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INFLUENCE OF PRE-HARVEST FOLIAR APPLICATION OF NAPHTHALENE ACETIC ACID AND ZINC SULPHATE ON FRUIT RETENTION, YIELD AND QUALITY PARAMETERS OF MANGO

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ABSTRACT

An experiment was carried out in Horticulture Garden, Department of Fruit Science, C. S. Azad University of Agriculture and Technology, Kanpur (U.P.), India, during the year 2024 and found that the increased level of NAA and $ZnSO_4$ had influenced minimum fruit drop with increased fruit retention and yield as compared to other treatments, including control. For these nine treatments *viz.*, two levels of each NAA (10 and 20 ppm) and $ZnSO_4$ (0.2 and 0.4%) along with their combinations including a control, replicated thrice in RBD were used for the experimental work. The treatments were applied on the tree at the pea stage of fruit on 1st April 2024 with a very fine nozzle sprayer. The foliar application of plant bio-regulatorsalong with micronutrients plays an important role in manipulating many physiological phenomena, improving yield, quality and enhancing the productivity of plants by fulfilling the nutritional needs of fruit crops. From the experiment, it is reported that the treatment of NAA20 ppm+$ZnSO_4$ 0.4% significantly reduced fruit drop (92.99%) with increased number of fruits per panicle (5.62), highest fruit retention (7.01%), fruit weight (224.76 g), fruit yield per tree (53.32 kg), length and breadth of fruit (11.98 cm and 6.81 cm), fruit volume (240.221 cc), specific gravity (1.04 g/cc), pulp content (66.76 %) and minimum peel content (11.43%) and stone (21.81%). The same treatment also produced a favourable effect on fruit quality in terms of increased TSS (19.07°Brix), total sugars (18.05%), ascorbic acid (45.34 mg/100g pulp) and reduced titratable acidity (0.32%).

Key Words: Mango, Amrapali, NAA, $ZnSO_4$, fruit drop, fruit retention, yield and quality

Introduction

Mango (*Mangifera indica* L.), an important and delicious fruit of the tropical regions, holds a premier position amongst all the commercial fruits in the country. The mango industry has vast potential and plays a vital role in the development of economic status and better linkage in international trade. The mango is cultivated in almost all the states of India. Mango is recognized as a well-accepted fruit world wide due to its luscious taste, captivating flavour and attractive colour. Mango is also a rich source of carbohydrates as well as vitamin A and a fairly good source of vitamin C. The application of NAA increased fruit set, decreased fruit drop, and brought a beneficial change in the quality of many fruits. Raising auxin concntration in plants prevents abscission, where as the application of Zinc (Zn) is an essential trace element for plants, being involved in many enzymatic reactions and is necessary for their good growth and development. Zinc is also involved in regulating the protein and carbohydrate metabolism. Zinc availability to plants is reduced in high-pH soils. Zinc uptake rate was faster in mango trees when zinc sulfate was foliar applied as compared with its soil application. The foliar application of plant bio-regulators can also minimize the intensity of damage caused by fruit dropping, which helps improve the yield and fruit quality of mangoes. Keeping these all in view, an experiment was carried out to investigate the effect of foliar application of Naphthalene acetic acid and Zinc sulphate alone and in combination on fruit

retention, yield and quality of Mango cv. Amrapali.

Materials and Methods

Twenty-seven years old but properly maintained plants of the mango cv. Amrapali was selected for experimentation in the Garden, Department of Fruit Science, C.S. Azad University of Agriculture and Technology, Kanpur (U.P.), India, during the year 2024. There were nine treatments *viz.*; two levels of each NAA (10 and 20ppm) and $ZnSO_4$ (0.2 and 0.4%) along with their combinations, including a control, replicated thrice in RBD, which were used for the experimental work. The treatments were applied on the tree at the pea stage of fruit development on 01st April 2024 using a very fine nozzle sprayer. The detergent powder was well mixed in the spray solution, acting as a sticker before spraying. The information recorded on different parameters during experimentation was statistically analyzed.

Observations on the number of fruits per panicle, fruit drop and fruit retention percentage, length and breadth of fruits were recorded during the fruiting season. Data on fruit weight and yield per plant were also recorded at each picking. Data on fruit volume, specific gravity, pulp, peel and stone percentage were recorded. The TSS of fruits was recorded with the assistance of an Erma hand refractometer. The titratable acidity, total sugars and ascorbic acid content were determined by the techniques recommended in A.O.A.C. (1980).

Results and Discussion

Number of fruits per panicle: Significantly maximum number of fruits per panicle (5.62) was recorded in plants which were treated with NAA 20ppm + ZnSO4 @ 0.4% (T_8) followed by T_7 (NAA10 ppm+$ZnSO_4$ 0.4%) and T_6 (NAA20ppm+$ZnSO_4$ 0.2%) treatment, whereas, plant kept under control (T_0) gave the minimum quantity (3.69) of fruits per panicle (Fig. 1). The more significant number of fruits per panicle were produced due to early panicle emergence and production of higher hydrolytic enzyme activity and also leaf metabolite mobilization for panicle development. Similar findings were recorded by Majumder *et al.*, (2011), Jackson *et al.*, (2019), Tripathiand Viveka Nand (2022) and Singh *et al.*, (2023) in mango.

Fruits drop and retention per cent: The application of plant bio-regulators and micronutrients was found to have a substantial impact on the number of fruits that were retained and dropped during the current trial. A preharvest spray of NAA 20ppm + $ZnSO_4$ @ 0.4% (T_8) resulted in the highest fruit retention and lowest fruit drop (7.01% and 92.99%, respectively) followed by T_7 (NAA10 ppm+$ZnSO_4$ 0.4%) and T_6 (NAA20ppm+ $ZnSO_4$ 0.2%), respectively. Where as plants kept under control treatment (T_0), where no amount of any plant bio-regulator or micronutrient was applied, showed the lowest fruit retention and highest fruit drop (2.06% and 97.94%, respectively) (Table 1). NAA and Zinc sulphate at a higher level increased the foliar content, which ultimately encourages the endogenous production of auxin, there by reducing fruit drop and increasing fruit retention. The results are in agreement with the findings of Singh *et al.*, (2017), Tripathi *et al.*, (2019), Tripathi and Kumar (2022) and Singh *et al.*, (2023) in mango; Tripathi and Shukla (2010) and Tripathi and Shukla (2008) in strawberry and Tripathi *et al.*, (2018) in aonla.

Fruit weight: During the current experiment, all treatments performed significantly better in terms of fruit weight (g) than the control (Table 1). Application of NAA 20ppm + $ZnSO_4$ @ 0.4% (T_8) showed the maximum fruit weight (224.76g), followed by T_7 (NAA10 ppm+$ZnSO_4$ 0.4%) and T_6 (NAA20ppm+$ZnSO_4$0.2%), respectively, whereas, the control treatment (T_0) where non-amount of any plant bio-regulator or micronutrient

Table1: Effect of foliar feeding of NAA and $ZnSO_4$ on flowering, fruiting and yield characters of mango.

Treatments	Fruit drop (%)	Fruit retention (%)	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Fruit volume (cc)	Specific gravity (g/cc)	Pulp (%)	Peel (%)	Stone (%)
T_0- Control (Waterspray)	97.94	2.06	187.52	8.01	5.17	211.78	0.90	57.34	16.34	26.32
T_1- NAA10 ppm	94.84	5.16	213.98	9.98	5.81	216.80	0.98	61.01	14.87	24.12
T_2- NAA20 ppm	94.17	5.83	219.34	10.15	5.97	220.92	1.00	64.90	13.32	21.78
T_3- $ZnSO_4$ 0.2%	95.02	4.98	218.93	10.32	6.04	234.71	0.93	62.75	13.05	24.23
T_4- $ZnSO_4$ 0.4%	95.29	4.71	214.12	10.47	6.07	229.21	0.95	61.92	13.54	24.54
T_5- NAA10ppm+ZnSO40.2%	93.92	6.08	220.13	10.51	6.09	230.42	0.97	63.73	12.89	23.38
T_6-NAA20ppm+$ZnSO_4$ 0.2%	94.02	5.98	219.32	11.65	6.17	232.70	0.99	65.08	12.13	22.79
T_7-NAA10 ppm+$ZnSO_4$ 0.4%	93.98	6.20	222.14	11.83	6.32	238.70	1.01	65.25	12.07	22.68
T_8- NAA20 ppm+ZnSO40.4%	92.99	7.01	224.76	11.98	6.81	240.21	1.04	66.76	11.43	21.81
S.E. (m)±	0.10	0.07	3.20	0.12	0.07	2.71	0.01	0.88	0.24	0.28
C.D. at5%	0.30	0.21	9.70	0.37	0.23	8.20	0.04	2.68	0.72	0.87

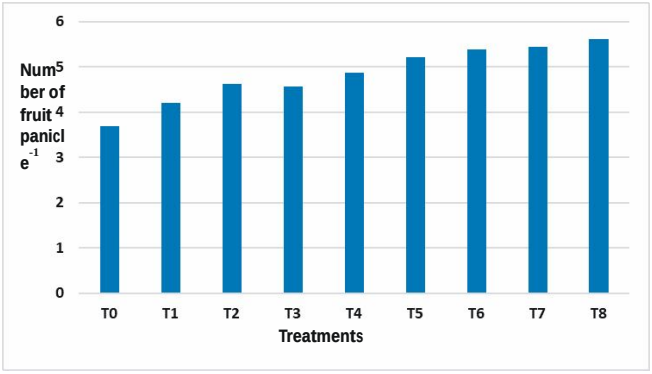

Fig.1: Effect of foliar spray of NAA and $ZnSO_4$ on number of fruits panicle-1of mango

was applied, had the lowest fruit weight (187.52g). This increase in the weight of fruits might be due to a better supply of nutrients and photosynthates in plants treated with foliar application of NAA and zinc, which might have made a rapid synthesis of metabolites, particularly carbohydrate, and their translocation to the fruits, causing relatively greater pulp content. The result is in agreement with the findings of Singh *et al.,* (2017), Kumar *et al.,* (2018), Tripathi *et al.,* (2019), Khan *et al.,* (2022), Tripathi and Kumar (2022), Singh *et al.,* (2023) and Samant *et al.,* (2025) in mango and Tripathi and Shukla (2008& 2010) in strawberry.

Fruit yield: Pre-harvest applications of NAA 20ppm + $ZnSO_4$ @ 0.4% have shown to be the most effective treatment in increasing fruit production, which was recorded as 53.32 kg $tree^{-1}$ followed by NAA10 ppm+$ZnSO_4$ 0.4% and NAA20ppm+$ZnSO_4$ 0.2% (T_8), respectively, while the control (T_0) treatment, where non-amount of any plant bio regulator or micronutrient were applied produced the lowest (42.48 kg $tree^{-1}$) of fruit yield (Fig. 2). During the current experimental period, an increase in fruit yield is directly related to the significance of these NAA and Zinc sulphate in improving physiological activities in plants which increases fruit retention percentage, length and breadth of fruit along with an increased average weight of fruits. The application of zinc also proved highly helpful in the process of

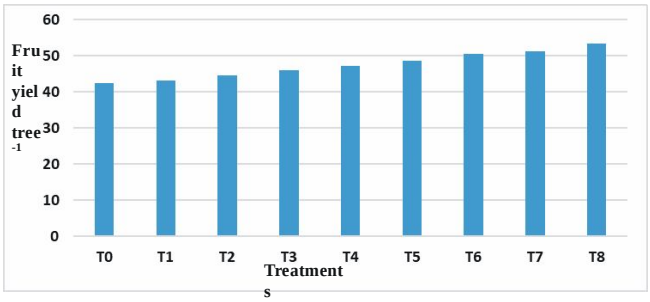

Fig.2: Effect of foliar spray of NAA and ZnSO4 on fruit yield tree-1of mango

photosynthesis, mobilization of food materials, and accumulation of quality constituents promoting physical attributes like fruit size and weight, which ultimately increased the yield. The present results are in agreement with the reports of Tripathi and Shukla (2010) and Tripathi and Shukla (2008) in strawberry; Sarkar and Ghosh (2004) and Tripathi and Vivekan and (2022), Bhowmick and Banik (2011), Singh, *et al.,* (2017), Tripathi *et al.,* (2019) and Samant*et al.,* (2025) in Mango.

Fruit length and breadth: The foliar treatment of NAA and Zinc sulphate substantially impacted fruit length and breadth. The fruits produced from the plants treated with NAA 20ppm + $ZnSO_4$ @ 0.4% (T_8) had a significantly higher length and breadth of fruit (11.98 and 6.81 cm, respectively) followed by T_7 (NAA10 ppm+$ZnSO_4$ 0.4%) and T_6 (NAA20ppm+$ZnSO_4$ 0.2%), respectively, while the fruits produced from the plants kept under control (T_0) treatment showed the lowest fruit length 8.01 cm and breadth 5.17 cm (Table 1). This increase in the size of mango fruits can be attributed to the greater mobilization of water into fruits and food material from the site of their production to the storage organs under the influence of applied NAA and zinc sulphate. An increase in cell size is usually a factor in plant growth. There is some evidence that auxin effectively reduces the stone's size and softens the cell wall, thus increasing its flexibility and plasticity. This would allow stretching of cell wall along with greater water uptake and increased cell size, ultimately increasing the size of fruits. The present results are in agreement with the reports of Sharma *et al.,* (2005), Saraswat *et al.,* (2006) in litchi, Singh *et al.,* (2017) and Tripathi *et al.,* (2019) in mango.

Fruit volume and specific gravity: Fruit volume and specific gravity of fruits were also significantly influenced by the foliar application of plant bio-regulators. It is observed that fruits with higher volume and specific gravity (240.21 cc and 1.04g/cc) were produced from the plants, which were treated with the combination of NAA 20ppm + $ZnSO_4$ @ 0.4% (T_8). In contrast, fruits with minimum volume and specific gravity (211.78 cc and 0.90g/cc) were recorded under untreated (control) plants (Table 1). This increase in specific gravity using NAA and $ZnSO_4$ might be due to increased fruit pulp and decreased stone weight. These findings are in accordance with the results of Tripathi *et al.,* (2019), Khan *et al.,* (2022) and Singh, *et al.,* (2023) in mango.

Fruit pulp, peel and stone per cent: Observations recorded on pulp and peel per cent revealed that combined application of ^{NAA20} ppm+$ZnSO_4$ 0.4% (T_8) resulted in a significant increase in pulp per cent (66.76) and reduction

in peel percent (11.43) in mango fruit (Table 1). It is alsoclearly reported that a significantly minimum reduction in stone per cent (221.81) was also recorded in the combined application of NAA20 ppm+$ZnSO_4$ 0.4% (T_8). The minimum pulp per cent (57.34) and maximum peel (16.34) and stone per cent (26.32) were recorded under control. This increase in pulp percentage might be due to moreabsorption of water and direct or indirect effect of plantbio-regulator (NAA) and micronutrient ($ZnSO_4$) which increase the volume of inter-cellular spaces in the pulp. These results are by the reports of Tripathi *et al.*, (2019), Khan *et al.*, (2022), Singh *et al.*, (2023), Samant *et al.*, (2025) in mango, Tripathi and Shukla (2008) in strawberry and Saraswat *et al.*, (2006) in litchi.

Total soluble solids and Total sugars: Maximum accumulation of total soluble solids (19.07^{0}Brix) and total sugars content (18.05%) in mango fruits were recorded with the combination of NAA20 ppm+$ZnSO_4$ 0.4%, while minimum TSS and Total sugar (14.96^{0}Brix and 13.73%, respectively) were recorded under control (Table 2). This increase in the total soluble solids and total sugar content of fruits may be because auxins playan important role in photosynthesis, which results in the accumulation of carbohydrates and ultimately increases the TSS content in mango fruit. An adequate amount of zinc improved the auxin content and acted as a catalyst for the oxidation process. This increase in total sugar content may be because zinc works as a stimulator of amino acids and appears to be helpful in the process of photosynthesis and in the accumulation of carbohydrates, which ultimately help translocate more sugar and TSS to the fruits. It has been reported that starch is more converted into sugar (source to sink) in the presence of these plant bio-regulators and micronutrients. The results are under the findings of Singh *et al.*, (2017), Tripathi *et al.*, (2019), Tripathiand Viveka Nand (2022) inmango and Shukla *et al.*, (2011) inaonla, Badal and Tripathi (2021) in guava.

Titratable acidity: The treatments with different plant bio-regulators significantly influenced the titratable acidity percentage in mango fruits. The minimum acidity per cent (0.32%) was recorded with NAA20 ppm+$ZnSO_4$ 0.4% (T_8), whereas the maximum (0.53%) was found under control (Table 2). The titratable acidity content of fruits decreased with the foliar application of plant bio-regulator (NAA) and Zinc sulphate at different concentrations, which might be due to an increase in the translocation of carbohydrates and an increase in the metabolic conversion of acids to sugars by the reaction involving reversal of glycolytic pathway and used in respiration or both. Another reason for the reduction in acidity per cent in plant bio-regulator-treated fruits might be the early ripening of fruits induced by the plant bio-regulators spray due to which acid degradation might have occurred. These results are in accordance with the reports of Singh *et al.*, (2017), Tripathi *et al.*, (2019), in mango, Tripathi and Shukla (2010) in strawberry, Tiwari *et al.*, (2017) and Kumar *et al.*, (2017) inaonla.

Ascorbic acid: The ascorbic acid content of fruits was significantly influenced by the spraying of plant bio-regulators compared to the control. Significantly, the maximum amount of ascorbic acid (45.34mg 100g^{-1} pulp) was found with the combination of NAA20 ppm+$ZnSO_4$ 0.4% (T_8), whereas the minimum (31.19mg 100g^{-1} pulp) was recorded under control (Table 2). This increase in the ascorbic acid content of mango fruit was due to an increase in the synthesis of catalytic activity by the enzyme and coenzyme, which are represented in ascorbic acid synthes is. The adequate amounts of zinc improve the auxin content and act as a catalyst in the oxidation process. These findings are in close accordance with the results of Singh *et al.*, (2017), Tripathi *et al.*, (2019), Kumar *et al.*, (2018), Singh *et al.*, (2023), Samant*et al.*, (2025) in mango and Tiwari *et al.*, (2017) in aonlacv NA-7.

Table 2: Effect of foliar feeding of NAA and $ZnSO_4$ on fruit quality parameters of mango.

Treatments	TSS (^{o}Brix)	Ascorbic acid (mg /100gpulp)	Titratable acidity (%)	Total sugar (%)
T_0- Control (Waterspray)	14.96	31.19	0.53	13.73
T_1- NAA10 ppm	16.7	35.01	0.49	15.51
T_2- NAA20 ppm	17.6	35.23	0.45	16.45
T_3- $ZnSO_4$ 0.2%	17.32	37.01	0.39	16.23
T_4- $ZnSO_4$ 0.4%	18.02	36.93	0.40	16.92
T_5- NAA10ppm+$ZnSO_4$ 0.2%	18.43	42.16	0.37	17.36
T_6-NAA20ppm+$ZnSO_4$ 0.2%	18.7	40.72	0.34	17.66
T_7-NAA10 ppm+$ZnSO_4$ 0.4%	19.02	43.98	0.35	17.97
T_8- NAA20 ppm+$ZnSO_4$ 0.4%	19.07	45.34	0.32	18.05
S.E. (m)±	0.29	0.59	0.006	0.14
C.D. at 5%	0.88	1.80	0.018	0.43

Conclusion

The above-mentioned results clearly show that the preharvest spray of NAA20 ppm+$ZnSO_4$ 0.4% (T_8) had a positive effect on fruit set, fruit drop and fruit retention as well as a higher number of fruit sets per panicle. On the other hand, the used materials increased the yield of Amrapali mango with fruit weight and yield per tree followed by treatment including all sprayed materials. As fruit quality parameters (physical and chemical properties)

are concerned, it is clear that spraying of NAA20 ppm+$ZnSO_4$ 0.4% gave a high improvement in quality parameters as compared with the control.

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