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Influence of Pre-harvest Application of Gibberellic Acid and Borax on Fruit Retention, Yield and Quality of Mango (*Mangifera indica* L.) cv. Dashehari

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ABSTRACT: To investigate the influence of pre-harvest application of Gibberellic acid and Borax on fruit retention, yield and quality of Mango (*Mangifera indica* L.) cv. Dashehari, an experiment was carried out in the garden, Department of Fruit Science, C.S. Azad University of Agriculture and Technology, Kanpur - 208002 (U.P.), India, during the year 2022-23. The experiment was laid out in Randomized Block Design (RBD), using nine diverse treatments *viz.*, T_1-GA_3 20ppm, T_2-GA_3 40 ppm, T_3-Borax (0.2%), T_4-Borax (0.4%), T_5-GA_3 20ppm + Borax (0.2%), T_6-GA_3 40ppm + Borax (0.2%), T_7-GA_3 20ppm + Borax (0.4%), T_8-GA_3 40 ppm + Borax (0.4%), and T_9-control *i.e.*, water spray, replicated thrice on 13-year-old, uniform in growth, twenty-seven mango cv. Dashehari plants, spaced at 7x7 m apart. Mango is considered one of the well accepted fruits all over the world due to its luscious taste, captivating flavour and attractive colour. A variety of products can be prepared from both immature green and ripe fruits. The spraying was done at the pea stage of fruit setting using, a very tiny nozzle sprayer. Foliar application of Borax and GA_3 plays a crucial part in controlling a variety of physiological phenomena, boosting yield and quality, and increasing plant productivity. The use of boron facilitates the transport of sugar and speeds up fruit bud development. The spraying with a combination of GA_3 40ppm + Borax 0.4% (T_8) results in maximum number of fruits per panicle (7.14%), minimum fruit drop (85.06%), maximum fruit retention (14.94%), fruit length (11.66%), fruit width (7.14%), weight (243.32g), volume (240.91cc), fruit yield (57.14kg/plant), fruit pulp (72.32%), total soluble solids (22.08°Brix), total sugars (21.08%), ascorbic acid (34.96mg/100ml) with minimum fruit peel (16.64%), stone (11.04%) and titratable acidity (0.40%) under plains of Uttar Pradesh.

Keywords: Mango, GA_3, Borax, Flowering, Fruiting, Yield and Physio-chemical qualities.

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the most important tropical fruit of India, which belongs to the family Anacardiaceae. It is also known as the Symbol of love, King of the fruits, and Bathroom fruit. It has 40 chromosome number (2n=40). The mango fruit originated from the foothills of the Himalayas of southern Asia which includes eastern India, Burma and Andaman Island, bordering the bays of the Bengal. The origin place of mango is Indo-Burma region. Mango germplasm is abundant in India, with over 1000 types cultivated across the country. Mango is the choicest fruit in the world with a good source of both vitamins A and C and carbohydrates. Mango fruit contains up to 87% moisture, 11.6-24.3% carbohydrates and 0.3-1.0% protein.

Foliar spray of micronutrients and PGRs plays an important role in improving fruit yield as well as qualitative traits were recorded with the application of 0.4% Borax in guava fruit by Suman *et al*. (2021). Gibberellic acid (GA) is an essential plant hormone that controls several physiological processes in plants, including the growth and development of fruit. It also encourages fruit cell proliferation and elongation resulting increase in fruit size. Borax, is a micronutrient that is vital for the development and growth of plants. Application of GA_3 (20ppm) significantly reduced fruit drop (85.93%) and increased fruit retention (14.07%) but the application of GA_3 40ppm resulted in the maximum fruit yield, increased fruit length, fruit width, fruit weight and fruit volume, whereas fruits produced from the plants treated with $ZnSO_4$ at 1.0% have higher specific gravity and pulp percent in mango cv. Amrapali reported by Singh *et al.* (2017).

By boosting sugar content, enhancing colour and flavour, and lowering the prevalence of conditions such as fruit breaking, borax can enhance the quality of fruit. Boron is also necessary for the establishment of pollen tubes and flowers, both of which are crucial for fruit set and successful fertilization, therefore, keeping in view, the importance of these plant bio-regulator and

micronutrient the present experiment was planned to get concrete information on the effect of these in respect of fruit retention, yield and quality of mango.

MATERIALS AND METHODS

For this experimentation work well-established and healthy twenty-seven plants of thirteen-year-old mango cv. Dashehari was selected in the Garden, Department of Fruit Science, C.S. Azad University of Agriculture and Technology, Kanpur-208002 (U.P.), which were planted at a distance of 7.0×7.0 meters. In the orchard recommended cultural practices along with the application of the recommended dose of manures and fertilizers were followed. The experiment was laid out in randomized Block design (RBD) and replicated thrice with nine diverse treatments *viz.*, T_1-GA_3 20 ppm, T_2-GA_3 40 ppm, T_3-Borax (0.2 %), T_4-Borax (0.4 %), T_5-GA_3 20 ppm + Borax (0.2 %), T_6-GA_3 40 ppm + Borax (0.2 %), T_7-GA_3 20 ppm + Borax (0.4 %), T_8-GA_3 40 ppm + Borax (0.4 %), and T_9-control *i.e.*, water spray.

During experimentation observations on fruit per panicle, fruit drop, and fruit retention were made. Fruit weight and yield per plant were recorded during each picking by weighing machine. Ten randomly chosen fruits were measured using a vernier caliper for their fruit length and width and expressed in centimeters (cm). Using a volumetric flask and the water displacement method, data on the volume of fruits were determined and expressed in cc. Additionally calculated were quality parameters such as the pulp, peel, and stone percent of fruit. Using a hand refractometer made by Erma, the TSS of fruits was measured. The procedures described in A.O.A.C. (1980) were used to determine total sugars, titratable acidity and ascorbic acid contents of mango fruit.

RESULTS AND DISCUSSION

The data presented in Table1 and Table 2, with respect to fruiting, yield, physical and biochemical attributes as influenced by the GA_3 and Borax application with single or combined effect. There was statistically significant difference between the treatments on account of the fruiting, yield, physical and biochemical attributes of mango.

Fruiting and yield parameters:

Number of fruits per panicle (%): Results predicted in Table 1, showed significantly on maximum number of fruits per panicle (7.14%) was recorded from the plants treated with the combination of GA_3 40ppm + Borax 0.4% (T_8), followed by 7.06%, which was recorded with GA_3 40ppm + Borax 0.2% (Table 1) treated plants, whereas, the minimum number of fruits per panicle (5.40%) was found under control (T_9) treatment. Application of GA_3 accelerates the development of differentiated inflorescence which also leads to an increased number of fruits per panicle. The findings obtained by Prasad *et al.* (2011) and Nkansah *et al*. (2012) in mango, Badal and Tripathi (2021b) in guava, are similar to the current results.

Fruit drop and retention (%): The plants which are sprayed with the combination of GA_3 40ppm + Borax 0.4% proved significantly effective in improving the fruit drop (%) and fruit retention (%). The minimum fruit drop (85.06%) and better fruit retention (14.94%) were noticed in GA_3 40 ppm + Borax (0.4%) (T_8), followed by fruit drop of 86.14% and fruit retention of 13.86%, which were noticed in $GA_3$40ppm + Borax 0.2% (Table 1). Those plants which are not treated with any PGRs and micronutrient kept under control treatment show maximum fruit drop (94.32%) and minimum fruit retention (5.68%). Gibberellic acid causes the production of a larger number of flowers with rapid elongation of the peduncle, leading to the full development of flower buds having all reproductive parts functional leading to increased fruit set and fruit retention thus also minimizing fruit drop. It may be owing to the application of boron which enhances pollen germination, and pollen tube growth causing low fruit drop thereby increasing fruit retention. The results of current study are in conformity with the findings of Maurya *et al.* (2020) and Tripathi and Kumar (2022) in Mango, Tripathi and Shukla (2010) in Strawberry and Tripathi *et al.* (2018) in aonla.

Physical parameters:

Fruit length and width (cm). The maximum fruit length (11.66 cm) and width (7.16 cm) of fruit were recorded with the foliar spray of GA_3 40ppm + Borax 0.4% (T_8) followed by 11.32cm length and 7.03cm width, which were found with the combined application of GA_3 40ppm + Borax 0.2% (T_6). The plants kept under control showed a minimum length (7.96 cm) and width (4.32 cm) of fruit (Table 1). The application of GA_3 and boron in the present investigation was found to maximize the fruit size (*i.e.*, length and width), may be due to accelerated rate of transportation of photosynthates from the leaf to the developing fruits. Since boron plays an important role in nitrogen metabolism and cell division and cell enlargement, which ultimately might have increased the fruit size of fruits. These findings are in agreement with Bhowmick and Banik (2011) in Mango.

Fruit weight (g): The maximum fruit weight (243.32g) was gained which were plants treated with foliar spray of GA_3 40ppm + Borax 0.4% (T_8) followed by 236.36g fruit weight was recorded with the application of GA_3 40ppm + Borax 0.2% (T_6). The plant under control (T_9) showed minimum fruit weight *i.e.*, 170.76g (Table 1). The application of GA_3 and boron in the present study maximized average fruit weight by accelerating the transportation of photosynthates from the leaf to the developing fruits. Since boron plays an important role in nitrogen metabolism and cell division and cell enlargement, it might have increased the fruit size and thus resulted in increased average fruit weight. Similar results have been reported by Maurya *et al.* (2020); Tripathi and Kumar (2022); Kumar *et al.* (2018); Sarkar and Ghosh (2004) in Mango.

Fruit yield (kg/tree). Plants which are treated with the combination of GA_3 40ppm + Borax 0.4% produced maximum fruit yield (57.14kg/tree) followed by the combined application of GA_3 40ppm + Borax 0.2%, which gave fruit yield of 54.73kg/tree. The plants kept under control showed a minimum fruit yield of

40.64kg/tree (Fig. 1). The spike in fruit production brought on by pre-harvest applications of growth promoters like GA_3 and boron on plant leaves may be attributed to previously, more luxuriant vegetative growth, which later contributes to the synthesis of more metabolites for developing fruits. The significance of these plant bio-regulators and micronutrients in enhancing physiological functions, which improve fruit retention and fruit weight ultimately increased fruit yield. Similar findings were reported by Sarkar and Ghosh (2004); Tripathi and Vivekanand (2022) in aonla and Bhowmick and Banik (2011) in Mango.

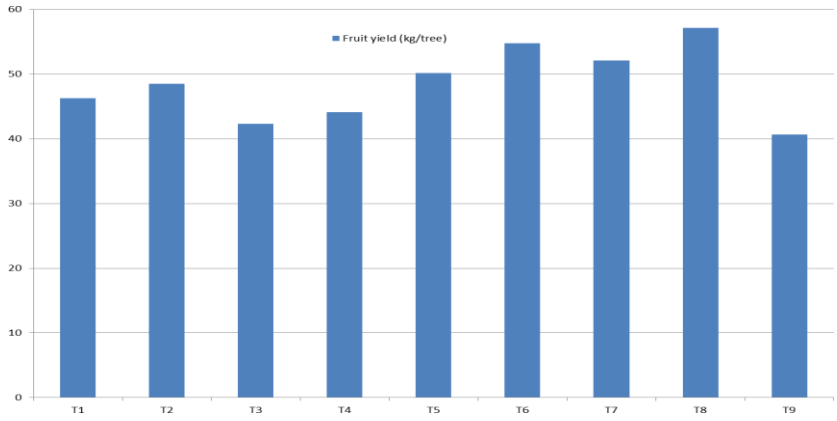

Fig. 1. Influence of pre-harvest application of Gibberellic acid and Borax on Fruit yield (kg/tree).

Fruit volume(cc): Significantly maximum fruit volume (240.91cc) was recorded with the foliar spray of GA_3 40ppm + Borax 0.4% (T_8) followed by GA_3 40ppm + Borax 0.2% which produced fruit volume of 235.01cc (Table 1), whereas, the minimum (179.32 cc) fruit volume was recorded in the fruits which were produced from the plants kept as control (T_9). This increase in the volume of fruits might be due to the direct involvement of GA_3 and boron in growth and indirectly through more accumulation and translocation of food materials causing an increase in the size of fruits. Similar results have been reported by Beerappa *et al.* (2019); Pomegranate and Pal *et al.* (2008) in Guava.

Fruit pulp, peel and stone (%): Observations recorded on fruit pulp, peel and stone percent clearly shows that the combination of GA_3 40ppm + Borax 0.4% resulted in a significantly increased in pulp (72.32%), reduction in peel (16.64%) and stone (11.04%) in fruits (Table 2), whereas, the minimum fruit pulp (63.21%) and maximum peel and stone (21.71%and 15.08%, respectively) were recorded in the fruits which were produced from the plants kept under control (T_9) treatment. The application of GA_3 and boron helped in maximizing the fruit pulp and minimizing the peel and stone percent by accelerating the transportation of photosynthates from the leaf to the developing fruits. The results given by Maurya *et al.* (2020); Tripathi and Kumar (2022); Shrivastava and Jain (2006) in Mango are in agreement with the present findings.

Biochemical parameters:

Total soluble solids (°B) and total sugars (%). Significantly maximum TSS (22.08°Brix) and total sugars (21.08%) contents were recorded with the combined application of GA_3 40ppm + Borax 0.4% followed by 21.86°Brix and 20.85%, respectively with the application of GA_3 40ppm + Borax 0.2% (Fig. 2 and Table 2), while minimum TSS and total sugars (18.82°Brix and 17.62%) were recorded in the fruits which were produced from the plants kept as control. This increase in TSS and total sugars might be due to the increase in mobilization of carbohydrates from the source to sink (fruits) by auxin which may be attributed to the fact that application of GA_3 and Boron might have increased α-amylase activity and thus there was a conversion of starch into sugars and hence improved total soluble solids content. Similar findings have been obtained by various researchers such as Tsomu and Patel (2019) in Mango cv. Mallika, Tripathi *et al.* (2018); Shukla *et al.* (2011) in Aonla and Gupta *et al.* (2022) in Litchi.

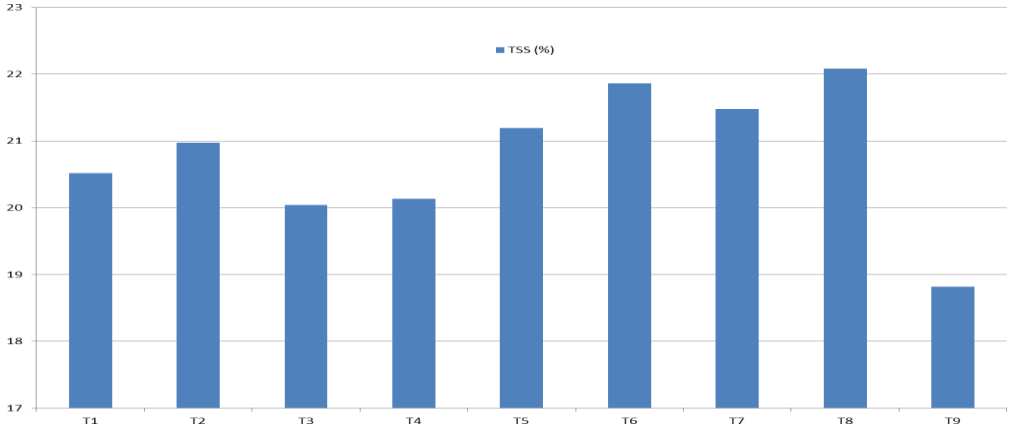

Fig. 2. Influence of pre-harvest application of Gibberellic acid and Borax on Total soluble solids (°Brix).

Titratable acidity (%): The lowest titratable acidity (0.40%) was obtained in fruits produced from the plants treated with the combined application of GA_3 40ppm + Borax 0.4% (T_8) followed by 0.41% titratable acidity which was recorded in GA_3 40ppm + Borax 0.2%(T6) treated plants, whereas, the maximum titratable acidity (0.60%) was recorded in the fruit produces from the plants kept as untreated plants (Table 2). The role of growth regulators in decreasing the titratable acidity of fruits might be either due to the conversion of sugar and their derivatives by a reaction involving reverse glycolytic pathway or its utilization in respiration or both which may be held responsible for reducing acidity. Similar findings have been obtained by various researchers such as Kumar *et al*. (2023) and Kumar *et al*. (2022) in Phalsa.

Ascorbic acid(mg/100ml): Significantly maximum (34.96mg/100ml) ascorbic acid was recorded with the foliar application of GA_3 40ppm + Borax 0.4% (T_8) followed by GA_3 40ppm + Borax 0.2% (T_6) which showed 35.02mg/100ml (Table 2) of ascorbic acid, whereas, the minimum ascorbic acid (28.64 mg/100ml) was obtained from untreated plants kept under control treatment (T_9). This increase in ascorbic acid content may have resulted in enhanced synthesis of ascorbic acid due to favourable metabolic activity involving certain enzymes and metallic ions under the influence of plant growth regulators like GA_3 and micronutrients such as boron. An increase in ascorbic acid content might be due to the perpetual synthesis of glucose-6-phosphate throughout the growth and development of the fruits which is thought to be the precursor of vitamin C. Similar findings have been obtained by various researchers such as Dubey *et al*. (2017) in strawberry cv. Chandler and Kumar *et al.* (2018) in mango cv. Amrapali.

Table 1: Influence of pre-harvest application of Gibberellic acid and Borax on fruit drop, retention and yield characters of mango cv. Dashehari.

Treatments	Number of fruits/panicle (%)	Fruit drop (%)	Fruit retention(%)	Fruit length(cm)	Fruit Width(cm)	Fruit weight (g)	Volume of fruit (cc)
T_1-GA_3 20 ppm	6.60	88.41	11.59	10.23	6.31	201.34	206.93
T_2-GA_3 40 ppm	6.72	88.04	11.96	10.50	6.43	208.61	213.14
T_3-Borax (0.2 %)	6.22	92.21	7.79	9.80	5.98	188.04	195.36
T_4-Borax (0.4 %)	6.38	91.02	8.98	10.01	6.04	192.36	200.24
T_5-GA_3 20 ppm + Borax (0.2 %)	6.84	87.88	12.12	10.92	6.59	216.32	220.16
T_6-GA_3 40 ppm + Borax (0.2 %)	7.06	86.14	13.86	11.32	7.03	236.36	235.01
T_7-GA_3 20 ppm + Borax (0.4 %)	6.96	87.24	12.76	11.03	6.97	223.46	225.57
T_8-GA_3 40 ppm + Borax (0.4 %)	7.14	85.06	14.94	11.66	7.16	243.32	240.91
T_9-control *i.e.,* water spray	5.40	94.32	5.68	7.96	4.32	170.76	179.32
S.E.(m)+	0.11	1.24	1.24	0.13	0.13	2.89	4.05
C.D. (5%)	0.33	3.72	3.72	0.39	0.38	8.67	12.15

Table 2: Influence of pre-harvest application of Gibberellic acid and Borax on fruit quality characters of mango cv. Dashehari.

Treatments	Fruit pulp (%)	Fruit Peel (%)	Fruit Stone (%)	Total Sugars (%)	Titratable acidity(%)	Ascorbic acid (mg/100ml)
T_1-GA_3 20 ppm	68.02	18.85	13.13	19.41	0.51	32.04
T_2-GA_3 40 ppm	68.63	18.39	12.98	19.87	0.50	32.46
T_3-Borax (0.2 %)	65.67	20.28	14.05	18.91	0.53	30.87
T_4-Borax (0.4 %)	66.42	19.82	13.76	19.01	0.52	31.67
T_5-GA_3 20 ppm + Borax (0.2 %)	70.91	17.02	12.07	20.24	0.45	33.32
T_6-GA_3 40 ppm + Borax (0.2 %)	72.04	16.70	11.26	20.85	0.41	34.02
T_7-GA_3 20 ppm + Borax (0.4 %)	71.88	16.76	11.36	20.46	0.42	33.71
T_8-GA_3 40 ppm + Borax (0.4 %)	72.32	16.64	11.04	21.08	0.40	34.96
T_9-control *i.e.,* water spray	63.21	21.71	15.08	17.62	0.60	28.64
S.E.(m)+	1.23	0.31	0.15	0.28	0.006	0.64
C.D. (5%)	3.69	0.93	0.45	0.82	0.019	1.91

CONCLUSIONS

Based on the findings of the present investigation, we can conclude that foliar spray of Gibberellic acid and borax on mango fruit crop resulted in significant improvement of flowering and fruiting behaviour of mango fruits which ultimately leads to physical and biochemical attributing parameters of mango. The higher concentration of plant growth regulators (40 ppm GA_3) and micronutrients (0.4% Borax) in combination is more effective than the lowest doses of the remaining treatments.

FUTURE SCOPE

The use of plant bio-regulators and micro-nutrients plays a significant part in increasing the yield of quality fruits with the reduction in fruit drop along with increased fruit retention. Since mango is an important fruit crop all over the world, that's why in the future, more studies can be carried out on other cultivars alone or in the combination of both *i.e.,* plant bio-regulator and micro-nutrients on more parameters to standardize doses specific to the particular regions.

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Conflict of Interest. None.

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