grower [30,31].

Table 2. Effect of NAA, Urea, Nano-urea and Biofertisol on reducing sugar (%), nonreducing sugar (%) and total sugar (%)

Notation	Treatment	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)
T_1	Control (Water)	5.88 ^{g}	10.90 ^{g}	15.23 ^{i}
T_2	NAA @ 20 ppm	6.68 ^{a}	9.33 ^{b}	17.41 ^{bc}
T_3	NAA @ 30 ppm	6.70 ^{a}	9.30 ^{ab}	17.49 ^{ab}
T_4	NAA @ 40 ppm	6.74 ^{a}	9.25 ^{a}	17.63 ^{a}
T_5	Urea @ 2%	6.57 ^{b}	10.23 ^{d}	16.77 ^{d}
T_6	Urea @ 3 %	6.58 ^{b}	9.62 ^{c}	17.24 ^{c}
T_7	Urea @ 4%	6.65 ^{ab}	9.34 ^{ab}	17.53 ^{ab}
T_8	Nano urea @ 0.2%	6.42 ^{c}	10.27 ^{d}	16.52 ^{e}
T_9	Nano urea @ 0.3%	6.38 ^{c}	10.30 ^{d}	16.61 ^{de}
T_{10}	Nano urea @ 0.4%	6.11 ^{d}	10.60 ^{e}	15.70 ^{f}
T_{11}	Biofertisol @ 0.5%	6.10 ^{de}	10.82 ^{e}	15.63 ^{fg}
T_{12}	Biofertisol @ 1%	6.02 ^{ef}	10.79 ^{f}	15.46 ^{gh}
T_{13}	Biofertisol @ 1.5%	6.00 ^{f}	10.87 ^{fg}	15.43 ^{h}
	SE(m)±	**0.03**	**0.03**	**0.06**
	C. D. (*p=0.05*)	**0.09**	**0.09**	**0.18**
	C.V (%)	**0.82**	**0.52**	**0.65**

4. CONCLUSION

Based on the experiment conducted, it is found that treatment T_4 (NAA 40 ppm) performed superior over other treatments in all quality parameters i.e., TSS, Acidity (%), TSS:Acidity ratio, Total sugar, reducing sugar and non-reducing sugar percentage. Whereas treatment T_3 (NAA 30ppm) was also perform best in all aspects of the research.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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