RESEARCH ARTICLE

EFFECT OF BEST PLANT BIO-REGULATORS AND MICRONUTRIENT FOR ACHIEVING HIGHER YIELD AND QUALITY OF MANGO (*MANGIFERA INDICA* L.) FRUITS CV. AMRAPALI

Rajeev Kumar, V.K. Tripathi, Saurabh Tomar* and Mahendra Chaudhary

Department of Horticulture, Chandra Shekhar Azad University of Agriculture and Technology Kanpur 208002 (U.P.) India
Email: chaudhary.csa@gmail.com

Received-08.11.2018, Revised-26.11.2018

Abstract: An investigation was carried out on 19 years old plantation of mango (*Mangifera indica* L.) cv. Amrapali at C.S.A.U.A.&T., Kanpur (U.P.) India, during the year 2013-2014. In all, 15 treatments foliar application of plant bio-regulators and micronutrient were tested in RBD design replicated thrice. The result obtained revealed that the foliar application of GA_3 (40 ppm) + $ZnSO_4$ (1.0%) results in significantly more fruit length, fruit width, fruit weight and pulp per cent with decrease in stone per cent. Increased total soluble solids (^{O}Brix), total sugars (%), ascorbic acid (Vitamin C) were also found maximum with the same treatment *viz.*, pre-harvest application of GA_3 (40 ppm) + $ZnSO_4$ (1.0%) and acidity in the fruit was drastically reduced under this treatment.

Keywords: Mango, GA_3, NAA, Zinc sulphate, Yield, Quality

INTRODUCTION

The mango (*Mangifera indica* L.) is belongs to family Anacardiaceae and one of the most important and delicious fruit of the tropical countries and hold a premier position amongst the commercial fruits, grown in India. It is also known as king of fruits and national fruit of India. Mango industry has vast potentiality to play vital role in the development of economic status of the country and better linkage in the international trade. It is indigenous to north-east India and north Myanmar in the foot-hills of the Himalaya and is said to have originated in the Indo-Burma region. The major mango producing countries are including India, Bangladesh, Burma, Sri Lanka, China, Malaysia, Florida, Hawaii, Mexico, Thailand, Australia, Pakistan, Indonesia, Philippines. In India, its cultivation is mentioned since pre- historic times for more than 4000 year ago. India covers about 34.90% area and 20.70% production of total fruits cultivated (NHB database 2013-14). The total annual production of mango in India is estimated to be 18431330 mt. and 2515970 ha. cultivated area with 7.3 mt. per ha productivity (NHB database 2013-14). The mango is cultivated in almost all the states of India, like Uttar Pradesh, Andhra Pradesh, Bihar, West Bengal, Karnataka, Gujarat, Maharashtra, Madhya Pradesh, Tamil Nadu, Kerala and Punjab. The maximum area of mango is in Maharashtra (485000 ha.) followed by Andhra Pradesh (304110 ha), whereas, the maximum production (4300980 mt.) and productivity (16.4 mt. / ha) of mango is in Uttar Pradesh, followed by maximum production in Andhra Pradesh (2737010 mt.) and maximum productivity in Jharkhand (10.1 mt. / ha).

Mango is recognized as one of the well accepted fruits all over the world due to its luscious taste, captivating flavour and attractive colour. It plays an important role in balancing diet of human being by providing about 64-66 calories per 100g of ripe fruits. It is a rich source of carbohydrate as well as vitamins A and C. Mango fruit contains 73.0-86.7% moisture, 11.6-24.3% carbohydrate, 0.3-1.0% protein, 0.1-0.8% fat, 0.3-0.7% mineral, 650-25900 µg vitamin 'A and 3-83mg vitamin 'C per 100g fruit. Seed kernels also contain 9.5% protein, 8-12% fat, 79.2% starch, 2% mineral matter and 2% fibers.

Mango fruits are considered as excellent table fruit. A variety of products can be prepared from both immature green and ripe fruits. The green mature fruits are used extensively by food processing industry to prepare a wide variety of products such as dried slices, mango powder, pickles and chutneys. Ripe fruits are utilized in preparing squash, nectar, jam, jelly, cereals flakes, custard powder, baby food, toffee etc. Unani physicians hold mangoes in very high esteem because of its many medicinal values. They are used for strengthening the nervous and blood systems, ridding the bloody from toxins and treating anemia. In Ayurveda, dried mango flowers are used to cure dysentery, diarrhea and inflammation of the urinary tract. India has a rich wealth of mango germplasm with more than 1000 varieties grown throughout the country. However, only about 21 of them are commercially cultivated in different regions (Yadav, 1997). The most well-known commercially cultivated varieties in northern region of India are Bombay Green, Langra, Dashehari, Lucknow Safeda and Chausa. Almost all northern cultivars are biennial in bearing habit. Consequently, a large number of promising hybrids have been evolved by desirable combinations to obtain regular bearing varieties. Among the promising mango hybrids, Amrapali is a well-known late maturing regular bearing dwarf hybrid. Fruit possesses excellent quality with high pulp per cent

*Corresponding Author

and TSS with deep orange red flesh colour and excellent taste. Well suited hybrid cultivar for commercial cultivation in northern region of the country. It was evolved at IARI, New Delhi as a result of cross between Dashehari (alternate bearer) and Neelum (regular bearer) in 1978. 'Amrapali' is superior in comparison to parents in fruit quality like high percentage of pulp, TSS, acidity and β- carotene content.

The foliar application of plant bio-regulators and micronutrients have immense important role in improving fruit set, productivity and quality of fruits. It has also beneficial role in the recovery of nutritional and physiological disorder in fruit trees. Foliar application is based on the principle that the nutrients are quickly absorbed by leaves and transported to different parts of the plant to fulfil the functional requirement of nutrition. Foliar application of nutrient is obviously an ideal way to evading the problem of nutrient availability. This method is highly helpful for the correction of trace element deficiencies, to restore disrupted nutrient supply and to overcome stress factors limiting their availability. This method has been commercialized in a number of fruit crops like Citrus, Pineapple and Guava *etc.* Plant bio-regulators and micronutrient such as GA_3, NAA and $ZnSO_4$ play an important role for fruit set, fruit yield and quality. Zinc plays an important role in growth and development of fruits, vegetables and cereals. It is one of the essential elements for the formation of chlorophyll and hence useful towards photosynthetic activity. Zinc is a constituent of some enzymes, indole acetic acid in plants and essential for CO_2 evolution, utilization of carbohydrate, phosphorus metabolism and synthesis of proteins. Napthalene acetic acid is helpful in the induction of flowering, prevent shedding of buds, flowers and unripe fruits, enlarge fruit size and also increase the yield and quality of many fruits, whereas, GA_3 application is found more effective in retaining the maximum fruit percentage per panicle with increase in fruit size and fruit weight in mango and in many other fruits.

MATERIALS AND METHODS

The present investigation entitled "Influence of pre-harvest application of plant bio-regulators and micronutrient on fruit set, fruit drop, yield and quality of mango (*Mangiferaindica* L.) cv. Amrapali" was carried out in the Department of Horticulture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.) during 2013-2014. The 45 *Mango* trees having uniform growth were selected randomly for the study. The cultural operations and basal application of manures and fertilizers were applied as per recommended schedule for Mango plantation. In all 15 treatments viz., to T_1-GA_3 (20 ppm), T_2-GA_3 (40 ppm), T_3-NAA (20 ppm), T_4-NAA (40 ppm), T_5-$ZnSO_4$ (0.5%), T_6-$ZnSO_4$ (1.0%), T_7-GA_3 (20 ppm) + $ZnSO_4$ (0.5%), T_8-GA_3 (20 ppm) + $ZnSO_4$ (1.0%), T_9-GA_3 (40 ppm) + $ZnSO_4$ (0.5%), T_{10}-GA_3 (40 ppm) + $ZnSO_4$ (1.0%), T_{11}-NAA (20 ppm) + $ZnSO_4$ (0.5%), T_{12}-NAA (20 ppm) + $ZnSO_4$ (1.0%), T_{13}-NAA (40 ppm) + $ZnSO_4$ (0.5%), T_{14}-NAA (40 ppm) + $ZnSO_4$ (1.0%), T_{15}-Control (water spray) were tested in randomized block design using 3 replications. Spraying of plant bio regulators and micro-nutrient was done at pea stage of fruit set. Spraying of material was done using as pee pneumatic foot sprayer fitted with nozzle. In each spraying, 10 litre solute material per tree as per treatment was used. The observations on each tree were recorded for fruiting behavior, Fruit yield (kg/tree), Fruit length (cm), Fruit width (cm), Fruit weight (g), Pulp (per cent), Peel per cent and Stone per cent. Sampled fruits from each tree were analyzed chemically for recording their quality in terms of Total soluble solids (^{0}Brix), Titratable acidity per cent, Ascorbic acid (mg/100g pulp), Total sugars (%) and TSS: acid ratio. Whole data were analysed character wise by using standard statistical method suggested by Panse and Sukhatme (1985).

RESULT AND DISCUSSION

Data pertaining to the maximum fruit yield per plant (50.95 kg/plant) was recorded with application of GA_3 (40 ppm)+ $ZnSO_4$ (1.0%), which is significantly higher than remaining all other treatments except T_{14} and T_9, which produces 48.95 kg and 47.69 kg/tree, respectively, whereas, the minimum fruit yield per plant was recorded under control (38.86 kg/plant). When the effect of both plant bio-regulators was assessed, it is clearly revealed that GA_3 40 ppm treated plants produced maximum fruit yield per plant (43.10 kg) followed by GA_3 (20 ppm) treated plants (41.67 kg) but they were statistically at par with each other, whereas, minimum fruits yield per plant (40.43 kg) was recorded in NAA 20 ppm treated plants. The maximum fruit length (11.83 cm) was recorded with the application the GA_3 (40 ppm) + $ZnSO_4$ (1.0%) and this fruit length was significantly higher as compared to remaining other treatments except T_9 which is statistically at par (11.05 cm) with GA_3 (40 ppm) + $ZnSO_4$ (0.5%) treated plants, whereas, the minimum fruit length was recorded under control (8.76 cm). Among both plant bio-regulators GA_3 and NAA, applied during experimentation period, maximum fruit length (9.98 cm) was obtained in GA_3 40 ppm treated plants, which is statistically at par with GA_3 20 ppm (9.63 cm), whereas, minimum (9.41 cm) fruit length was recorded in NAA 40 ppm treated plants. The maximum fruit width (7.15 cm) was recorded with application of GA_3 (40 ppm) + $ZnSO_4$ (1.0%) and this fruit width was significantly higher than remaining all other treatments except T_9 (6.98 cm), which is statistically at par with NAA 40 ppm + $ZnSO_4$ (1.0%) treated plants, whereas, the minimum fruit width was recorded under control (4.95cm). Among the both plant bio-regulators GA_3 and NAA tested, significantly maximum fruit width (6.36 cm) was recorded in GA_3 40 ppm treated plants closely followed by GA_3 20 ppm (5.98 cm), whereas, minimum (5.35 cm) fruit width was recorded in NAA 20 ppm treated plants. The maximum fruit weight (247.38 g) was recorded in the fruits which were produced from the plants treated with the pre-harvest application of GA_3 (40 ppm) + $ZnSO_4$ (1.0%), which is significantly higher than remaining all other treatments, except T_{10} and T_6 which produced 225.45 g and 223.43 g fruit weight, respectively, whereas, the minimum fruit weight was recorded under control (176.79 g). When the effect of both plant bio-regulators is compared, significantly maximum fruit weight (216.25g) was recorded in NAA 20 ppm followed by GA_3 40 ppm (205.29g) treated plants, whereas, the minimum (188.40g) fruit weight was recorded in NAA 40 ppm treated plants. The maximum pulp per cent (71.06%) was recorded with spraying of GA_3 (40 ppm) + $ZnSO_4$ (1.0%) followed by (69.76%) pulp with GA_3 (40 ppm) + $ZnSO_4$ (0.5%) treated fruits and this fruit pulp per cent was significantly higher than remaining all other treatments, whereas, the minimum fruit pulp per cent (61.73%) was recorded under control. Among both plant bio-regulators was compared and observed that the fruits produced from the plants treated with GA_3 40 ppm resulted maximum fruit pulp per cent (66.98%) followed by the NAA 40 ppm (66.37%) treated plants which is statistically at par with each other, whereas, minimum fruit pulp per cent (65.90%) was recorded in NAA 20 ppm treated plants. The minimum peel per cent (12.53%) was recorded in the fruits treated with the pre-harvest application of GA_3 (20 ppm) + $ZnSO_4$ (1.0%) followed by (13.69%) NAA (40ppm) + $ZnSO_4$ (1.0%) treated plants which produced 13.69% peel per cent in fruits, whereas, the maximum fruit peel per cent was recorded under control (17.58%). Effect of both plant bio-regulators was studied it was found that the minimum fruit peel per cent (14.96%) was recorded in GA_3 40 ppm followed by GA_3 20 ppm (15.85%) treated plants, whereas, the maximum (16.85%) fruit peel per cent was recorded in NAA 20ppm treated plants. All plant bio-regulators treatment were statistically at par with each other. The minimum stone per cent (15.97%) was obtained in the plants treated with the spraying of GA_3 (40 ppm) + $ZnSO_4$ (0.5%) and this fruit stone per cent was significantly lower than remaining all other treatments under investigation followed by16.02% with NAA (40 ppm) + $ZnSO_4$ (0.5%) treated plants, whereas, the maximum stone per cent was recorded under control (20.68%). Among the both plant bio-regulators used, NAA 20ppm treated plants produced minimum stone per cent (17.24%) which is statistically at par with NAA 40 ppm (17.52%), treated plants, whereas the maximum (18.05%) stone per cent was recorded in GA_3 40 ppm treated plants. Maximum TSS content (22.10^{0}Brix) was recorded in the plants when they were treated with GA_3 (40 ppm) + $ZnSO_4$ (1.0%) and this TSS content of fruits was significantly higher as compared to remaining all other treatments followed by 21.54^{0}Brix with GA_3 (40 ppm) + $ZnSO_4$ (0.5%) treated plants, being statistically at par with each other, whereas, the minimum fruit TSS content was recorded under control (17.98^{0}Brix). Effects of both plant bio-regulators were compared, it was noted that maximum TSS content (19.53^{0}Brix) was recorded with GA_3 20 ppm closely followed by the NAA 20 ppm (19.15^{0}Brix) treated plants, which is statistically at par with each other, whereas, the minimum (18.83^{0}Brix) TSS content was recorded in NAA 40 ppm treated plants. The minimum titratable acidity content (0.412%) was recorded in the fruits which were sprayed with the application of GA_3 (40 ppm) + $ZnSO_4$ (1.0%) and this titratable acidity content of fruit was significantly lower than remaining all other treatments under investigation, whereas, the maximum titratable acidity content was recorded under control (0.610%). Both the plant bio-regulators were compared, it is clearly noticed that plants treated with GA_3 20 ppm produced significantly minimum titratable acidity content (0.549%) as compared to remaining all other treatments such as GA_3 40 ppm, NAA 20ppm and NAA 40 ppm treated plants which recorded 0.587%, 0.563% and 0.599%, respectively titratable acidity content. Maximum ascorbic acid (34.67 mg/100g pulp) was recorded with the application of GA_3 (40ppm) + $ZnSO_4$ (1.0%), which is significantly higher than remaining all other treatments under investigation, except T_9 and T_{14} which produced 33.83 mg/100g pulp and 32.93 mg/100g pulp, respectively, whereas, the minimum ascorbic acid (27.02 mg/100g pulp) content in fruit was recorded under control. Among both plant bio-regulators used under investigation, the maximum ascorbic acid (31.85 mg/100g pulp) content in fruits was recorded in NAA 40 ppm treated plants closely followed by GA_3 20 ppm (30.93 mg/100g pulp), whereas, the minimum (26.79 mg/100g pulp) ascorbic acid content was recorded in GA_3 40 ppm treated plants. Maximum total sugar content (21.08%) was obtained with the application of GA_3 (40 ppm) + $ZnSO_4$ (1.0%) and this total sugars content of fruit was significantly higher than remaining all other treatments, whereas, the minimum total sugar content of fruit was recorded under control (16.88%). Both the plant bio-regulators tested under experimentation, GA_3 20 ppm treated plants produced maximum total sugars content (18.13%) which is significantly higher than all other plant bio-regulators treatments, whereas, the minimum total sugars content (17.40%) was with NAA 40 ppm treatment. The highest TSS: acid ratio (53.64) was recorded with the application of GA_3 (40 ppm) + $ZnSO_4$ (1.0%) and this TSS: acid ratio of fruits was significantly higher than remaining all other treatments under investigation, whereas, the minimum TSS: acid ratio of fruit was recorded under control (29.47). Among both plant bio-regulators was assessed, it is observed that application of GA_3 20 ppm produced maximum fruit TSS: acid ratio (35.57) closely followed by NAA 20 ppm (34.01), whereas, the minimum TSS: acid ratio (31.43) was recorded in NAA 40 ppm treated plants.

Physical characters of fruit

The spraying of GA_3, NAA and Zinc sulphate are improved fruit characters over control presented in Table-1. These results are in close conformity with the findings recorded by Sarkar and Ghosh (2004) in mango cv. Amrapali, who reported that maximum fruit length and fruit weight with GA_3 at 30 mg/litre and Tripathi and Shukla (2010), who also found increased fruit size with GA_3 at 100 ppm in strawberry. The weight of fruit improved appreciably in all the treatments over control. However, maximum impact was observed with T_{10} **(**GA_3 (40 ppm) + $ZnSO_4$ at 1.0%. This increase in fruit weight by GA_3 application might be due to the accumulation of more food material in fruit trees. Singh *et. al.* (1994) and Tripathi and Shukla (2008) also reported maximum fruit weight, length and diameter with the use of GA_3. The recorded observations pulp, peel and stone per cent clearly indicate that pre-harvest application of GA_3 (40 ppm) + $ZnSO_4$ at 1.0% (T_{10}) resulted in significant increase in pulp per cent and reduction of peel and stone per cent in mango fruit. The minimum pulp per cent and maximum peel and stone per cent was recorded under control. This increase in pulp percentage may be due to more absorption of water, plant bio-regulators and micronutrient which increase the volume of inter-cellular spaces in the pulp. These results are in accordance with the reports of Vejendla *et al.* (2008) who found higher pulp in mango cv. Amrapali with the spraying of $ZnSO_4$ (0.75%) and also Moazzam *et al.* (2011) who noted maximum pulp weight and less stone weight in comparison to control with the foliar application of (0.4%) $FeSO_4$ + (0.8%) H_3BO_3 + (0.8%) $ZnSO_4$.

Chemical characters of fruit

Data furnished in Table-2 revealed that application of GA_3, NAA and Zinc sulphate are improved fruit quality Total soluble solids (TSS) or ascorbic acid and TSS: acid ratio over control. The maximum accumulation of total soluble solids (TSS) content in mango fruits was recorded with GA_3 (40 ppm) + $ZnSO_4$ (1.0%), while minimum under control. This increase in total soluble solids contents of fruits may be due to the fact that plant bio-regulators and micronutrient play an important role in the photosynthesis which ultimately lead to the accumulation of carbohydrates and ultimately increase of TSS content of mango fruit. The adequate amount of zinc improved the auxin content and it also acted as catalyst in oxidation process. The results are in close conformity with the finding of Sarkar and Ghosh (2005), Vashistha *et al*. (2010**)** and Shrivastava and Jain (2006) in mango. The use of different plant bio-regulators and micronutrient treatments significantly influenced the acidity percentage in mango fruits. The minimum acidity percentage was noted with GA_3 (40 ppm) + $ZnSO_4$ (1.0%), whereas, the maximum in control. Acidity content of fruits decreased with the foliar application of plant bio-regulators and micronutrient, which might be due to an increase in translocation of carbohydrates and increase in metabolic conversion of acids to sugars by the reaction involving reversal of glycolytic path way and used in respiration or both. Another reason for reduction in acidity per cent in plant bio-regulators and micronutrient treated fruits, might be the early ripening of fruits which was induced by the plant bio-regulators and micronutrient spray due to which degradation of acid might have occurred. These results are in accordance to the reports of Shrivastava and Jain (2006), who also found significant reduction in acidity content in mango cv. Langra with urea at 2% and GA_3 (100 ppm) and Tripathi and Shukla (2010) in strawberry. Ascorbic acid content of fruits was significantly influenced by plant bio-regulators and micronutrient spraying as compared to control. Significantly maximum amount of ascorbic acid was found with GA_3 (40ppm + $ZnSO_4$ (1.0%), whereas, minimum was recorded with control. The increased ascorbic acid content of fruit juice was due to increase in the synthesis of catalytic activity by enzyme and coenzyme, which are represented in ascorbic acid synthesis. The adequate amounts of zinc improve the auxin content and it also acts as catalyst in oxidation process. These findings are in closely accordance with the results of Rajak *et al.* (2010), who reported maximum ascorbic acid content (mg/100 g pulp) in fruits with $ZnSO_4$ (0.6%), and Borax (0.8%) and minimum under control in mango cv. Amrapali fruits. Tripathi and Shukla (2008) in strawberry also found increased ascorbic acid content with GA_3 treatment. The similar pattern in respect to total sugars content and TSS/acid ratio was also recorded as they were also influenced by plant bio-regulators and micronutrient. The highest total sugars and TSS/acid ratio content was recorded with GA_3 (40 ppm) + $ZnSO_4$ (1.0%) and minimum in control. This increase in total sugars content and TSS/acid ratio may be due to the fact that zinc works as stimulator of amino acids and appears to be helpful in the process of photosynthesis and in accumulation of carbohydrates which ultimately help in the translocation of more sugar and TSS to the fruits. It has been reported that there is a greater conversion of starch into sugar (source to sink) in the presence of these plant bio-regulators and micronutrient. The results are in accordance to the finding of Kumar *et al.* (2011), who reported maximum total sugars in mango cv. Amrapali with 2% urea + $ZnSO_4$ (1.0%).

However, maximum TSS/acid ratio was obtained with 2% urea + $ZnSO_4$ (0.5%) and Bhowmick *et al.* (2012), who noted maximum total sugars and non-reducing sugar with the application of $ZnSO_4$ (1.0%) in mango cv. Amrapali.

Table 1. Effect of pre-harvest application of plant bio-regulators and micronutrient on physical characters of mango fruits.

Treatments	Fruit yield per/plant (kg)	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	Pulp (%)	Peel (%)	Stone (%)
T_1-GA_3 (20 ppm)	41.67	9.63	5.98	195.56	66.24	15.85	17.90
T_2-GA_3 (40 ppm)	43.10	9.98	6.36	205.29	66.98	14.96	18.05
T_3-NAA (20 ppm)	40.43	9.41	5.35	216.25	65.90	16.85	17.24
T_4-NAA (40 ppm)	41.63	9.59	5.55	188.40	66.37	16.10	17.52
T_5-$ZnSO_4$ (0.5%)	37.23	9.88	5.78	209.87	65.36	16.99	17.64
T_6-$ZnSO_4$ (1.0%)	39.39	9.73	6.10	223.43	64.95	16.43	18.61
T_7-GA_3 (20 ppm) + $ZnSO_4$ (0.5%)	44.92	10.19	6.05	202.53	68.22	15.10	16.67
T_8-GA_3 (20 ppm) + $ZnSO_4$(1.0%)	46.13	10.46	6.47	204.26	68.62	13.69	17.68
T_9-GA_3 (40 ppm) + $ZnSO_4$ (0.5%)	47.69	11.05	6.93	225.45	69.76	14.26	15.97
T_{10}-GA_3 (40 ppm) + $ZnSO_4$ (1.0%)	50.95	11.83	7.15	247.38	71.06	12.53	16.40
T_{11}-NAA (20 ppm) + $ZnSO_4$ (0.5%)	45.17	10.07	6.10	208.32	67.68	14.52	17.79
T_{12}-NAA (20 ppm) + $ZnSO_4$ (1.0%)	46.89	10.02	6.63	219.76	68.27	15.35	16.87
T_{13}-NAA (40 ppm) + $ZnSO_4$ (0.5%)	47.03	10.12	6.69	207.85	68.95	15.02	16.02
T_{14}-NAA (40 ppm) + $ZnSO_4$ (1.0%)	48.95	10.16	6.98	217.95	69.59	14.10	16.30
T_{15}-Control (water spray)	38.86	8.76	4.95	176.79	61.73	17.58	20.68
S. E. m ±	0.882	0.348	0.146	3.795	1.303	0.485	0.120
CD at 5%	2.569	1.013	0.424	11.050	3.795	1.406	0.351

Table 2. Effect of pre-harvest application of plant bio-regulators and micronutrient on quality parameters of mango fruits.

Treatments	TSS (^{0}Brix)	Acidity (%)	Ascorbic acid (mg/100g pulp)	Total sugars (%)	TSS: acid ratio
T_1-GA_3 (20 ppm)	19.53	0.549	29.93	18.13	35.57
T_2-GA_3 (40 ppm)	18.95	0.587	30.38	17.43	32.28
T_3-NAA (20 ppm)	19.15	0.563	28.62	17.79	34.01
T_4-NAA (40 ppm)	18.83	0.599	29.99	17.40	31.43
T_5-$ZnSO_4$ (0.5%)	19.65	0.545	28.92	18.22	36.05
T_6-$ZnSO_4$ (1.0%)	19.93	0.537	29.85	18.43	37.11
T_7-GA_3 (20 ppm) + $ZnSO_4$ (0.5%)	20.25	0.506	30.78	18.97	40.01
T_8-GA_3 (20 ppm) + $ZnSO_4$ (1.0%)	20.45	0.502	31.19	19.21	40.73
T_9-GA_3 (40 ppm) + $ZnSO_4$ (0.5%)	21.54	0.441	33.83	20.19	48.84
T_{10}-GA_3 (40 ppm) + $ZnSO_4$ (1.0%)	22.10	0.412	34.67	21.08	53.64
T_{11}-NAA (20 ppm) + $ZnSO_4$ (0.5%)	20.05	0.511	31.08	18.80	39.23
T_{12}-NAA (20 ppm) + $ZnSO_4$ (1.0%)	20.87	0.498	31.49	19.49	41.90
T_{13}-NAA (40 ppm) + $ZnSO_4$ (0.5%)	20.99	0.499	32.15	19.58	42.06
T_{14}-NAA (40 ppm) + $ZnSO_4$ (1.0%)	21.10	0.487	32.93	19.72	43.32
T_{15}-Control (water spray)	17.98	0.610	27.02	16.88	29.47
S. E. m ±	0.127	0.017	0.579	0.146	0.606
CD at 5%	0.371	0.051	1.679	0.426	1.766

REFERENCES

Bhowmick, N. and Banik, B. C. (2011). Influence of pre-harvest foliar application of growth regulators and micronutrients on mango cv. Himsagar. *Indian Journal of Horticulture,* **68** (1): 103-107.

Kumar, R., Kumar, P., Singh, U.P. and Chatterjee, D. (2011). Effect of chemicals on physico- chemical characteristics of Amrapali mango. *Journal of Interacademicia,* **15** (4): 544-548.

Moazzam, A., Tahir, F.M., Shahzad, J. and Mahmood, N. (2011). Effect of foliar application of micronutrients on the quality of mango (*Mangifera indica* L.) cv. Dashehari fruit. *Mycopath,* **9** (1): 25-28.

Panse, V.G., and Sukhatme, P.V. (1985). Randomized Blocks and Latin Square. *Statistical Methods for Agricultural Workers*, ICAR, New Delhi. Pp. 152-165.

Rajak, U., Rani, R., Kumar, R., Mandal, B.K. and Prasad, K.K. (2010). Effect of foliar application of urea, borax and zinc on flowering, fruiting and fruit quality of Amrapali mango. *Environment and Ecology,* **28** (3): 1668-1671.

Sarkar, S. and Ghosh, B. (2004). Effect of growth regulators on fruit morphology, retention and yield of mango cv. Amrapali. *Indian Agriculturist,* **48** (3/4): 185-188.

Sarkar, S. and Ghosh, B. (2005). Effect of growth regulators on biochemical composition of mango cv. Amrapali. *Environment and Ecology,* **23** (2): 379-380.

Shrivastava, D. K. and Jain, D. K. (2006). Effect of urea and GA_3 on physiochemical properties of mango cv. Langra during on year. *Karnataka Journal of Agricultural Sciences,* **19** (3): 754-756.

Singh, J. N., Singh, D. K. and Chakravarty, D. (1994). Effect of urea and NAA on fruit retention and physicochemical composition of mango cv. Langra. *Orissa Journal of Horticulture* **22** (1/2): 26-30.

Tripathi, V.K. and Shukla, P.K. (2008). Influence of plant bio-regulators and micronutrients on flowering and yield of strawberry cv. Chandler. *Annals of Horticulture,* **1**(1):45-48.

Tripathi, V.K. and Shukla, P.K. (2010). Influence of plant bio-regulators, boric acid and zinc sulphateon yield and fruit characters of strawberry cv. Chandler. *Prog. Hort.* **42** (2): 186-188.

Vashistha, K., Yadav, A.L., Singh, H.K. and Yadav, D.K. (2010). Effect of foliar spray of nutrients on fruit drop, yield and quality attributes of mango fruit (*Mangifera indica*L.) cv. Amrapali. *Plant Archives,* **10** (1): 359-360.

Vejendla, V., Maity, P.K. and Banik, B.C. (2008). Effect of chemicals and growth regulators on fruit retention, yield and quality of mango cv. Amrapali. *Journal of Crop and Weed,***4** (2): 45-46.

Yadav, I. S. (1997). Mango research in India in the past 50 years. *Indian Horticulture,* **42** (2): 10-17.