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Effect of Plant Growth Regulators on Fruit Yield and Fruit Quality of Mango (*Mangifera indica* L.) cv. Amrapali

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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

An experiment on "Effect of Plant growth regulators on fruit yield and fruit quality of Mango (*Mangifera indica* L.) cv. Amrapali" was conducted at the research plot, College of Horticulture, Chiplima during the year 2020-21 by using Randomized Block Design with three replications and ten treatments. Three concentrations of NAA i.e. 10, 20 and 30 ppm, three concentrations of GA_3 i.e. 10, 20 and 30 ppm and three concentrations of 2,4-D i.e. 10, 20 and 30 ppm were applied at pea and marble stage of fruit. Research work was held on 07 years old plants of mango cv. Amrapali. Highest fruit weight (263.21g), and total yield of 18.34 kg per plant were recorded under T_7. The minimum yield (4.41 kg per plant) was recorded under T_1 (Control). The highest number of fruits per plant(69.67) and fruit yield (18.34 kg per plant) was recorded under treatment T_7 (30 ppm foliar application of GA_3). The maximum TSS: acid ratio (115.81) was obtained with T_{10} (30 ppm

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concentration of 2,4-D) which was known to be superior from all other treatments. The minimum TSS: acid ratio (55.00) was estimated under T_1. Ascorbic acid content of mango cv. Amrapali ranged from 39.34 mg/100g (T_{10}) to 55.97 mg/100g (T_1). The highest total sugar content (14.99 %) was estimated in T10 (2,4-D at 20 ppm) while the lowest total sugar content (10.42 %) was estimated in T1 (Control). T10 (30 ppm foliar applications of 2,4-D) showed maximum ascorbic acid content (55.97 mg/100g), while lowest (39.34 mg/100 g) was recorded under T1 (Control). It is concluded that the foliar application of 30 ppm GA3 (Gibberellic acid) and 30 ppm 2,4-D were found to be optimum concentrations which showed best results by increasing yield and fruit quality of mango cv. Amrapali.

Keywords: Mango; amrapali; yield; quality.

1. INTRODUCTION

Mango (*Mangifera indica* L.) belongs to Anacardiaceae family, is cultivated in the Indian subcontinent for well over 4000 years [1] and has been recognized as the 'King of fruits'. India is the major producer in the world with an area of 2.262 Million hectares with annual production 19.686 Million tonnes and productivity of 8.7 Metric tonnes/ha. It is an excellent source of vitamin A (4800 I.U.) and vitamin C (13 mg/100mg) and the fruit is utilized at all stages of its development both in its immature and mature or ripe stage and can also be processed into products such as jam, juice, cut fresh fruit, dried chips, fruit concentrate and fruit leather etc. Amrapali is a mango hybrid (Dashehari X Neelum), gaining popularity for its dwarf stature and regular bearing habit. Fruits are green, apricot yellow, medium sized, sweet in taste with high T.S.S. The soil and climate of Odisha is very much congenial for cultivation of mango. It enjoys the climate advantage of growing of both North and South Indian varieties successfully. More than 300 mango varieties exist in the state of Odisha. One of the most important bottleneck in the production of mango is the heavy drop of fruits (99.9%) during different developmental stages.

There are several causes of fruit drop including unfavourable climatic conditions, poor fruit set, competition between developing fruitlets, drought or lack of irrigation, nutrient deficiency, incidence of serious pests and diseases (Majumder and Sharma, 1990). Foliar sprays of growth regulators (NAA, GA_3 and CPPU) could be used as one of these horticultural practices that reduce fruit drop and enhance the yield. The plant growth regulators positively affected yield attributing properties like fruit size and fruit weight of mango [2,3]. The yield contributing characters due to foliar application of 35 ppm GA_3 at the pea and marble stages of fruit production increased fruit retention, decreased fruit drop, and resulted in the highest number of fruits and total yield [4]. Fruit quality at harvest depends on the combined effect of energy, water and flow in and out of the fruit. The fruit quality can be improved by application of various chemicals and plant growth regulator at certain period before harvesting of fruits for proper maintaining the balance of nutrient in the fruit so that fruit quality and shelf life could be maintained for longer duration after harvest [5].

To achieve higher yield and quality of mango so many factors are responsible viz. TSS, Acidity, Sugars, Ascorbic acid, pulp percentage, Shelf life etc. All these attributes in response to so many pre harvest practices, the application of plant growth regulator play important role, but the exact information about the specific plant growth regulator and its concentration is lacking. The information about effect of plant growth regulators on enhancing fruit yield, fruit quality and shelf life of Amrapali variety of mango grown in West Central Table Land Zone of Odisha is meager [6,7]. Looking at all the above aspects, the present investigation was taken up to study the "Effect of plant growth regulators on fruit yield, fruit quality and shelf-life of Mango (*Mangifera indica* L.) cv. Amrapali' at Research plot, College of Horticulture, Chiplima.

2. MATERIALS AND METHODS

The present investigation on "Effect of plant growth regulators on fruit yield, fruit quality of Mango (*Mangifera indica* L.) cv. Amrapali" was conducted at the research plot, College of Horticulture, Chiplima, Sambalpur, Odisha University of Agriculture and Technology which is situated about 20 kms away from famous Hirakud Dam during the year 2020-2021. It lies in between 20° 21' N latitude and 80° 55' longitudes and has altitude of 155 m (above mean sea level).The soil of the experimental site is sandy

loam having pH (5.22), electrical conductivity (0.11 dS/m) and organic carbon content of 0.65%. The climate of the site is characterized by warm and semi dry with hot and dry summer and mild winter. The trial was conducted in mango var. Amrapali with 10 treatments replicated thrice in randomized block design. The plants were spaced at 5m X 5m. The treatment details are : T_1 Control (Water spray), T_2 NAA(10 ppm), T_3 NAA(20 ppm), T_4 NAA(30 ppm), T_5GA_3(10 ppm), T_6 GA_3(20 ppm), T_7 GA_3(30 ppm), T_8 2,4-D (10 ppm), T_9 2,4-D (20 ppm) and T_{10} 2,4-D (30 ppm).

For the preparation of the stock solution, an electronic balance was taken and the necessary amount of GA_3, NAA, and 2,4-D was weighed with the aid of the electronic balance. The desired amount of 2,4-D and GA_3 were dissolved in 10 ml of 99 percent absolute ethyl alcohol, but NAA was dissolved in a few drops of NH_4OH to prevent precipitation. The final volume was then increased to 1 litre by adding distil water. This solution was used as a stock solution and desired quantities were taken from it, and concentration was achieved by adding distilled water. Treatment wise the plant growth regulators were sprayed twice on 2nd March and 1st April of 2021 from 9.00 a.m. to 2.00 p.m. At the pea stage and marble stage of fruit growth, different concentrations of NAA, GA_3 and 2,4-D were sprayed. The solutions were sprayed on the fruit and foliage as per their recommendation. Intercultural operations were carried out during field preparation. All weeds around the plant were cleared by hand weeding and shallow hoeing in the pre monsoon season and it was done again in the months of September and October (post monsoon season).The plants were irrigated during fruit development stage at regular interval.

The mature uniform sized and fresh mango fruits of Amrapali per tree were harvested starting from last week of May to 2nd week of June. At each harvest, the total number of fruits per plant was counted. After the completion of harvesting, the total number of fruits per plant was calculated. The weight of fruits per plant was reported separately at each harvest. The total weight of harvested fruit was then measured in kilogram at the final harvest. The yield was calculated by multiplying the number of fruits per plant with average fruit weight and expressed as kg per plant. The weight of pulp was determined by subtracting the weight of the stone and peel from the weight of the whole fruits. The data pertaining to fruit size, fruit weight, fruit volume, pulp weight, peel weight, stone weight, TSS, sugars, acidity, ascorbic acid and shelf-life recorded during the experiment were statistically analyzed and presented with tabulation and graphical representation.

The Total soluble solid was determined using a digital refractometer and expressed in terms of degree Brix (^{0} Brix). The titratable acidity and reducing sugar present was calculated using the following formula given by [8]. The ascorbic acid content was measured by the standard method [9]. The shelf life of ten fruits per treatment was recorded by keeping the fruits at room temperature i.e. ambient storage condition. Shelf life of fruit was considered as number of days from harvesting to marketable fruits or optimum eating stage (till the decaying of fruits started. The statistical analysis of the data recorded was done according to the standard procedures given for Randomized Block Design by Panse and Sukhatme [10].

3. RESULTS AND DISCUSSION

After application of different concentrations of plant growth regulators at pea and marble stage of fruit growth and development, observations recorded on number of fruits per plant, fruit yield, physico-chemical characterstics and shelf-life at 30, 60 and 90 days after spraying are recorded. The results revealed that there were significant variation with respect to various yield and yield attributing parameters during the study period (Table 1). The fruit size (fruit length of 11.51 cm and fruit breadth of 7.20 cm) was observed highest in T_7 (GA_3 at 30 ppm) and lowest (fruit length of 9.21 cm and fruit breadth of 5.97 cm) in T_1 (Control). The probable reason might be due to the fact that exogenous application of GA_3 increases cell size of mesocarp, which also accelerated the fruit growth and fruit size. GA_3 increases cell plasticity which caused cell elongation by loosening of cell wall and enlargement of vacuoles. This result corroborate the findings of Vishwakarma et al. [11] who obtained maximum fruit size in mango cv. Amrapali with application of GA @25 mg/l, Moneruzzaman et al. [12] who obtained higher fruit size in Wax apple and Singh et al. [13] and Debnath et al. [14] who noticed enhanced fruit size in Phalsa due to application of GA_3 at 20 ppm.

Among the various concentrations of different plant growth regulators, foliar application of (30 ppm of GA_3) i.e. T_7 gave maximum number of

fruits per plant (69.67) while lowest number of fruits per plant (21.67) was obtained in T_1 (Control) (Table 1). GA_3 increases number of fruits by inhibiting vegetative growth and enhancing better flowering, fruit set and ultimately maximize fruit retention and also plays an effective role in translocating extra metabolites towards the reproductive parts or sink i.e. fruits. The observations were similar with the observations of Osama et al. [15] and Kulkarni et al. [16] in mango. The fruit yield was enhanced by all concentrations of different plant growth regulators compared with control. The treatment T_7 (30 ppm foliar application of GA_3) showed maximum yield (18.34 kg/plant) of fruits, whereas minimum fruit yield (4.41 kg/plant) was obtained in T_1 (Control). The significant increase in fruit yield is a cumulative effect of increase in number of fruits because of reduction in fruit drop and higher fruit weight by the direct and indirect effect of foliar application GA_3.The plant growth regulators positively affected yield attributing properties like fruit retention, fruit size and fruit weight of mango cv. Amrapali which might be responsible for enhanced yield. Foliar spray of GA_3 might also have affected the physiological processes resulting into higher production of mango. These results are in conformity with the finding of Bezerra et al. [17], Nkansh [18] and Ghosh [19] and Dheeraj et al. [20] in mango.

The mango plant sprayed with various concentrations of plant growth regulators had increased the fruit weight and fruit volume as compared to control. Maximum fruit weight (263.21 g) and fruit volume (256.32 ml) were obtained under T_7 (30 ppm foliar application of GA_3) while lowest fruit weight (202.77 g) and fruit volume (194.66 ml) were obtained under T_1 (Control). Any increase in length, and breadth of the fruit brought a corresponding increase in weight of fruit. This result accepted the hypothesis that, the fruit weight is a function of length and fruit breadth of fruit. The possible explanation for increase in fruit size and fruit weight was also due to faster movement of simple sugars into fruit and involvement in cell expansion [21]. The appropriate reason behind the increased fruit weight and fruit volume might be due to accumulation of more sugar and water under the influence of exogenous application of growth promoting substances. The role of GA_3 was to multiply and to lengthen the meristem cells, which resulted in the increase of fruit volume. Similar observation was also reported by Kulkarni et al. [16] who obtained higher fruit weight and fruit volume by foliar application of GA_3 as compared to control in mango.

The specific gravity (1.042) was recorded highest under T_1 (Control) and lowest (1.023) under T_{10} (2,4-D at 30ppm). For judging maturity of mango fruits, specific gravity holds a good index. In the present investigation, specific gravity of mango fruit was not affected by various concentrations of plant growth regulators. Among the various treatments, there are no significant differences observed with respect to specific gravity in different cultivars of mango.

Table 1. Effect of plant growth regulators on fruit yield, fruit size and specific gravity of Mango cv. Amrapali

Treatment	Fruit weight (g)	Number of harvested fruits per plant	Yield (Kg/ Plant)	Fruit length (cm)	Fruit volume (ml)	Fruit breadth (cm)
T_1- Control	202.77	21.67	4.41	9.21	194.66	5.97
T_2 - NAA(10 ppm)	241.78	39.67	9.60	10.43	233.00	6.51
T_3- NAA(20 ppm)	213.22	68.33	14.57	10.66	205.00	6.64
T_4-NAA(30 ppm)	236.84	64.67	15.31	11.34	228.48	6.76
T_5-GA_3(10 ppm)	204.37	31.67	6.47	10.74	197.40	6.54
T_6-GA_3(20 ppm)	258.45	67.00	17.31	11.42	249.66	7.12
T_7-GA_3(30 ppm)	263.21	69.67	18.34	11.51	256.32	7.20
T_8-2,4-D (10 ppm)	206.08	59.33	12.22	10.17	199.62	6.38
T_9-2,4-D (20 ppm)	225.67	63.33	15.64	10.02	219.33	6.41
T_{10}-2,4-D (30 ppm)	232.98	69.00	16.07	10.85	227.67	6.28
SE(m) $\pm$	9.52	9.90	2.59	0.45	9.16	0.23
C.D. at 5 %	27.55	28.64	7.49	1.31	26.50	0.67

Table 2. Effect of plant growth regulators on stone weight, peel weight and pulp weight of Mango cv. Amrapali

Treatments	Stone weight (g)	Peel weight (g)	Pulp weight(g)	Stone (%)	Peel (%)	Pulp (%)
T_1- Control(Water spray)	34.04	45.55	123.19	16.76	22.47	60.77
T_2 - NAA(10 ppm)	37.30	40.06	164.41	15.48	16.48	68.04
T_3- NAA(20 ppm)	34.28	35.73	143.21	16.06	16.70	67.24
T_4-NAA(30 ppm)	34.12	36.46	166.27	14.44	15.44	70.12
T_5-GA_3(10 ppm)	30.64	40.81	132.92	15.47	19.79	64.75
T_6-GA_3(20 ppm)	41.42	41.11	175.92	15.99	15.99	68.02
T_7-GA_3(30 ppm)	35.43	55.13	172.65	13.62	15.84	70.54
T_8-2,4-D (10 ppm)	32.94	34.82	138.31	15.98	16.93	67.09
T_9-2,4-D (20 ppm)	32.81	39.34	153.52	14.58	17.30	68.12
T_{10}-2,4-D (30 ppm)	31.65	36.88	164.44	13.50	20.99	65.52
SE(m) $\pm$	NS	3.74	6.41	NS	1.14	1.60
C.D. at 5 %	NS	10.82	18.53	NS	3.31	4.63

The treatment T_7 (GA_3 at 30ppm) exhibited maximum average peel weight (55.13 g), while lowest average weight of peel (34.82 g) was obtained under T_8 (10 ppm foliar application of 2,4-D) as evident from the data depicted in Table 2. The data on average peel weight revealed that foliar application of plant growth regulators showed significant effect on peel weight of mango fruit. The results revealed that the stone weight of fruit was not significantly influenced with various concentrations of the plant growth regulators. The T_7 (GA_3 at 30 ppm) represented maximum stone weight, while minimum stone weight was found under T_5 (GA_3 at 10 ppm). The increase in peel weight could be attributed to the fact that enhancement of fruit size might resulted in increase in peel weight. It is in conformity with the results of Shrivastava and Jain [22] and Merwad et al. [23] in mango. The pulp weight was observed to be highest (175.92 g) in T_7 i.e. with the application of 30 ppm GA_3, while lowest pulp weight (123.19 g) was obtained in T_1 (Control). Increased pulp content of fruit might be due to higher accumulation and translocation of extra metabolites from other part of the plants towards developing fruits. However, Ruby et al. (2004) obtained maximum pulp weight by foliar application of GA_3 at 100 ppm. Gibberelic acid stimulated the functioning of a number of enzymes in the physiological process which probably caused an increase in pulp weight. The results were also in accordance with the findings of Shrivastava and Jain [22] in mango and Meena et al. [24] in aonla.

3.1 Quality Parameters

Fruit quality is mainly judged by the balance between total soluble solids and acidity present in the fruit. Amongst the different treatments, the maximum total soluble solids (18.53°) was found in T_{10} (30 ppm 2,4-D) in comparison to rest of treatments and control (Table 3). Total soluble solids (TSS) determine the quality and consumer preference. The enhancement in quality of fruit could be due to the catalytic action of 2,4-D particularly at higher concentration. The foliar application of plant growth regulators like 2,4-D quickly increased the uptake of macronutrients in the tissues and parts of the mango plants, decreased the nutritional deficiencies and thereby improved the fruit quality. The increase in TSS content of fruits might be due to the fact that the application of plant growth regulators enhances the hydrolysis of polysaccharides into soluble solids and also increased mobilization of carbohydrate from source to sink. By foliar applications of plant growth regulators the activity of cytoplasmic sucrose phosphate synthase, a key enzyme regulating the pool size of sucrose in the leaf shown to be stimulated and also promotes phloem loading. Similar result pertaining to higher TSS due to application of plant growth regulators like 2,4-D were also obtained by Taduri et al. [25] and Parauha [26] in Amrapali variety of mango.

The highest acidity (0.26%) content was registered under T_1 (Control) and minimum acidity (0.16%) was observed under T_{10} (30ppm foliar application of 2,4-D). The data revealed that the foliar application of plant growth regulators significantly influenced the acidity percentage of mango fruit. Transformation of organic acids to sugars is one of the reasons for decrease in acidity during fruit maturity and ripening (Badhe et al. 2007).Present investigation showed that there was a general

trend of decreasing acidity percentage in various concentrations of plant growth regulators as compared to control. As mango is a climacteric fruit, acidity percentage of mango decreases due to conversion of acid into sugar and their utilization as respiratory substrate during the period of growth and development of fruit. This result is in conformity with the findings of Painkra (2008) who obtained minimum acidity with foliar application of 2,4-D at 10 ppm in mango var. Langra. The TSS: acid ratio plays an important role in determining the quality of the fruit. The TSS: acid ratio was recorded highest (115.81) in T_{10} (2,4-D at 30 ppm) while it was lowest (55.00) in T_1 (Control). The highest TSS: acid ratio obtained under treatment T_{10} is due to highest TSS (18.53 ^{0}Brix) and lowest acidity (0.16%) content. Higher TSS: acid ratio in fruit from 2,4-D treated plants is probably due to enhancement in the level of TSS and corresponding decrease in acidity content. Similar results were obtained by Sharma et al. [27] in litchi (Table 3).

Table 3. Effect of plant growth regulators chemical parameters on quality parameters in Mango cv. Amrapali

Treatment	TSS (^{0}Brix)	Acidity (%)	TSS: acid ratio	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	Ascorbic acid (mg/100g)
T_1- Control	14.30	0.26	55.00	10.42	4.91	5.23	39.34
T_2 - NAA(10 ppm)	15.67	0.19	82.47	11.66	4.93	6.39	44.30
T_3- NAA(20 ppm)	14.70	0.23	63.91	10.59	5.03	5.29	41.22
T_4-NAA(30 ppm)	16.07	0.20	80.35	12.19	5.80	6.08	42.76
T_5-GA_3(10 ppm)	14.90	0.24	62.08	11.20	4.97	5.91	43.19
T_6-GA_3(20 ppm)	17.77	0.21	84.61	13.88	5.32	8.13	43.95
T_7-GA_3(30 ppm)	18.50	0.17	108.82	14.81	6.18	8.19	47.54
T_8-2,4-D (10 ppm)	16.13	0.19	84.89	12.57	4.75	7.43	45.13
T_9-2,4-D (20 ppm)	17.77	0.18	98.72	14.23	5.77	8.04	46.15
T_{10}-2,4-D (30 ppm)	18.53	0.16	115.81	14.99	6.35	8.21	55.97
SE(m) ±	0.76	0.02	5.21	0.68	NS	0.57	1.25
C.D. at 5 %	2.21	0.04	15.07	1.96	NS	1.66	3.62

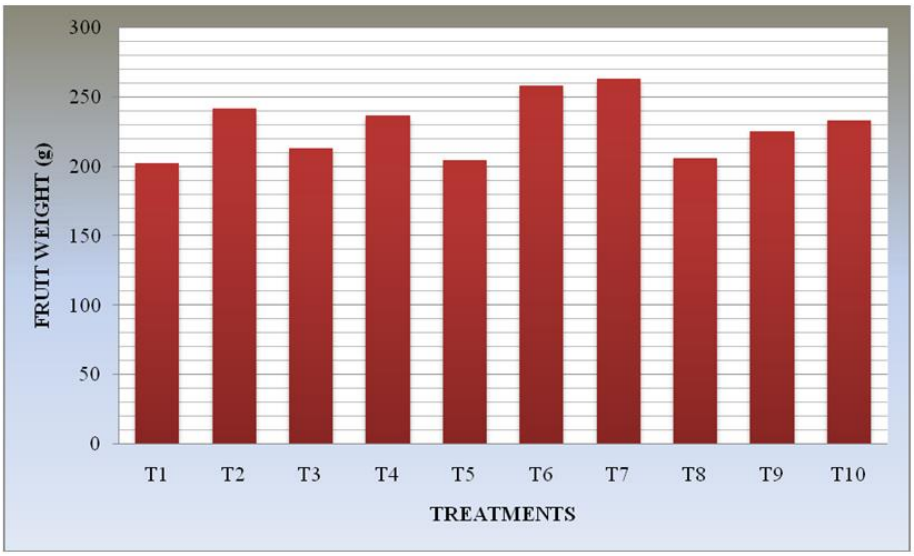

Fig. 1. Fruit weight (g) as influenced by foliar spray of plant growth regulators in mango cv. Amrapali

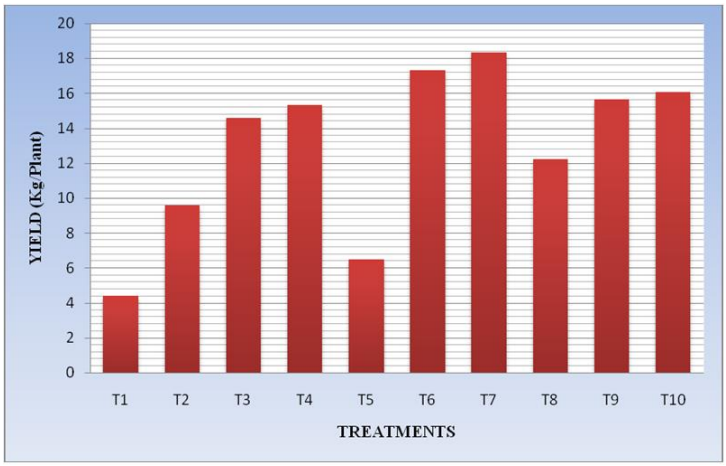

Fig. 2. Fruit yield (kg/plant) as influenced by foliar spray of plant growth regulators in mango cv. Amrapali

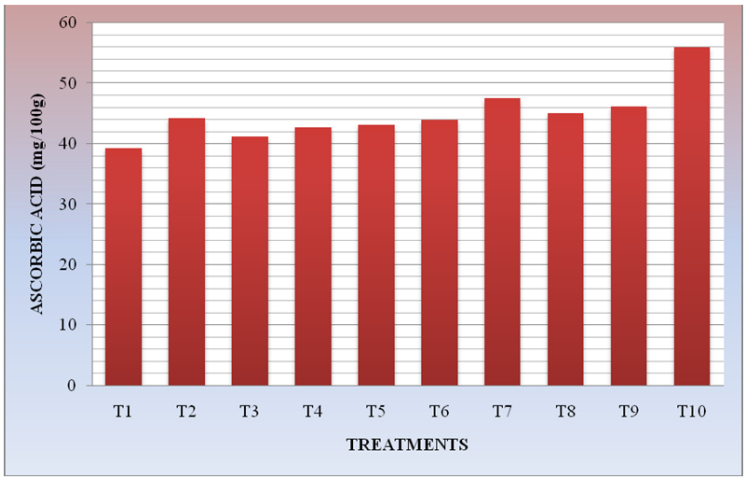

Fig. 3. Ascorbic acid (mg/100g) as influenced by foliar spray of plant growth regulators in mango cv. Amrapali

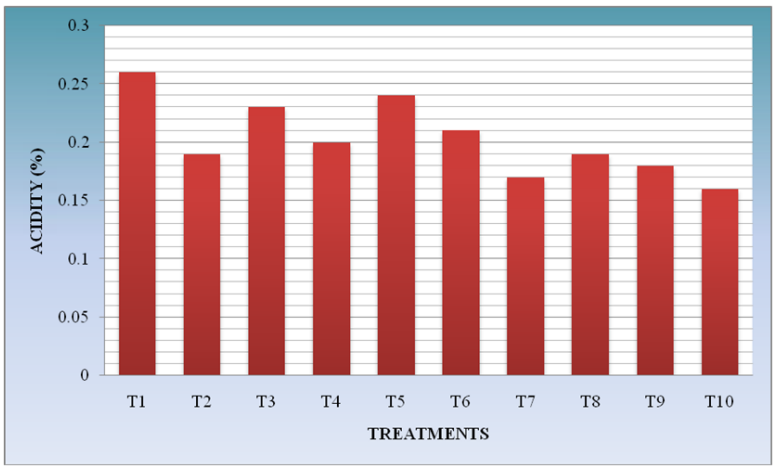

Fig. 4. Acidity (%) as influenced by foliar spray of plant growth regulators in mango cv. Amrapali

Plate 1. Field view of the experiment

Plate 2. T_7 at Harvest maturity stage

Plate 3. Measurement of fruit length by using a digital slide caliper

Plate 4. Fruit samples in T_1

Plate 5. Fruit samples in T_7

Plate 6. Fruit samples in T_{10}

The total sugar content was enhanced by various concentrations of plant growth hormones as compared to T_1 (Control). The highest total sugar content (14.99 %) was estimated in T_{10} (2,4-D at 20 ppm) while the lowest total sugar content (10.42 %) was estimated in T_1 (Control). Treatments like T_7 (14.81 %), T_9 (14.23 %) and T_6 (13.88 %) were found to be significantly at par with T_{10} with respect to total sugar content. The sugar content might be increased due to degradation of polysaccharides into simple sugars by metabolic activities, conversion of organic acids into sugars, and loss of moisture which subsequently increases total soluble solids. This is in consonance with the findings of Nawaj et al. (2008) who reported higher total sugar, reducing and non-reducing sugar content in Kinnow mandarin with foliar spray of 2,4-D at 10 ppm. The reducing sugar content was not significantly enhanced by various concentrations of plant growth regulators as compared to T_1 (Control).

Present investigations showed that, T_{10} (30 ppm foliar applications of 2,4-D) showed maximum ascorbic acid content (55.97 mg/100g), while lowest (39.34 mg/100 g) was recorded under T_1 (Control). Increased ascorbic acid content might be due to synthesis of glucose-6-phosphate throughout the growth and development of fruits, which is known as the precursor of vitamin C. However, Wahdan et al. [28] obtained higher ascorbic acid content with application of 40 ppm GA_3 in mango cv. Succary Abiad.

4. CONCLUSION

The foliar application of 30 ppm GA_3 at pea and marble stage of mango fruit significantly enhanced the number fruits per plant and thereby maximize the total fruit yield. The average fruit size, average fruit weight, peel weight, pulp weight and fruit volume of mango cv. Amrapali were also observed to be enhanced by foliar application of GA_3 at 30 ppm. Different fruit quality parameters like total soluble solids (TSS), reducing sugar, non-reducing sugar, total sugar, TSS: acid ratio and ascorbic acid content were enhanced with foliar application of 30 ppm 2,4-D whereas, acidity of fruit was found to be minimum with the spray of 30 ppm 2,4-D. By all investigations it can be concluded that the foliar application of 30 ppm GA_3 (Gibberellic acid) and 30 ppm 2,4-D (2,4 dichlorophenoxy acetic acid) were found to be optimum concentrations which showed best results by increasing yield and fruit quality of mango cv. Amrapali. This result in accordance with the findings of Singh et al. [29] who reported that foliar application of GA3 affected the performance of the trees by amending their flowering, fruit yield & quality of mango. Experiments were conducted to check the fruit quality, change in flowering pattern and fruit set of mango trees. Basically GA3 at a concentration of 10-75 ppm increases the fruit set, respectively.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Candolle De. Origin of cultivated plants. Vegal Paul Trench and company London.1904:1-67.
2. Gaikawad GB, Nainwad RV. Effect of plant growth regulators and chemicals on quality of mango (*Mangifera indica* L.) var. Kesar. The Pharma Innovation Journal. 2022; 11(9):2892-2893.
3. Nawaz MA, Ahmad W, Ahmad S and Khan MM. Role of growth regulators on preharvest fruit drop, yield and quality in Kinnow mandarin. Pakistan Journal of Botany. 2008;40(5):1971-1981.
4. Sahu C, Sharma HG and Panigrahi HK. Effect of plant growth regulators on fruit retention and fruit drop of mango (*Mangifera indica L*.) cv. Dashehari. International Journal of Science and Research. 2020;9(4):1165-1167.
5. Bisen S, Thakur RS. Beneficial effects of pre-harvest application calcium nitrate and gibberellic acid on storage behaviour of guava fruits. Jawahar Lal Nehru Krishi vishwa Vidyalaya Research Journal. 2012;46(3):322-327.
6. Patel U, Varu DK, Chaudhari J. Effect of pre-harvest spray of chemicals on shelflife and quality of mango cv. Kesar. The Asian Journal of Horticulture. 2015;10(2): 187-193.
7. Shainika SK, Tambe TB. Effect of plant growth regulators and micronutrients on flower and fruit retention in mango (*Mangifera indica* L) CV. Kesar. International Journal of Chemical Studies. 2020;8(4):3716-3719.

8. Ranganna S. Manual of Analysis of Fruit and Vegetable Products, 2nd Edition, Tata Mc Graw Hill Publishing Company Ltd., New Delhi; 1977.
9. AOAC. Official methods of analytical chemist, International, 17th Edition. Washington D.C; 2000.
10. Panse VC, Sukhatme PV. Statistical methods for Agricultural workers. Indian Council of Agricultural Research, New Delhi. 1989;199-210.
11. Vishwakarma PK, Masu PK, Singh S. Effect of various pre-harvest treatments on shelf life and morphological characteristics of fruits of mango (Mangifera indica L.) var. 'Amrapali'. Journal of Horticultural Sciences. 2022;17(1):ISSN: 0973-354X.
12. Moneruzzaman KM, Hossain ABMS, Normaniza O and Boyce AN. Growth, yield and quality responses to gibberellic acid (GA_3) of Wax apple *Syzygium samarangense*var. *Jambu air madu* fruits grown under field conditions. African Journal of Biological Science. 2011; 10(56):11911-11918.
13. Singh JP, Kumar S, Katiyar PN, Dwivedi AK. Effect of calcium nitrate, GA_3 and ethrel on fruiting, ripening and chemical traits of phalsa (*Grewia subinaequalis* Dc). Annals of Horticulture. 2011;4(1):77-83.
14. Debnath A, Vanajalatha K, Momin U, Reddy M. Effect of NAA, GA_3, kinetin and ethrel on yield and quality in phalsa (*Grewia subinaequalis*). Asian Journal of Horticulture. 2011;6(2):474-477.
15. Osama HME, Gammal, Amro SM, Salama, Saber MM and Bakeer. Effect of growth regulator, antioxidant and application date on fruiting and fruit quality of mango trees cv. Keitt. Journal of Agriculture and Veterinary Science. 2014; 8(12):87-95.
16. Kulkarni SS, Patil SS, Magar SD. Effect of plant growth regulators on yield and quality of mango (*Mangifera indica L*.) cv. Kesha. Journal of Pharmacognosy and Phytochemistry, 2017;6(5):2309-2313.
17. Bezerra JB, Jesus PR, Souza ID. Plant regulators on the growth, quality and production of 'Tommy Atkins' mango fruits. Revista Brasileire de Fruiticultura. 2021; 43(3):e-546.
18. Nkansah GO, Ofosu-Anim J and Mawuli A. Gibberellic Acid and Naphthalene Acetie Acid affect fruit retenion, yield and quality of Keitt Mangoes in the Coastal Savanna Ecological Zone of Ghana. American Journal of Plant Physiology. 2012;7: 243-251.
19. Ghosh SN. Effect of plant growth regulators on fruit retention and physico-chemical properties of mango cv. Amrapali grown in laterite soil at close spacing. Journal of Crop and Weed. 2016;12(3): 83-85.
20. Dheeraj G, Bhagwan A, Rajkumar M and Shridhar D. Studies on the effect of combination of bioregulator and growth regulators on flowering and yield of mango. International Journal of Agricultural Science and Rescarch. 2016; 6(3):13-24.
21. Brahmachari VS, Mandal AK, Rani R, Kumar R. Effect of growth substances on flowering and fruiting characters of Sardar guava (*Psidium gavjava* L.). Horticulture Journal. 1997;9(1):1-7.
22. Shrivastava DK, Jain DK. Effect of urea and GA_3 On physiochemical properties of mango cv. Langra during on year. Karnataka Journal of Agricultural Sciences. 2006;19 (3):754-756.
23. Merwad MA, Eisa RA, Saleh, Maher Saad M. The beneficial effect of NAA, Zn, Ca and B on fruiting, yield and fruit quality of alphonso mango trees. International Journal of Chem Tech Research. 2016; 9(3):147-157.
24. Meena D, Tiwari R, Singh OP. Effect of nutrient spray on growth, fruit yield and quality of aonla. Annals of Plant Soil Research. 2014;16(3):242-245.
25. Taduri M, Reddy NN, Lakshmi J, Joshi V. Effect of pre harvest treatments on shelf life and quality of mango cv. Amrapali. The Pharma Innovation Journal. 201;76(7):54-59.
26. Parauha S, Pandey SK. Influence of plant growth regulators and nutrients on fruit retention, yield and quality attributes of mango (*Mangifera indica* L.) cv. Amrapali. Journal of Pharmacognosy and Phytochemistry. 2019;8(2):550-555.
27. Sharma R, Tiwari R. Effect of growth regulator sprays on growth, yield and quality of guava under malwa plateau conditions. Annals of Plant and soil Research. 2015;17(3):287-291.

28. Wahdan MT, Habib SE, Bassal MA, Qaoud EM. Effect of some chemicals on growth, fruiting, yield and fruit quality of mango cv. Succary Abiad. Journal of American Science. 2011;7(2):651-658.

29. Sigh S, Thakur A, Singh SK. Effect of foliar application of gibberellic acid on growth and development of mango (*Mangifera indica*). International Journal of Research and Analytical Reviews (IJRAR). 2018; 5(4):161-166.

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