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Influence of plant growth regulators and micronutrients on yield and quality attributes of mango CV. mallika

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Abstract
The present experiment was carried out at Horticultural Research Farm, Department of Horticulture, B.A. College of Agriculture, Anand Agricultural University, Anand during spring- summer season for two years on a mango cultivar Mallika to assess the effect of growth regulators (NAA and GA_3) and micronutrients ($ZnSO_4$ and borax) on and yield parameters and quality of mango. The experiment comprised of 15 treatments with different PGR's and micronutrients *i.e.*, NAA (T_1 = 20 mg/l, T_2 = 40 mg/l), GA_3 (T_4 = 25 mg/l, T_5 = 50 mg/l) and zinc sulphate (T_5 = 0.5%) and borax (T_6 = 0.2 %) and combined treatments *i.e.* NAA 20 mg/l + $ZnSO_4$ 0.5 % (T_7), NAA 20 mg/l + Borax 0.2 % (T_8), NAA 40 mg/l + $ZnSO_4$ 0. 5 % (T_9), NAA 40 mg/l + Borax 0.2% (T_{10}), GA_3 25 mg/l + $ZnSO_4$ 0.5 % (T_{11}), GA_3 25 mg/l + Borax 0.2 % (T_{12}), GA_3 50 mg/l + $ZnSO_4$ 0.5% (T_{13}), GA_3 50 mg/l + Borax 0.2% (T_{14}) along with water spray/control (T_{15}) were applied as foliar spray at full bloom, pea and marble stage of fruit growth. Combined effect of NAA 20 mg/l + Borax 0.2% significantly increased the number of fruits per plant (213.33), fruit yield (79.97 kg/tree) and various biochemical properties such as titratable acidity (%), TSS (%), reducing sugar (%), non reducing sugar (%), total sugar and ascorbic acid (mg/100g).

Keywords: Mango, fruit set, fruit drop, growth regulators, micronutrients

Introduction
Mango (*Mangifera indica* L.) is a premier fruit crop of India considering its acreages, production, popularity among the people and designated as the 'National Fruit of India' (Bhowmick *et al.*, 2012) [7]. In mango production many problems are associated with fruit set, yield and quality due to imbalance supply of nutrients and it results in poor health of tree, fruit quality, increase in fruit drop and moreover the unhealthy plants are also more prone to attack of insect- pest and diseases. Foliar application of the growth regulators (NAA 40 ppm, GA_3 60ppm) and micronutrients ($ZnSO_4$ 1.5%, Borax 0.75%) at marble stage of fruit development of mango cv. Himsagar prevented premature pre-harvest drop of fruits and as a consequence increased the number and quality of fruits over control (Bhowmick and Banik, 2011) [6]. India shares about 56% of total mango production in the world. Besides India, it is also being cultivated in Srilanka, Bangladesh, Burma, Pakistan, Thailand, Vietnam, Malaysia, Philippines, Indonesia, South Africa, USA, Venezuela and Brazil. The major growing states are Uttar Pradesh, Andhra Pradesh, Gujarat, Bihar, Karnataka, Tamil Nadu, Kerala, Maharashtra, Orissa and West Bengal. Mango is almost grown in all states of India. Uttar Pradesh is leading state in total production, whereas, Andhra Pradesh is leading in area under mango Besides delicious taste, excellent flavour and attractive fragrance, it is rich in vitamin A (765 IU/100g pulp) and C (16mg/100g pulp) (Source: National Horticulture Board). Mango fruit is excellent source flavonoids like *beta-carotene, alpha-carotene* and *beta-cryptoxanthin*. These compounds have been known to have antioxidant properties and are essential for vision. Consumption of natural fruits rich in carotenes is known to protect from lung and oral cavity cancers (Source: USDA National Nutrient data base). 'Mallika' is the result of the hybridization of the Indian mango varieties 'Neelum' and 'Dashehari'. The grafted tree remain manageable for cultural practices. Fruit is normally ready to harvest between June to July. 'Mallika' produces high quality, fibreless orange pulp. The fruit has prominent citrus, melon and honey notes and is exceptionally sweet.

Materials and Methods
The experiment was conducted at Horticultural Research Farm, Department of Horticulture, B.A. College of Agriculture, Anand Agricultural University, Anand during spring- summer season for two years on a mango cultivar Mallika. The selected trees were uniform in size and of 15 years old. The experiment comprised of 15 treatments with different PGR's and

micronutrients *i.e.*, NAA (T_1 = 20 mg/l, T_2 = 40 mg/l), GA_3 (T_4 = 25 mg/l, T_5 = 50 mg/l) and zinc sulphate (T_5 = 0.5%) and borax (T_6 = 0.2 %) and combined treatments *i.e.* NAA 20 mg/l + $ZnSO_4$ 0.5 % (T_7), NAA 20 mg/l + Borax 0.2 % (T_8), NAA 40 mg/l + $ZnSO_4$ 0. 5 % (T_9), NAA 40 mg/l + Borax 0.2% (T_{10}), GA_3 25 mg/l + $ZnSO_4$ 0.5 % (T_{11}), GA_3 25 mg/l + Borax 0.2 % (T_{12}), GA_3 50 mg/l + $ZnSO_4$ 0.5% (T_{13}), GA_3 50 mg/l + Borax 0.2% (T_{14}) along with water spray/control (T_{15}) were applied as foliar spray at full bloom, pea and marble stage of fruit growth. The experiment was laid out in Completely Randomized Design with three repetitions and one plants in each replication formed a unit for recording observations. The total number of fruits harvested per tree was counted at harvest and expressed as number of fruits per tree. From each of the treatments three marketable fruits were selected randomly from each experimental tree and their weight was recorded separately at harvest and average fruit weight was recorded in gram. The fruits harvest from each tree were weighed in all the pickings and recorded in kilogram for fruit yield and statistical analysis was done through the method described by Gomez and Gomez (1967) [15]. The shelf life of fruits was noted by keeping the fruits at room temperature and the days taken from harvesting to optimum eating stage. Total Soluble Solids of mango fruit was recorded by using a Hand refractometer (0-32 ºC). Method described by Ranganna (1979) was adopted for estimation of titratable acidity (%), reducing sugar (%), non reducing sugar (%), total sugar and ascorbic acid (mg/100g).

Results and Discussions

Data presented in Table 1 shows significant differences on number of fruits. It is clear from the results that treatment T_8 *i.e.* NAA 20 mg/l + Borax 0.2% gave maximum no. of fruits (221.67, 205.00, 213.33) during both the years and in pooled results respectively and it was found at par with treatments NAA 40 mg/l + Borax 0.2% (T_{10}), GA_3 25 mg/l + Borax 0.2% (T_{12}), GA_3 50 mg/l + Borax 0.2% (T_{14}), GA_3 25 mg/l + $ZnSO_4$ 0.5 % (T_{11}) and NAA 40 mg/l + $ZnSO_4$ 0. 5 % (T_9). All the micronutrients when sprayed alone or in combination involved directly in various physiological processes and enzymatic activity. This might have resulted into better photosynthesis, greater accumulation of starch in fruits. The involvement of zinc in auxin synthesis and boron in translocation of starch to fruits. The balance of auxin in plant regulates the fruit drop or retention in plants, which altered the control of fruit drop and increased the total number of fruits per tree. Similar results were observed by Haidry *et al.* (1997) [18], Shinde *et al.* (2006) [33], Baghel *et al.* (2003) [2], Baghel *et al.* (2004) [3], and Naqvi *et al.* (2004) [23] in mango and Kumar *et al.* (2009) [21] in litchi, Trivedi *et al.* (2012) [40] and Bhoyar and Ramdevputra (2016) [8] in guava. The ability of gibberellic acid to prevent the abscission of young fruit appears to be a secondary effect on abscission process.

It is evident from the data (Table 1) that treatment T_7 *i.e.* NAA 20 mg/l + $ZnSO_4$ 0.5 % recorded significantly higher fruit average weight (376.50 g, 388.75 g and 382.63 g) during the first year, second and in pooled results, respectively along with other treatments *viz.* T_9, T_8, T_{10}, T_4, T_{11}, T_1, T_3, T_5 and T_{13}. This increment in fruit size due to application of growth regulators NAA can be attributed to the involvement of PGRs in cell division, cell expansion and increased volume of intercellular spaces in mesocarpic cells. It could also be due to higher mobilization of food and minerals from other plant parts towards the developing fruits that are extremely active metabolic sink. The application of NAA might have a role in increasing the auxin level of fruits which in turn helped in the development of fruit components as there is direct correlation between auxin content and fruit growth in several plants. The results were also in accordance with the findings of Haidry *et al.* (1997) [18], Shinde *et al.* (2006) [33] in mango.

Data presented in Table 1 also revealed the maximum fruit yield i*.e.* 81.37, 78.57 and 79.97 kg/tree during the two years and in pooled, respectively with treatment T_8 *i.e.* NAA 20 mg/l + Borax 0.2% which was found at par with the treatments NAA 40 mg/l + Borax 0.2% (T_{10}), NAA 40 mg/l + $ZnSO_4$ 0. 5 % (T_9), GA_3 25 mg/l + Borax 0.2% (T_{12}), GA_3 25 mg/l + $ZnSO_4$ 0.5 % (T_{11}), NAA 20 mg/l + $ZnSO_4$ 0.5 % (T_7) and GA_3 50 mg/l + Borax 0.2% (T_{14}). The significant increase in fruit yield per tree is a cumulative effect of increase in number of fruits because of reduction in fruit drop by the direct and indirect effect of foliar spray of plant growth regulators and micronutrients in mango Nkansah *et al.* (2012) [26]. Promotion of starch formation followed by rapid transportation of carbohydrates in plants activated by micronutrients like zinc and boron are also well established (Nehete *et al.* 2011) [25]. Foliar spray of NAA and borax significantly increased the fruit set in mango which helps in increasing the number of fruits per tree resulting in higher fruit yield and fruit weight due to the more rapid translocation of sugars from leaves to developing fruits (Dutta, 2004) [13]. Similar findings were also observed by Banik *et al.* (1997) [4], Banik and Sen (1997) [5], Sanna and Abd-El-Migeed (2005) [30], Nehete *et al.* (2011) [25], Bhowmick *et al.* (2012) [7], Jarande *et al.* (2013), Singh *et al.* (2013) [36], Gurjar *et. al.* (2015) [16] and Oosthuyse (2015) [27] in mango.

It is evident from the data of Table 2 that treatment T_7 *i.e* NAA 20 mg/l + $ZnSO_4$ 0.5 % recorded significantly higher shelf life (13.67, 14.00 and 13.83 days) during the years 2013-14, 2014-15 and in pooled results, respectively followed by treatments T_9, T_{12}, T_1, T_2, T_{13}, T_{10}, T_4 and T_{14}. Antagonistic effect of growth regulators which inhibit ethylene production and delayed the conversion of starch to sugar helps in increasing shelf life and lower the spoilage rate in fruits. The enhancement in quality of fruit could be due to the catalytic action of micronutrients particularly at higher concentration. Hence, the foliar application of micronutrients quickly increased the uptake of macronutrients in the tissues and organs of the mango plants, decreased the nutritional deficiencies and improved the fruit quality (Anees, 2011) [1]. The results are also supported by the findings of Kahlon and Uppal (2005) [19], Srivastava and Jain (2006) [34], Bhusan *et al.* (2015) [10], Chauhan *et al.* (2015) [11] in mango.

It is observed from Table 3 that significantly higher TSS was found with treatment T_8 *i.e* NAA 20 mg/l + Borax 0.2% (24.22 ^{0}Brix) at 9th day which was similar with T_{10}, T_1, T_2, T_3 T_4 and T_6. Increasing trend in TSS was observed upto 9th day and a slight decrease at 12th day of storage. During storage TSS of fruits varied significantly with different treatments. However, higher TSS was recorded in treated fruits as compared to control. The increase in TSS with the advancement of storage period may be assigned to hydrolysis of starch content of the fruits in the presence of enzymes, viz., α -amylase, β -amylase and starch phosphorelase, resulting in general increase in TSS (Salisbury and Ross, 1984). The conversion of cell wall materials such as pectin and hemi cellulose into simple soluble sugars during storage may also be responsible for the increase TSS content. After 9 days of storage, total soluble solids declined. The decline in TSS at later stages might be due to the utilization of carbohydrate and

possibly oxidation of fat and proteins as the respiratory substrates as suggested by Bhullar *et al.,* 1983 [9].

The minimum acidity (table 4) in fruits during the storage period at 3rd (0.32, 0.30 and 0.31 %), 6th (0.31, 0.27 and 0.29 %), 9th (0.24, 0.20 and 0.22 %) and 12th day (0.18, 0.16 and 0.17 %) respectively, was recorded in treatment T_8 (NAA 20 mg/l + Borax 0.2%) during 1st, 2nd year and in pooled analysis. The decrease in acidity of fruits might have been attributed to their conversion in sugars and their derivatives by the reactions involving reversal of glycolytic pathway and also might be used in respiration (Singh and Maurya, 2004). The results are also in accordance with Singh *et al*. (2013) [36] and Singh *et al.* (2009) [21] in mango. NAA recorded lower acidity which might be due to synthesis of auxin in plants and it increased the physiological activities leading to decrease acidity in fruits. The results are also in accordance with the findings of Haidry *et al.* (1997) [18], Shinde *et al.* (2006) [33].

The response of PGR's and micronutrients on reducing sugar differed significantly (Table 5). It was revealed from the results that maximum reducing sugar of fruits during the storage period at 3rd (11.23, 11.47 and 11.35 %), 6th (11.73, 11.86 and 11.80 %), 9th (12.13, 12.23 and 12.18 %) and 12th day (11.73, 11.54 and 11.64 %) respectively, was recorded in treatment NAA 20 mg/l + Borax 0.2%. Kahlon and Uppal (2005) [19] suggested that conversion of starches and polysaccharides into simple sugars with the advancement of storage was responsible for the increase of reducing sugar and onward decline was due to the utilization of sugar in evapotranspiration and other bio chemical activities in mango fruits. These results are in conformity with the findings of Banik *et al.* (1997) [4], Negi (2009) [24] and Nkansah *et al.* (2012) [26] in mango. It is clear from the results (Table 6) that NAA 20 mg/l + Borax 0.2% (13.18%) recorded higher non reducing sugar at 3rd day while at 6th day it was found higher with T_{11} *i.e.* GA_3 50 mg/l + $ZnSO_4$ 0.5% (17.81%) which was at par with all the treatments except control. Lastly, at 9th and 12th day of storage, again higher non reducing sugar was recorded with treatment T_8 *i.e.* NAA 20 mg/l + Borax 0.2% (19.20 and 15.12%).

The results pertaining to total sugars (Table 7) shows significant response to application of PGR's and micronutrients over control. Maximum total sugars was recorded with treatment T_8 *i.e* NAA 20 mg/l + Borax 0.2% at 3rd (24.53 %), 9th (31.38 %) and 12th day (26.75 %) of storage, respectively, whereas at 6th day of storage, higher total sugars (28.77 %) was recorded with T_{10} *i.e.* NAA 40 mg/l + Borax 0.2%. NAA had shown significant increase in the reducing sugar, non reducing sugar and total sugar of mango fruits and this might be due to synthesis of auxin in plants, which increase the physiological activities and in turn helps in increasing sugar contents. The results are also in accordance with the findings of Sharma *et al.* (1990) [32], Haidry *et al.* (1997) [18] and Shinde *et al.* (2006) [33].

The results of the present investigation revealed that effect of PGR's and micronutrients treatments on ascorbic acid content observed significant responses which is indicated in Table 8. During 1st, 2nd year and in pooled analysis, maximum ascorbic acid of fruits at 3rd (29.32, 29.50 and 29.41 mg/100g pulp), 6th (28.27, 28.33 and 28.30 mg/100g pulp), 9th (26.81, 26.83 and 26.82 mg/100g pulp) and 12th day (23.86, 23.90 and 23.88 mg/100g pulp) respectively, was recorded in treatment T_8 (NAA 20 mg/l + Borax 0.2%) during storage which was at par with T_{10}. The increase in ascorbic acid might be due to the catalytic influence of growth regulators on its bio-synthesis from its precursor glucose-6-phosphates throughout the development of fruit which is thought to be the precursor of vitamin C. During ripening ascorbic acid in general progressively decreases with an increase in the storage period on account of oxidation of ascorbic acid. The higher value of ascorbic acid content with treatment boron 0.2% might be due to higher level of sugars in boron treated fruit, which increased the content of ascorbic acid, since ascorbic acid is synthesized from sugar. Similar result was observed by Sankar *et al.* (2013) [31] in mango. The results are in accordance with findings of Srivastava and Jain (2006) [34] in mango, Shukla *et al.* (2011) [35] in aonla. Losses in ascorbic acid content of fruits were directly proportional to the length of storage period. Mapson (1970) [22] suggested that loss in ascorbic acid on prolonged storage is attributed to the rapid conversion of L-ascorbic acid into dehydro-ascorbic acid in presence of ascorbinase enzyme.

Conclusion

From the two years of field study, it can be concluded that three spray applications of NAA 20 mg/l + Borax 0. 2 % at full bloom, pea and marble stages effectively increased the fruit yield (79.97 kg/tree) and various biochemical parameters such as highest TSS, reducing and non reducing sugar, total sugar and ascorbic acid whereas the highest shelf life (13.83 days) of fruits during storage was recorded with NAA 20 mg/l + $ZnSO_4$ 0.5 % on mango cv. Mallika.

Table 1: Effect of foliar application of PGR's and micronutrients on yield parameters

Treatment No.		No. of fruits per tree			Average fruit weight (g)			Fruit yield (kg/tree)		
		1st year	2nd year	Pooled	1st year	2nd year	Pooled	1st year	2nd year	Pooled
T_1		180.33	166.67	173.50	362.07	375.00	368.54	65.25	62.68	63.97
T_2		185.33	171.67	178.50	353.23	368.69	360.96	65.46	63.02	64.24
T_3		179.67	161.67	170.67	360.13	374.56	367.35	64.96	60.65	62.81
T_4		176.67	160.00	168.33	364.62	377.47	371.05	64.30	60.39	62.35
T_5		175.67	158.33	167.00	359.14	374.13	366.64	62.93	59.29	61.11
T_6		187.33	173.33	180.33	344.34	365.61	354.97	64.55	63.14	63.84
T_7		191.67	183.33	187.50	376.50	388.75	382.63	72.25	71.39	71.82
T_8		221.67	205.00	213.33	367.63	383.21	375.42	81.37	78.57	79.97
T_9		201.67	188.33	195.00	370.23	385.15	377.69	74.56	72.52	73.54
T_{10}		215.00	201.67	208.33	363.42	382.51	372.96	78.03	77.11	77.57
T_{11}		203.67	191.67	197.67	358.47	379.45	368.96	73.04	72.64	72.84
T_{12}		211.67	198.33	205.00	347.87	367.41	357.64	73.58	72.86	73.22
T_{13}		200.33	185.33	192.83	353.45	378.58	366.02	70.58	70.22	70.40
T_{14}		206.67	195.00	200.83	345.64	363.85	354.75	71.30	71.04	71.17
T_{15}		161.67	142.33	152.00	285.00	300.33	292.67	46.10	42.76	44.43
T	S.Em ±	9.25	8.39	6.65	10.96	9.92	6.28	3.53	3.59	2.36

	C. D. (P =0.05)	26.71	24.22	19.21	31.65	28.64	18.45	10.20	10.37	6.82
YXT	S.Em ±	-	-	8.21	-	-	11.81	-	-	3.78
	C. D. (P =0.05)	-	-	NS	-	-	NS	-	-	NS
C.V. %		8.29	8.12	7.65	5.36	4.63	5.64	8.92	9.34	9.67

Treatment details			
Tr. No.	**Treatments**	**Tr. No.**	**Treatments**
T_1	NAA 20 mg/l	T_9	NAA 40 mg/l + $ZnSO_4$ 0. 5 %
T_2	NAA 40 mg/l	T_{10}	NAA 40 mg/l + Borax 0.2%
T_3	GA_3 25 mg/l	T_{11}	GA_3 25 mg/l + $ZnSO_4$ 0.5 %
T_4	GA_3 50 mg/l	T_{12}	GA_3 25 mg/l + Borax 0.2%
T_5	$ZnSO_4$ 0.5 %	T_{13}	GA_3 50 mg/l + $ZnSO_4$ 0.5 %
T_6	Borax 0.2 %	T_{14}	GA_3 50 mg/l + Borax 0.2%
T_7	NAA 20 mg/l + $ZnSO_4$ 0.5 %	T_{15}	Control (water spray)
T_8	NAA 20 mg/l + Borax 0.2%		

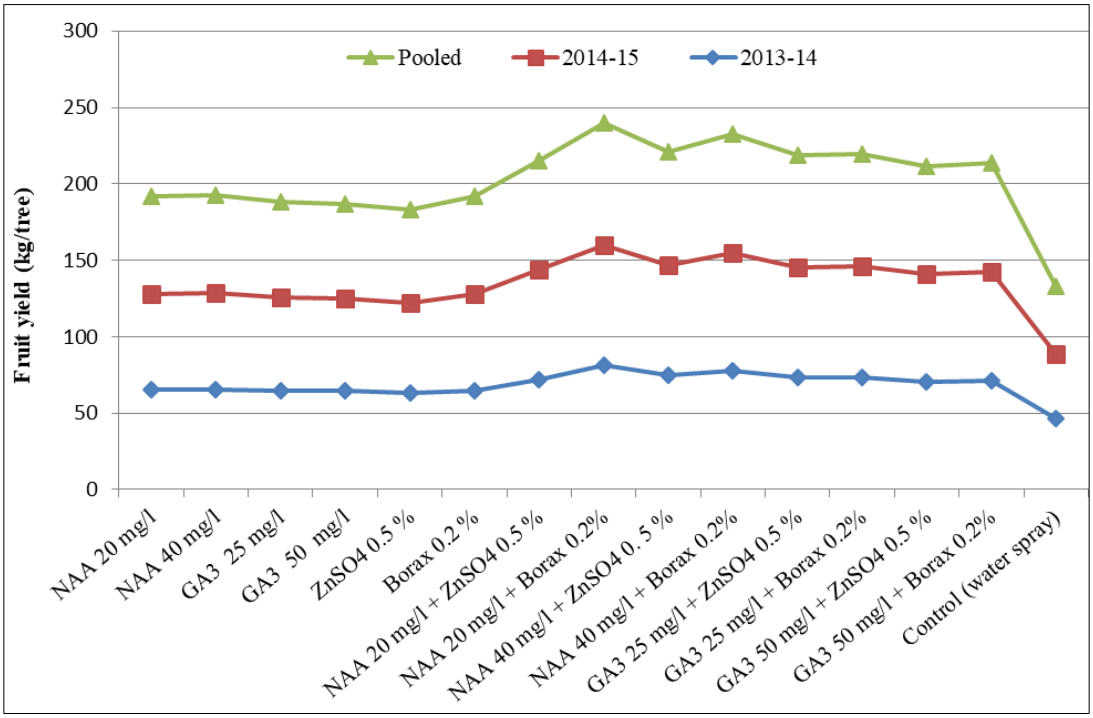

Fig 1: Effect of foliar application of PGR's and micronutrients on fruit yield (kg/tree)

Table 2: Effect of foliar application of PGR's and micronutrients on shelf life of mango fruits

Tr. No.	**Treatments**	**Shelf life (days)**		
		2013-14	**2014-15**	**Pooled**
T_1	NAA 20 mg/l	13.00	13.67	13.33
T_2	NAA 40 mg/l	13.33	13.00	13.17
T_3	GA_3 25 mg/l	12.33	13.33	12.83
T_4	GA_3 50 mg/l	12.67	13.33	13.00
T_5	$ZnSO_4$ 0.5 %	12.00	12.67	12.33
T_6	Borax 0.2 %	11.67	12.33	12.00
T_7	NAA 20 mg/l + $ZnSO_4$ 0.5 %	13.67	14.00	13.83
T_8	NAA 20 mg/l + Borax 0.2%	12.67	13.00	12.83
T_9	NAA 40 mg/l + $ZnSO_4$ 0. 5 %	13.33	13.67	13.50
T_{10}	NAA 40 mg/l + Borax 0.2%	13.00	13.33	13.17
T_{11}	GA_3 25 mg/l + $ZnSO_4$ 0.5 %	12.67	13.00	12.83
T_{12}	GA_3 25 mg/l + Borax 0.2%	13.00	13.67	13.33
T_{13}	GA_3 50 mg/l + $ZnSO_4$ 0.5 %	13.33	13.00	13.17
T_{14}	GA_3 50 mg/l + Borax 0.2%	12.67	13.33	13.00
T_{15}	Control (water spray)	10.00	11.00	10.50
T	S.Em ±	0.58	0.42	0.34
	C. D. (P =0.05)	1.69	1.22	0.97
YXT	S.Em ±	-	-	0.51
	C. D. (P =0.05)	-	-	NS
	C.V. %	8.01	5.58	6.86

Table 3: Effect of foliar application of PGR's and micronutrients on total soluble solid (TSS) at different storage period

Tr. No.	Treatments	Total soluble solids (^{0}Brix)											
		3rd day		Pooled	6th day		Pooled	9th day		Pooled	12th day		Pooled
		1st year	2nd year		1st year	2nd year		1st year	2nd year		1st year	2nd year	
T_1	NAA 20 mg/l	16.57	16.83	16.70	19.57	19.83	19.70	23.23	23.67	23.45	21.67	21.77	21.72
T_2	NAA 40 mg/l	16.17	16.5	16.34	18.67	19.17	18.92	22.83	23.00	22.92	21.59	21.63	21.61
T_3	GA_3 25 mg/l	16.08	16.43	16.26	18.97	19.33	19.15	23.50	23.83	23.67	21.13	21.43	21.28
T_4	GA_3 50 mg/l	16.32	16.47	16.40	19.83	20.17	20.00	23.33	23.50	23.42	21.37	21.57	21.47
T_5	$ZnSO_4$ 0.5 %	15.68	16.00	15.84	19.75	20.20	19.98	22.75	22.87	22.81	20.65	20.8	20.73
T_6	Borax 0.2 %	15.83	16.17	16.00	20.83	21.17	21.00	23.17	23.67	23.42	19.81	20.00	19.91
T_7	NAA 20 mg/l + $ZnSO_4$ 0.5 %	17.50	18.17	17.84	21.00	21.33	21.17	22.83	23.00	22.92	20.58	20.67	20.63
T_8	NAA 20 mg/l + Borax 0.2%	18.08	18.33	18.21	19.58	20.17	19.88	24.10	24.33	24.22	22.45	22.50	22.48
T_9	NAA 40 mg/l + $ZnSO_4$ 0. 5 %	17.68	18.17	17.93	20.41	20.83	20.62	21.83	22.00	21.92	21.78	22.00	21.89
T_{10}	NAA 40 mg/l + Borax 0.2%	17.83	18.00	17.92	20.77	21.00	20.89	23.61	24.00	23.81	20.03	20.17	20.10
T_{11}	GA_3 25 mg/l + $ZnSO_4$ 0.5 %	16.9	17.00	16.95	19.61	20.00	19.81	21.40	21.66	21.53	19.9	20.33	20.12
T_{12}	GA_3 25 mg/l + Borax 0.2%	17.08	17.33	17.21	19.07	19.17	19.12	21.17	21.33	21.25	19.07	20.17	19.62
T_{13}	GA_3 50 mg/l + $ZnSO_4$ 0.5 %	17.53	17.67	17.60	19.48	20.17	19.83	22.42	22.66	22.54	20.36	20.67	20.52
T_{14}	GA_3 50 mg/l + Borax 0.2%	17.11	17.37	17.24	20.14	20.36	20.25	22.08	22.33	22.21	19.97	20.33	20.15
T_{15}	Control (water spray)	14.41	14.67	14.54	17.77	18.00	17.89	19.76	20.00	19.88	17.74	18.33	18.04
T	S.Em ±	1.01	1.02	0.67	0.79	0.80	0.52	0.73	0.73	0.48	0.59	0.68	0.42
	C. D. (P =0.05)	NS	NS	1.89	NS	NS	1.47	2.12	2.12	1.36	1.71	1.95	1.19
YXT	S.Em ±	-	-	1.02	-	-	0.79	-	-	0.73	-	-	0.63
	C. D. (P =0.05)	-	-	NS	-	-	NS	-	-	NS	-	-	NS
C.V. %		10.54	10.40	10.47	6.95	6.88	6.91	5.63	5.58	5.61	4.99	5.61	5.32

Table 4: Effect of foliar application of PGR's and micronutrients on fruit acidity at different storage period

Tr. No.	Treatments	Fruit acidity (%)											
		3rd day		Pooled	6th day		Pooled	9th day		Pooled	12th day		Pooled
		1st year	2nd year		1st year	2nd year		1st year	2nd year		1st year	2nd year	
T_1	NAA 20 mg/l	0.36	0.34	0.35	0.33	0.31	0.32	0.24	0.22	0.23	0.21	0.17	0.19
T_2	NAA 40 mg/l	0.38	0.35	0.37	0.35	0.32	0.34	0.26	0.23	0.25	0.22	0.18	0.20
T_3	GA_3 25 mg/l	0.39	0.37	0.38	0.35	0.34	0.35	0.29	0.28	0.29	0.24	0.23	0.24
T_4	GA_3 50 mg/l	0.41	0.39	0.40	0.36	0.36	0.36	0.31	0.3	0.31	0.27	0.25	0.26
T_5	$ZnSO_4$ 0.5 %	0.40	0.36	0.38	0.34	0.32	0.33	0.29	0.26	0.28	0.23	0.21	0.22
T_6	Borax 0.2 %	0.36	0.35	0.36	0.32	0.3	0.31	0.28	0.24	0.26	0.20	0.19	0.20
T_7	NAA 20 mg/l + $ZnSO_4$ 0.5 %	0.35	0.33	0.34	0.33	0.29	0.31	0.24	0.22	0.23	0.19	0.17	0.18
T_8	NAA 20 mg/l + Borax 0.2%	0.32	0.30	0.31	0.31	0.27	0.29	0.24	0.20	0.22	0.18	0.16	0.17
T_9	NAA 40 mg/l + $ZnSO_4$ 0. 5 %	0.37	0.32	0.35	0.34	0.31	0.33	0.27	0.24	0.26	0.21	0.18	0.20
T_{10}	NAA 40 mg/l + Borax 0.2%	0.34	0.31	0.33	0.3	0.28	0.29	0.24	0.21	0.23	0.19	0.17	0.18
T_{11}	GA_3 25 mg/l + $ZnSO_4$ 0.5 %	0.37	0.34	0.36	0.32	0.3	0.31	0.26	0.24	0.25	0.22	0.18	0.20
T_{12}	GA_3 25 mg/l + Borax 0.2%	0.39	0.36	0.38	0.32	0.31	0.32	0.27	0.25	0.26	0.21	0.19	0.20
T_{13}	GA_3 50 mg/l + $ZnSO_4$ 0.5 %	0.36	0.35	0.36	0.33	0.31	0.32	0.26	0.25	0.26	0.22	0.2	0.21
T_{14}	GA_3 50 mg/l + Borax 0.2%	0.38	0.36	0.37	0.34	0.32	0.33	0.29	0.26	0.28	0.19	0.19	0.19
T_{15}	Control (water spray)	0.5	0.49	0.50	0.44	0.43	0.44	0.35	0.32	0.34	0.25	0.24	0.25
T	S.Em ±	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	C. D. (P =0.05)	0.05	0.04	0.03	0.04	0.04	0.03	0.03	0.03	0.02	0.03	0.02	0.02
YXT	S.Em ±	-	-	0.01	-	-	0.01	-	-	0.01	-	-	0.01
	C. D. (P =0.05)	-	-	NS	-	-	NS	-	-	NS	-	-	NS
C.V. %		7.64	6.34	7.07	7.75	6.73	7.30	7.58	6.57	7.15	7.71	6.60	7.25

Table 5: Effect of foliar application of PGR's and micronutrients on reducing sugar of fruits at different storage period

Tr. No.	Treatments	Reducing sugar (%)											
		3rd day		Pooled	6th day		Pooled	9th day		Pooled	12th day		Pooled
		1st year	2nd year		1st year	2nd year		1st year	2nd year		1st year	2nd year	
T_1	NAA 20 mg/l	9.51	9.93	9.72	10.81	10.92	10.87	11.38	11.40	11.39	11.01	10.91	10.96
T_2	NAA 40 mg/l	9.67	9.91	9.79	10.68	10.79	10.74	11.17	11.39	11.28	11.05	10.86	10.96
T_3	GA_3 25 mg/l	9.54	9.78	9.66	10.6	10.72	10.66	11.23	11.35	11.29	10.87	10.60	10.74
T_4	GA_3 50 mg/l	9.56	9.81	9.69	10.5	10.62	10.56	11.03	11.13	11.08	10.65	10.53	10.59
T_5	$ZnSO_4$ 0.5 %	9.71	9.95	9.83	10.58	10.68	10.63	11.14	11.28	11.21	10.71	10.68	10.70
T_6	Borax 0.2 %	9.99	10.23	10.11	10.37	10.77	10.57	11.33	11.44	11.39	10.97	10.78	10.88
T_7	NAA 20 mg/l + $ZnSO_4$ 0.5 %	10.32	10.57	10.45	11.47	11.42	11.45	11.57	11.59	11.58	10.86	11.03	10.95
T_8	NAA 20 mg/l + Borax 0.2%	11.23	11.47	11.35	11.73	11.86	11.80	12.13	12.23	12.18	11.73	11.54	11.64
T_9	NAA 40 mg/l + $ZnSO_4$ 0. 5 %	10.43	10.67	10.55	11.23	11.36	11.30	11.60	11.70	11.65	11.23	11.04	11.14
T_{10}	NAA 40 mg/l + Borax 0.2%	11.10	11.34	11.22	11.6	11.72	11.66	12.03	12.09	12.06	11.67	11.53	11.60
T_{11}	GA_3 25 mg/l + $ZnSO_4$ 0.5 %	10.44	10.68	10.56	10.33	10.46	10.40	11.00	11.08	11.04	10.66	10.47	10.57
T_{12}	GA_3 25 mg/l + Borax 0.2%	10.42	10.67	10.55	10.63	10.76	10.70	11.10	11.19	11.15	10.7	10.44	10.57
T_{13}	GA_3 50 mg/l + $ZnSO_4$ 0.5 %	10.35	10.59	10.47	10.57	10.69	10.63	11.07	11.17	11.12	10.63	11.19	10.91

T_{14}	GA_3 50 mg/l + Borax 0.2%	10.01	10.25	10.13	10.35	10.47	10.41	11.05	11.14	11.10	10.68	11.35	11.02
T_{15}	Control (water spray)	8.95	9.19	9.07	9.7	9.82	9.76	10.00	10.13	10.07	9.97	9.81	9.89
T	S.Em ±	0.29	0.37	0.22	0.30	0.36	0.22	0.34	0.33	0.22	0.29	0.3	0.19
	C. D. (P =0.05)	0.84	1.07	0.62	0.87	1.04	0.61	0.97	0.96	0.62	0.84	0.86	0.55
YXT	S.Em ±	-	-	0.33	-	-	0.33	-	-	0.33	-	-	0.29
	C. D. (P =0.05)	-	-	NS	-	-	NS	-	-	NS	-	-	NS
C.V. %		5.00	6.18	5.64	4.83	5.72	5.30	5.17	5.04	5.11	4.61	4.80	4.71

Table 6: Effect of foliar application of PGR's and micronutrients on non reducing sugar of fruits at different storage period

Tr. No.	Treatments	Non reducing sugar (%)											
		3rd day		Pooled	6th day		Pooled	9th day		Pooled	12th day		Pooled
		1st year	2nd year		1st year	2nd year		1st year	2nd year		1st year	2nd year	
T_1	NAA 20 mg/l	12.36	12.04	12.20	13.82	14.25	14.04	14.76	14.98	14.87	12.16	12.34	12.25
T_2	NAA 40 mg/l	11.63	11.59	11.61	13.98	14.09	14.04	14.43	14.33	14.38	11.78	12.08	11.93
T_3	GA_3 25 mg/l	11.09	10.92	11.01	12.47	12.38	12.43	13.70	13.75	13.73	11.73	11.81	11.77
T_4	GA_3 50 mg/l	10.97	10.83	10.90	13.47	13.41	13.44	14.10	14.13	14.12	11.85	12.06	11.96
T_5	$ZnSO_4$ 0.5 %	13.02	12.25	12.64	15.66	15.59	15.63	15.96	15.91	15.94	14.06	14.31	14.19
T_6	Borax 0.2 %	12.34	12.23	12.29	15.63	15.43	15.53	16.17	16.14	16.16	14.87	15.31	15.09
T_7	NAA 20 mg/l + $ZnSO_4$ 0.5 %	11.41	11.23	11.32	15.27	16.48	15.88	16.10	16.23	16.17	14.33	14.29	14.31
T_8	NAA 20 mg/l + Borax 0.2%	13.10	13.26	13.18	17.60	15.11	16.36	19.18	19.22	19.20	14.90	15.33	15.12
T_9	NAA 40 mg/l + $ZnSO_4$ 0. 5 %	12.23	12.09	12.16	16.43	16.98	16.71	17.07	17.14	17.11	13.77	14.30	14.04
T_{10}	NAA 40 mg/l + Borax 0.2%	11.93	11.83	11.88	16.43	17.78	17.11	18.33	18.16	18.25	14.30	14.61	14.46
T_{11}	GA_3 25 mg/l + $ZnSO_4$ 0.5 %	12.66	12.58	12.62	17.77	17.84	17.81	17.50	17.51	17.51	13.77	14.12	13.95
T_{12}	GA_3 25 mg/l + Borax 0.2%	11.87	11.4	11.64	16.67	16.71	16.69	16.90	17.60	17.25	14.07	14.45	14.26
T_{13}	GA_3 50 mg/l + $ZnSO_4$ 0.5 %	11.75	11.64	11.70	16.53	16.64	16.59	17.23	17.26	17.25	15.03	14.26	14.65
T_{14}	GA_3 50 mg/l + Borax 0.2%	12.65	12.65	12.65	17.32	17.36	17.34	18.42	18.41	18.42	15.05	14.51	14.78
T_{15}	Control (water spray)	9.71	9.59	9.65	10.93	10.84	10.89	10.50	10.50	10.50	9.20	9.55	9.38
T	S.Em ±	0.77	0.53	0.57	0.88	0.68	0.71	0.72	0.71	0.47	0.84	0.58	0.47
	C. D. (P =0.05)	NS	1.52	1.64	2.54	1.97	2.04	2.08	2.04	1.32	2.42	1.67	1.34
YXT	S.Em ±	-	-	0.47	-	-	0.49	-	-	0.71	-	-	0.72
	C. D. (P =0.05)	-	-	NS	-	-	NS	-	-	NS	-	-	NS
C.V. %		11.18	7.74	6.88	9.95	7.66	5.59	7.75	7.59	7.67	10.84	7.32	9.21

Table 7: Effect of foliar application of PGR's and micronutrients on total sugars of fruits at different storage period

Tr. No.	Treatments	Total sugars (%)											
		3rd day		Pooled	6th day		Pooled	9th day		Pooled	12th day		Pooled
		1st year	2nd year		1st year	2nd year		1st year	2nd year		1st year	2nd year	
T_1	NAA 20 mg/l	21.87	21.97	21.92	24.63	25.17	24.90	26.13	26.38	26.26	23.17	23.25	23.21
T_2	NAA 40 mg/l	21.30	21.50	21.40	24.67	24.88	24.78	25.60	25.72	25.66	22.83	22.94	22.89
T_3	GA_3 25 mg/l	20.63	20.70	20.67	23.07	23.10	23.09	24.93	25.10	25.02	22.60	22.41	22.51
T_4	GA_3 50 mg/l	20.53	20.63	20.58	23.97	24.03	24.00	25.13	25.26	25.20	22.50	22.58	22.54
T_5	$ZnSO_4$ 0.5 %	22.73	22.20	22.47	26.23	26.27	26.25	27.10	27.19	27.15	24.77	24.98	24.88
T_6	Borax 0.2 %	22.33	22.47	22.40	26.00	26.20	26.10	27.50	27.58	27.54	25.50	26.08	25.79
T_7	NAA 20 mg/l + $ZnSO_4$ 0.5 %	21.73	21.80	21.77	26.73	27.90	27.32	27.67	27.82	27.75	25.20	25.32	25.26
T_8	NAA 20 mg/l + Borax 0.2%	24.33	24.73	24.53	29.33	26.97	28.15	31.33	31.42	31.38	26.63	26.87	26.75
T_9	NAA 40 mg/l + $ZnSO_4$ 0. 5 %	22.67	22.77	22.72	27.67	28.33	28.00	28.67	28.84	28.76	25.00	25.34	25.17
T_{10}	NAA 40 mg/l + Borax 0.2%	23.03	23.17	23.10	28.03	29.50	28.77	30.37	30.26	30.32	25.97	26.14	26.06
T_{11}	GA_3 25 mg/l + $ZnSO_4$ 0.5 %	23.10	23.27	23.19	28.10	28.30	28.20	28.50	28.59	28.55	24.93	24.59	24.76
T_{12}	GA_3 25 mg/l + Borax 0.2%	22.30	22.07	22.19	27.30	27.47	27.39	28.00	28.79	28.40	24.77	24.89	24.83
T_{13}	GA_3 50 mg/l + $ZnSO_4$ 0.5 %	22.10	22.23	22.17	27.10	27.33	27.22	28.30	28.42	28.36	25.33	26.12	25.73
T_{14}	GA_3 50 mg/l + Borax 0.2%	22.00	22.90	22.45	27.67	27.83	27.75	28.13	29.56	28.85	25.40	25.87	25.64
T_{15}	Control (water spray)	18.67	18.78	18.73	20.63	20.67	20.65	20.50	20.63	20.57	19.17	19.36	19.27
T	S.Em ±	0.86	0.84	0.56	0.80	0.78	0.55	0.99	0.98	0.65	0.85	0.84	0.55
	C. D. (P =0.05)	2.49	2.42	1.57	2.32	2.26	1.56	2.86	2.83	1.83	2.44	2.42	1.56
YXT	S.Em ±	-	-	0.85	-	-	0.79	-	-	0.99	-	-	0.84
	C. D. (P =0.05)	-	-	NS	-	-	NS	-	-	NS	-	-	NS
C.V. %		6.79	6.56	6.67	5.33	5.16	5.25	6.33	6.19	6.26	6.04	5.95	5.99

Table 8: Effect of foliar application of PGR's and micronutrients on ascorbic acid content of fruits at different storage period

Tr. No.	Treatment	Ascorbic acid content (mg/100g pulp)											
		3rd day		Pooled	6th day		Pooled	9th day		Pooled	12th day		Pooled
		1st year	2nd year		1st year	2nd year		1st year	2nd year		1st year	2nd year	
T_1	NAA 20 mg/l	26.35	26.37	26.36	24.48	24.53	24.51	23.71	23.77	23.74	21.13	21.33	21.23
T_2	NAA 40 mg/l	25.88	25.97	25.93	23.95	24.07	24.01	23.50	23.57	23.54	21.03	21.13	21.08
T_3	GA_3 25 mg/l	25.65	25.83	25.74	24.67	24.70	24.69	23.34	23.37	23.36	21.23	21.27	21.25
T_4	GA_3 50 mg/l	25.73	25.93	25.83	24.57	24.60	24.59	23.51	23.60	23.56	21.23	21.23	21.23
T_5	$ZnSO_4$ 0.5 %	26.39	26.43	26.41	24.76	24.83	24.80	23.85	23.87	23.86	21.98	22.07	22.03

T_6	Borax 0.2 %	26.33	26.47	26.40	24.89	24.97	24.93	23.98	24.00	23.99	22.10	22.13	22.12
T_7	NAA 20 mg/l + $ZnSO_4$ 0.5 %	26.96	27.13	27.05	25.31	25.37	25.34	24.61	24.63	24.62	22.46	22.50	22.48
T_8	NAA 20 mg/l + Borax 0.2%	29.32	29.50	29.41	28.27	28.33	28.30	26.81	26.83	26.82	23.86	23.90	23.88
T_9	NAA 40 mg/l + $ZnSO_4$ 0. 5 %	26.97	27.00	26.99	25.36	25.50	25.43	24.51	24.53	24.52	22.48	22.57	22.53
T_{10}	NAA 40 mg/l + Borax 0.2%	28.71	28.87	28.79	27.77	27.83	27.80	26.21	26.23	26.22	23.53	23.57	23.55
T_{11}	GA_3 25 mg/l + $ZnSO_4$ 0.5 %	28.07	28.12	28.10	26.38	26.41	26.40	25.34	25.35	25.35	22.65	22.76	22.71
T_{12}	GA_3 25 mg/l + Borax 0.2%	28.17	28.30	28.24	26.42	26.47	26.45	25.48	25.50	25.49	22.77	22.83	22.80
T_{13}	GA_3 50 mg/l + $ZnSO_4$ 0.5 %	27.87	28.20	28.04	26.65	26.70	26.68	25.28	25.30	25.29	22.53	22.73	22.63
T_{14}	GA_3 50 mg/l + Borax 0.2%	28.56	28.60	28.58	26.47	26.53	26.50	25.91	25.93	25.92	22.67	22.77	22.72
T_{15}	Control (water spray)	24.31	24.37	24.34	22.14	22.20	22.17	19.80	19.83	19.82	19.21	19.27	19.24
T	S.Em ±	0.70	0.66	0.44	0.61	0.61	0.40	0.58	0.58	0.38	0.56	0.59	0.38
	C. D. (P =0.05)	2.02	1.91	1.26	1.77	1.77	1.14	1.68	1.68	1.08	1.61	1.69	1.06
YXT	S.Em ±	-	-	0.68	-	-	0.61	-	-	0.58	-	-	0.57
	C. D. (P =0.05)	-	-	NS	-	-	NS	-	-	NS	-	-	NS
C.V. %		4.48	4.21	4.34	4.18	4.16	4.17	4.13	4.13	4.13	4.40	4.58	4.49

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