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Jotirmayee Lenka
Scientist (Fruit Science), ICAR-Central Institute for Sub-tropical Horticulture, Rehmankhera, P.O Kakori, Lucknow, Uttar Pradesh, India

GC Acharya
ICAR-Central Horticultural Experiment Station-IIHR, Bhubaneswar, Odisha, India

P Sahu
ICAR-Central Institute of Water Management, C.S Pur, Bhubaneswar, Odisha, India

DK Dash
College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

D Samant
ICAR-Central Horticultural Experiment Station-IIHR, Bhubaneswar, Odisha, India

CM Panda
College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

KN Mishra
College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

RK Panda
College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

Correspondence
Jotirmayee Lenka
Scientist (Fruit Science), ICAR-Central Institute for Sub-tropical Horticulture, Rehmankhera, P.O Kakori, Lucknow, Uttar Pradesh, India

Effect of foliar nutrition of micronutrients and plant growth regulators on yield and quality of guava (*Psidium guajava* L.) cv. Allahabad Safeda

Jotirmayee Lenka, GC Acharya, P Sahu, DK Dash, D Samant, CM Panda, KN Mishra and RK Panda

Abstract
A field experiment was conducted during 2017-2019 at Central Horticultural Experiment Station-ICAR-IIHR, Bhubaneswar. The experiment was laid out in a Factorial Randomized Block Design with thirteen treatments and two season (Rainy and Winter). The results obtained from investigation shows that the foliar spray of SA@100ppm was found to be superior for increasing yield (31.13 and 17.73 kg/tree) during rainy and winter season, respectively. Maximum (6.49 and 6.59 cm) fruit length and fruit diameter were recorded under the foliar application of SA@100 ppm for both the season, respectively. Different quality parameters such as total soluble solid, ascorbic acid and reducing sugar were found to be higher under the treatment Borax@ 0.6%. Similarly, titrable acidity was also reduced significantly over the control with borax and SA at higher concentrations. Ascorbic acid was found superior under the treatment Borax 0.6% (194.71 and 190.16 mg/100g) during winter and rainy crop, respectively and minimum was recorded under control treatment.

Keywords: Guava, micronutrient, bio-regulator, fruit yield and quality

Introduction
Guava (*Psidium guajava* L.) is one of the most important fruit crops of India. It belongs to the natural order Myrtale and the botanical family Myrtaceae, which has 140 genera and 3000 species. It is classified under genus *Psidium*, which contains 150 species, but only *Psidium guajava* has been exploited commercially. It is a native of tropical America from where it was introduced in early 17th century in India by Portuguese (Hayes, 1974) [12].
This fruit is considered as “poor man’s apple” and “apple of tropics’’ because of its high nutritive value and low price in comparison to other fruit crops. It is often marketed as “super fruit” and considered a good source of riboflavin (30mg/100g) Fruits are an excellent source of vitamin C (210-305 mg / 100 g fruit pulp). The pectin content in guava ranges between 0.5 to 1.8 per cent. The fruits are mostly consumed as fresh and hold good potential for processing because of high pectin content.
The area under guava cultivation in India is 262 thousand hectares with an annual production of 3,648 thousand metric tonnes and a productivity of 13.9 metric tonnes/ha. The highest area under guava cultivation is in Uttar Pradesh (49.01thousand ha) with an annual production of 919.94 metric tonnes followed by Madhya Pradesh and Bihar. Punjab leads in productivity with 22.46 tonnes/ha. (NHB-2016-17)
Guava tree is hardy in nature and tolerate the drought and flood condition and adoptability to a wide range of soil and climatic conditions. Its cultural requirement is also very limited. Besides other factors of crop production, nutrients play an important role. It gives good response to manuring and fertilization in increasing fruit production.
Micronutrient and plant growth regulators are most powerful tool for manipulating the tree growth, flowering, fruiting, yield and quality. Micronutrients play a key role in plants growth and development. These elements are associated with various enzymatic activities and synthesis. Their acute deficiencies some time poses the problem of incurable nature (Kumar, 2002) [14]. They also help in the uptake of major nutrients and play an active role in the plant metabolism process starting from cell wall development to respiration, photosynthesis, chlorophyll formation, enzyme activity hormone synthesis, nitrogen fixation and reduction (Das, 2003) [7]

Zinc (Zn) is an essential micro-element required for proper growth and development of plants. It is involved in many enzymatic reactions, viz., protein and carbohydrate metabolism (Trivedi *et al*., 2012) [32]. Zinc is known to have an important role either as a metal component of enzymes or as a functional, structural or regulatory factor of a large number of enzymes. Similarly, boron is necessary for translocation of sugar; reproduction of plants and germination of pollen grains. Its role has been observed in hormone movement and active salt absorption. It has an important role in improving the fruit quality. Boron has an effect on cell wall structure and also has a major effect on cell elongation (pollen tube) and root growth (Meena *et al*., 2008) [18]. Boron is a constituent of cell membrane and essential for cell division. It acts as a regulator of potassium/calcium ratio in the plant and plays an important role in in nitrogen absorption, translocation of carbohydrates, auxin synthesis, ovule development, fertilization and fruit set.

Plant growth regulators like NAA and salicylic acid are known to play an essential role in plant growth, flower induction, fruit set, fruit growth, yield and quality. Work has been done to elucidate the significance of PGR to improve the quality and quantity of produce in many fruit crops (Tripathi and Shukla 2006; Amilkar *et al*., 2006; and Singh *et al*., 2007) [31, 3, 28].

NAA is an important growth regulator of auxin group, which helps to reduce fruit drop and to improve fruit set and overall quality. By the application of NAA, total soluble solid as well as vitamin C content of fruit are increased and acidity is reduced. NAA reduces the number of seed of the fruits. It also induces heavier fruiting and promotes flowering (Sharma and Tiwari, 2015) [26].

Salicylic acid is a new plant growth regulator for most of the horticultural crops (Raskin, 1992b) [24]. The role of SA is well established as a plant emorphogenesis regulator and in regulation of plant growth and development (Kumar and Tayal, 1982) [16]. It is also known for imparting resistance against biotic stress in plants (Gaffney *et al*., 1993) [9].

Materials and Methods

The study was conducted in conducted during 2017-2019 at the research farm of Central Horticultural Experiment Station-ICAR-IIHR, Bhubaneswar. Eight years old plants of uniform size planted at 5 x 5 m in square system were selected for the studies. The experimental site is located at 20°15' N latitude and 85°15' E longitude at an elevation of 25.5 m above mean sea level. Bhubaneswar falls under hot and humid tropical climate. The soil of the experimental site is sandy loam (80.45% sand, 10.19% silt and 9.36% clay) and strongly acidic (pH 4.6), low in organic carbon (0.20%), N (189.8 kg ha), P (8.5 kg ha) and K (140.58 kg ha). Guava plants were spaced at 5m x 5m accommodating 400 plants per ha. The experiment was laid out under Factorial Randomized Block Design with 13 treatments having three replications and two season. Treatments including T1 - Zinc Sulphate 0.2%, T2 - Zinc Sulphate 0.2%, T3 - Zinc Sulphate 0.6%, T4 - Borax 0.2%, T5 -Borax 0.4%, T6 - Borax 0.6%, T7 -NAA 50 ppm, T8 -NAA 75 ppm, T9 -NAA 100 ppm, T10 – SA 50 ppm T11 – SA 75 ppm T12 – SA 100 ppm T13-Control(Water Spray) and two season. The treatments were applied three times before flowering, at 50% fruit set and four weeks after fruit set during both the season. Observations were recorded fruit set, fruit retention, yield and fruit quality parameters (total soluble solids, acidity, vitamin C content total and reducing sugar).

Fruit Set (%)

The total number of flowers which set into fruits were counted on 20 tagged shoots and the percent of fruit set was calculated on the basis of number of flowers emerged during mrig (winter season) and ambe bahar (rainy season).

$$\text{Fruit set (\%)} = \frac{\text{Number of fruit set}}{\text{Total number of flowers}} \times 100$$

Fruit retention (%)

The fruit retention per cent is calculated with following formula:

Fruit retention (%) = Number of fruits at harvest/ initial number of fruit set x100.

Yield per tree

The fruits harvested from each tree were weighted from all the pickings and recorded in kilogram and converted into tonnes per hectare for both winter and rainy season crop.

Size of fruit

Fruit size in terms of length (cm) from the apex to stem end and diameter (cm) was measured using Vernier calliper and mean values were obtained

Hand refractometer was used for determination of TSS in ◦Brix. Acidity was estimated by simple acid-alkali titration method as described in Ranganna. (1977) [23]. Total sugars and reducing sugar in the fruit pulp were estimated by Shaffer Shomogi method (Ranganna, 1977) [23]. Assay method of ascorbic acid was followed given by Ranganna (1977) [23]

Results and Discussion

Fruit set and Fruit retention

The results of the present investigation revealed that influence of micronutrients and growth regulators on fruit set, and fruit retention. It is clear from the results (Table-1) that maximum fruit setting (80.65 and 77.90%) was recorded with plant received SA@100 ppm (T12) and the fruit retention was found maximum (73.27% and 67.54%) in NAA @ 100 ppm (T9) which was at par with SA@100 ppm (T12) in both rainy and winter season crop, respectively and minimum (36.32% and 34.94%) fruit retention was recorded in control for both rainy and winter season respectively.

The present results revealed that NAA increase the fruit retention may be due to auxin is well known as inhibitors for abscisic acid and ethylene which cause fruit drop (Ram, 1983) [22]. There is correlation between fruit drop and endogenous NAA status and existence of high level of internal auxin that prevent fruit drop. Since high level of endogenous hormones might help in building up endogenous hormone at appropriate level potent to enough reduces the fruit drop. These results are in conformity with the findings of Yadav *et al*. (2011) [33] in guava. Sharma and Tiwari (2015) [26] stated that NAA reduce the fruit drop, improve number of flowers, fruit set and fruit retention. Similar results were also obtained by Agnihotri *et al*. (2013) [1] and Hada *et al*. (2013) [11]. By foliar sprays of SA fruit retention was increased might be due to better photosynthetic activity (Singh and Usha, 2003) [27] leading to proper supply of carbohydrates to the fruits and also due to reduced abscission. Similar finding were also observed by Ahmed *et al*. (2015a) [2]; Ngullie *et al*. (2014) [19] in mango and Nicholas and Embree (2004) [21]

Yield

The interaction effect of different treatments on season was found to be significant on fruit yield in both the year of experiment. The highest yield (31.13 kg/tree and 17.73 kg/tree) was found in SA@100 ppm (T12) treatment and lowest yield (9.89 kg/tree and 5.95 kg/tree) was observed in control for both rainy and winter season, respectively. Salicylic acid is responsible for increase the yield by increased the fruit set percentage, increase in fruit weight and number of fruits per tree. These findings are in agreement with the findings of Ahmed *et al*. (2015a) [2] in mango; Faissal *et al*. (2014) [8]; Ngullie *et al*. (2014) [19]; Ashraf *et al*. (2012) in kinnow and Singh *et al*. (2001) [29].

Fruit Size

The interaction effect of different treatments on season was found to be significant on fruit size in both the year of experiment. In winter crop the maximum (6.52 cm) fruit length were found in SA@100 ppm (T12) which was at par with NAA@100 ppm (T9) (6.51). Fruit diameter was also maximum (6.59 cm) was in SA@100 ppm which was at par with SA@75 ppm and borax @0.6%, whereas minimum (5.92 cm) was recorded in control. The increase in fruit size was due to accelerated rate of cell division and cell enlargement and more intercellular space with the application of higher concentration of growth substances. Endogenous auxin is responsible for increasing fruit size in guava. The rapid growth of the fruit synchronized with the maximum amount of auxin present therein. The increase in length and diameter of guava fruit may be that higher concentration of mineral nutrients (boron and zinc) appears to have direct role in hastening the process of cell division and cell elongation due to which size and weight of fruits would have improved (Tirkey *et al*., 2018) [30]

Quality attributes

The interaction effect of different treatments showed significant variation on TSS, acidity, total, reducing sugar and ascorbic acid content for both winter and rainy season in guava

TSS

The effect of various plant growth regulators on total soluble solids content was found to be significant. The highest TSS content 12.25°B) was recorded in Borax @ 0.6% (T6) treatment while minimum (9.00 °B) was found in control. Boron is associated in the carbohydrate transport within plants. The sugars are transported more readily across cell membranes as a borate ion may be associated with the cell membrane where it could complex with sugar molecules and facilitate its passes across the membranes that might be reason of the increased TSS and sugars. The results are in conformity with those reported by Gauch and Dugger, 1953 [10] in the bael and Tirkey *et al*., 2018 [30] in guava

Titrable acidity

Titrable acidity influenced significantly by various treatment. The highest titrable acidity (0.49% and 0.42%) was found in control while lowest acidity (0.34% and 0.29%) was reported under with Borax@ 0.6% (T6). The decrease in acid content may be due to that the increased sugar and reduced leaf starch content, which was due to more transformation of starch into sugar and its translocation into the fruits (Kumar *et al*., 2013) [5].

Ascorbic acid

The ascorbic acid content of fruit pulp was significantly influenced by the various treatments. The highest ascorbic acid content (178.84 mg/100g) was reported in Borax @0.6% (T6) while lowest (144.95 mg/100g) was found in control. Higher ascorbic acid (Vitamin-C) content was recorded with different concentration of boron sprays on fruit plants. Increase in ascorbic acid content might be due to catalytic activity on its biosynthesis from its precursor glucose-6-phosphate or inhibition of its conversion into dehydro ascorbic acid by enzyme ascorbic acid oxidize or both as opined by Brahamchari and Rani (2001) [6].

Total sugar

The highest total sugar content (8.70%) was found in SA@100 ppm (T12) while lowest (7.97%) was reported under control in rainy season crop whereas in winter total sugar content was highest (9.73%) and minimum (8.94%) was recorded in control. The possible reason for increased sugar content in SA treatment because salicylic acid might be regulate the carbohydrate metabolism in both source and sink tissue of plants. The hydrolysis of sucrose by invertase regulates the levels of some plant hormones like indole-3-acetic acid, salicylic acid and jasmonic acid (LeClere *et al*., 2003) [17]. Reducing sugar increased might be due to translocation of more photosynthetic assimilates to the fruits and breakdown of starch during ripening. (Reddy and Sharma, 2016) [25]. the findings of Faissal *et al*. (2014) [8], Ngullie *et al*. (2014) [19].

Reducing sugar

It is clear from the Table 6 that the reducing sugar were affected due to various treatments. The maximum reducing sugar (4.81%) was recorded under Borax@ 0.6% (T6) treatment and minimum reducing sugar content (4.06%) was recorded in control (T13) treatment. The reason for increase in the content of reducing sugar might be due to efficient translocation of photosynthates to the fruits by regulation of boric acid (Iqbal *et al*., 2009) [13].

TSS-acid and Sugar-acid ratio

A marked increase in TSS acid and sugar-acid ratio was recorded when the plants were sprayed with different micronutrients and growth regulators (Table 7). The highest ratio (31.52 43.16) and (25.27 and 34.25) was recorded under Borax@ 0.6% (T6) treatment and lowest ratio (16.94 and 21.32) was observed under control (T13) treatment in both the rainy and winter season, respectively. The reason for increasing sugar- acid ratio by Borax treated fruit might be due related to increased sugar content and reduced acid content of fruits. The decrease in acid content and increase in TSS resulted into an increase in TSS/acid ratio. It may be due to that the increased sugar and reduced leaf starch content, which was due to more transformation of starch into sugar and its translocation into the fruits (Kumar *et al*., 2013) [5].

Table 1: Effect of micronutrients and plant growth regulators on fruit set and fruit retention of guava

Treatments	Fruitset (%)		Mean	Fruit retention (%)		Mean
	Winter (S1)	Rainy (S2)		Winter (S1)	Rainy (S2)	
T_1 - 0.2% $ZnSO_4$	61.69	71.24	66.47	48.64	53.69	51.16
T_2 - 0.4% $ZnSO_4$	66.90	72.49	69.69	50.33	54.94	52.63
T_3 - 0.6% $ZnSO_4$	69.56	73.77	71.67	56.03	57.51	56.77
T_4 - 0.2% Borax	73.39	73.46	73.43	58.30	59.05	58.67
T_5 - 0.4% Borax	73.94	75.00	74.47	62.34	63.15	62.74
T_6 - 0.6% Borax	74.60	75.16	74.88	63.44	65.25	64.34
T_7 - 50 ppm NAA	68.45	69.48	68.97	64.27	62.24	63.25
T_8 - 75 ppm NAA	71.71	72.95	72.33	66.95	67.84	67.39
T_9 - 100 ppm NAA	75.56	75.51	75.54	67.54	73.27	70.41
T_{10} - 50 ppm SA	72.77	77.37	75.07	50.99	66.91	58.95
T_{11} - 75ppm SA	75.58	78.16	76.87	56.24	68.40	62.32
T_{12} - 100 ppm SA	77.90	80.65	79.27	60.91	70.13	65.52
T_{13} - (Control)	58.84	63.25	61.05	34.94	36.32	35.63
Mean	70.84	73.73		48.64	53.69	

	T	S	T X S	T	S	T X S
SE(d)	1.348	0.529	1.907	1.595	0.626	2.255
CD (0.05)	2.716	1.065	3.841	3.213	1.260	4.544

Table 2: Effect of micronutrients and plant growth regulators on yield of guava

Treatments	Fruit Yield (Kg/tree)		Mean	Fruit Yield (t/ha)		Mean
	Winter (S1)	Rainy (S2)		Winter (S1)	Rainy (S2)	
T_1 - 0.2% $ZnSO_4$	8.23	14.65	11.44	3.29	5.86	4.58
T_2 - 0.4% $ZnSO_4$	8.97	17.07	13.02	3.59	6.83	5.21
T_3 - 0.6% $ZnSO_4$	9.91	18.81	14.36	3.96	7.52	5.74
T_4 - 0.2% Borax	8.90	19.97	14.44	3.56	7.99	5.77
T_5 - 0.4% Borax	10.65	21.00	15.83	4.26	8.40	6.33
T_6 - 0.6% Borax	11.35	23.60	17.48	4.54	9.44	6.99
T_7 - 50 ppm NAA	8.17	14.39	11.28	3.27	5.75	4.51
T_8 - 75 ppm NAA	9.06	16.33	12.70	3.62	6.53	5.08
T_9 - 100 ppm NAA	9.88	17.70	13.79	3.95	7.08	5.52
T_{10} - 50 ppm SA	11.92	22.78	17.35	4.77	9.11	6.94
T_{11} - 75ppm SA	13.70	26.48	20.09	5.48	10.59	8.04
T_{12} - 100 ppm SA	17.73	31.13	24.43	7.09	12.45	9.77
T_{13} - (Control)	5.95	9.89	7.92	2.38	3.96	3.17
Mean	10.34	19.52		4.14	7.81	

	T	S	T X S	T	S	T X S
SE(d)	0.172	0.068	0.244	-	-	-
CD (0.05)	0.347	0.136	0.491	-	-	-

Table 3: Effect of micronutrients and plant growth regulators on yield attributing characters of guava

Treatments	Fruit length (cm)		Mean	Fruit diameter (cm)		Mean
	Winter (S1)	Rainy (S2)		Winter (S1)	Rainy (S2)	
T_1 - 0.2% $ZnSO_4$	6.19	5.48	5.84	6.36	6.23	6.29
T_2 - 0.4% $ZnSO_4$	6.32	6.04	6.18	6.41	6.26	6.33
T_3 - 0.6% $ZnSO_4$	6.43	6.19	6.31	6.48	6.37	6.42
T_4 - 0.2% Borax	6.36	6.10	6.23	6.43	6.26	6.35
T_5 - 0.4% Borax	6.38	6.36	6.37	6.46	6.27	6.36
T_6 - 0.6% Borax	6.41	6.32	6.36	6.49	6.46	6.47
T_7 - 50 ppm NAA	5.70	5.45	5.57	6.23	6.09	6.16
T_8 - 75 ppm NAA	5.94	5.98	5.96	6.26	6.17	6.22
T_9 - 100 ppm NAA	6.51	6.08	6.29	6.34	6.28	6.31
T_{10} - 50 ppm SA	6.48	6.32	6.40	6.53	6.43	6.48
T_{11} - 75ppm SA	6.48	6.37	6.43	6.57	6.49	6.53
T_{12} - 100 ppm SA	6.52	6.47	6.49	6.70	6.48	6.59
T_{13} - (Control)	5.61	5.11	5.36	6.00	5.83	5.92
Mean	6.26	6.02		6.40	6.28	

	T	S	T X S	T	S	T X S
SE(d)	0.054	0.021	0.077	0.038	0.015	0.053
CD (0.05)	0.109	0.043	0.154	0.076	0.030	NS

Table 4: Effect of micronutrients and plant growth regulators on TSS and total titrable acidity in guava

Treatments	TSS (◦ brix)		Mean	Acidity (%)		Mean
	Winter (S1)	Rainy (S2)		Winter (S1)	Rainy (S2)	
T_1 - 0.2% $ZnSO_4$	11.52	8.73	10.13	0.40	0.43	0.42
T_2 - 0.4% $ZnSO_4$	11.87	9.37	10.62	0.37	0.42	0.39
T_3 - 0.6% $ZnSO_4$	12.02	9.55	10.78	0.36	0.39	0.38
T_4 - 0.2% Borax	11.77	10.28	11.03	0.33	0.38	0.36
T_5 - 0.4% Borax	12.15	10.68	11.42	0.32	0.36	0.34
T_6 - 0.6% Borax	12.25	10.67	11.46	0.29	0.34	0.32
T_7 - 50 ppm NAA	9.72	8.33	9.03	0.40	0.42	0.41
T_8 - 75 ppm NAA	10.08	8.57	9.33	0.40	0.40	0.40
T_9 - 100 ppm NAA	10.97	9.33	10.15	0.36	0.39	0.38
T_{10} - 50 ppm SA	10.67	9.57	10.12	0.38	0.39	0.38
T_{11} - 75ppm SA	10.97	10.32	10.64	0.36	0.37	0.37
T_{12} - 100 ppm SA	11.20	10.42	10.81	0.32	0.35	0.34
T_{13} - (Control)	9.00	8.77	8.88	0.42	0.49	0.46
Mean	11.09	9.58		0.36	0.40	

	T	S	T X S	T	S	T X S
SE(d)	0.095	0.037	0.135	0.008	0.003	0.012
CD (0.05)	0.192	0.075	0.271	0.016	0.006	0.023

Table 5: Effect of micronutrients and plant growth regulators on ascorbic acid of guava

Treatments	Ascorbic acid (%)		Mean
	Winter (S1)	Rainy (S2)	
T_1 - 0.2% $ZnSO_4$	163.79	145.91	154.85
T_2 - 0.4% $ZnSO_4$	168.56	147.50	158.03
T_3 - 0.6% $ZnSO_4$	172.51	153.86	163.18
T_4 - 0.2% Borax	173.60	156.55	165.08
T_5 - 0.4% Borax	190.16	158.25	174.21
T_6 - 0.6% Borax	194.71	162.97	178.84
T_7 - 50 ppm NAA	157.21	142.84	150.02
T_8 - 75 ppm NAA	162.09	149.48	155.78
T_9 - 100 ppm NAA	166.09	156.33	161.21
T_{10} - 50 ppm SA	155.84	143.72	149.78
T_{11} - 75ppm SA	158.69	149.53	154.11
T_{12} - 100 ppm SA	162.42	152.22	157.32
T_{13} - (Control)	150.52	139.39	144.95
Mean	167.40	150.66	

	T	S	T X S
SE(d)	0.563	0.221	0.796
CD (0.05)	1.134	0.445	1.604

Table 6: Effect of micronutrients and plant growth regulators on reducing and total sugar in guava

Treatments	Reducing Sugar (%)		Mean	Total Sugar (%)		Mean
	Winter (S1)	Rainy (S2)		Winter (S1)	Rainy (S2)	
T_1 - 0.2% $ZnSO_4$	5.60	4.67	5.14	9.35	8.35	8.85
T_2 - 0.4% $ZnSO_4$	5.65	4.69	5.17	9.51	8.48	8.99
T_3 - 0.6% $ZnSO_4$	5.62	4.71	5.17	9.62	8.63	9.13
T_4 - 0.2% Borax	5.68	4.73	5.20	9.66	8.28	8.97
T_5 - 0.4% Borax	5.65	4.76	5.21	9.66	8.48	9.07
T_6 - 0.6% Borax	5.71	4.81	5.26	9.73	8.54	9.14
T_7 - 50 ppm NAA	5.53	4.52	5.03	9.07	8.09	8.58
T_8 - 75 ppm NAA	5.65	4.56	5.11	9.25	8.14	8.70
T_9 - 100 ppm NAA	5.67	4.63	5.15	9.28	8.39	8.83
T_{10} - 50 ppm SA	5.62	4.61	5.11	9.43	8.45	8.94
T_{11} - 75ppm SA	5.66	4.65	5.16	9.36	8.51	8.94
T_{12} - 100 ppm SA	5.68	4.70	5.19	9.28	8.70	8.99
T_{13} - (Control)	5.51	4.06	4.78	8.94	7.97	8.46
Mean	5.63	4.62		9.39	8.39	

	T	S	T X S	T	S	T X S
SE(d)	0.032	0.012	0.045	0.042	0.017	0.060
CD (0.05)	0.063	0.025	0.090	0.085	0.034	0.121

Table 7: Effect of micronutrients and plant growth regulators on Sugar acid ratio and TSS acid ratio in guava

Treatments	Sugar acid Ratio		Mean	TSS acid ratio		Mean
	Winter (S1)	Rainy (S2)		Winter (S1)	Rainy (S2)	
T_1 - 0.2% $ZnSO_4$	23.39	19.47	21.43	28.82	20.39	24.61
T_2 - 0.4% $ZnSO_4$	25.78	20.46	23.12	32.21	22.62	27.42
T_3 - 0.6% $ZnSO_4$	27.15	22.20	24.68	33.95	24.58	29.27
T_4 - 0.2% Borax	29.38	21.62	25.50	35.85	26.84	31.35
T_5 - 0.4% Borax	30.86	23.40	27.13	38.26	29.42	33.84
T_6 - 0.6% Borax	34.25	25.27	29.76	43.16	31.52	37.34
T_7 - 50 ppm NAA	22.69	19.06	20.88	24.32	22.53	23.42
T_8 - 75 ppm NAA	23.46	20.42	21.94	25.56	21.48	23.52
T_9 - 100 ppm NAA	25.79	21.58	23.68	30.50	24.00	27.25
T_{10} - 50 ppm SA	24.89	22.05	23.47	28.17	24.98	26.58
T_{11} - 75ppm SA	26.42	22.80	24.61	30.97	27.66	29.32
T_{12} - 100 ppm SA	29.12	25.03	27.08	35.18	30.02	32.60
T_{13} - (Control)	21.32	16.94	19.13	21.45	17.71	19.58
Mean	26.50	21.56		31.42	24.91	

	T	S	T X S	T	S	T X S
SE(d)	0.163	0.064	0.230	0.266	0.104	0.377
CD (0.05)	0.328	0.129	0.464	0.536	0.210	0.759

Conclusions

On the basis of results obtained in present investigation it might be concluded that foliar spray of SA@100 followed by Borax @0.6% was most efficient to increase in fruit set, fruit retention, decreased fruit drop, increase the pulp weight, fruit length, diameter of fruit and reduced the seed weight which ultimately increased the yield per tree.

References

1. Agnihorti A, Tiwari R, Singh OP. effect of crop regulators on growth yield and quality of guava. Annals. of plant and soil research. 2013; 15(1):56-57.
2. Ahmed FF, Mansour AEM, Merwad MA. Physiological studies on the effect of spraying salicylic acid on fruiting of Sukkary mango trees. Int. J Chem. Tech. Res. 2015a; 8(4):2142-2149.
3. Amilkar MM, Luis AG, Dujarte VM, Rosa M, Consujelo N, Vicente G *et al*. Longterm effect of GA spray and Auxin application on crop value of Clausellina Satsuma. J Amer. Soc. Hort. Sci. 2006; 13(5):586-592.
4. Ashraf MY, Yaqub M, Akhter J, Khan MA, Khan A, Ebert G. Improvement in yield, quality and reduction in fruit drop in kinnow (*Citrus reticulata* Blanco) by exogenous application of plant growth regulators, potassium and zinc. Pakistan J Bot. 2013; 45(SI):433-440.
5. Bindhyachal R, Mandal BKr, Kumar U, Ravindra K, Kumar P. Response of guava to boron and growth regulators spray. Asian J Hort. 2016; 11(1):146-150.
6. Brahmachari VS, Rani R. Effect of growth substances on productivity, cracking, ripening and quality of fruits of litchi. Orissa J Hort. 2001; 29:44-45.
7. Das DK. Micronutrients: Their behaviours in soils and plants. 2nd ed Kalyani publication, Ludhiana, 2003, 1-2.
8. Faissal FA, Mohamed KK, Hamdy IMI. The synergistic effects of using plant extracts and salicylic scid on yield and fruit quality of Keitte mango trees. Stem Cell. 2014; 5(2):30-39.
9. Gaffney T, Friedrich L, Vernooij B, Negrotto D, Nye G, Uknel S, Ward E *et al*. Requirements of salicylic acid for the induction of sestemic required resistances. Science. 1993; 261:7543-756.
10. Gauch HG, Dugger WWJ. The physiological action of boron in higher plants-a review and interpretation. Technical Bulletin A, University Maryland Agriculture Experiment Station, USA, 1953, 80.
11. Hada TS, Singh BK, Veer K, Singh SP. Effect of different levels of boron and zinc on flowering, fruiting and growth parameter of winter season guava (*Psidium guajava* L.) cv. L-49. The Asian J Hort. 2013; 9(1):53-56.
12. Hayes WB. Fruit Growing in India. Kitabistan, Allahabad, 1974.
13. Iqbal M, Qasimkhan M, Jalal-Ud-Din K, Rahman, Munir M. Effect of foliar application of NAA on fruit drop, yield and physicochemical characteristics of guava cv. Red fleshed. Journal of Agricultural Res. 2009; 47(3):259-269.
14. Kumar P. Managing micronutrient deficiency in ornamental crops. Indian Horticulture. 2002; 46(4):30-31.
15. Kumar R, Tiwari R, Kumawat BR. Quantitative and qualitative enhancement in guava (*Psidium guajava* L.) cv. Chittidar through foliar feeding. Internat. J agric. Sci. 2013; 9(1):177-181.
16. Kumar S, Tayal MS. Effect of phenols and Gibbrellic acid on the germination and seedling growth of some legumes. J Ind. Bot. Soc. 1982; 61:125-128.
17. LeClere S, Scmelz EA, Chourey PS. Cell wall invertase-deficient miniature kernels have altered phytohormone levels. Phytochem. 2003; 69(3):692-699.
18. Meena VS, Yadav PK, Meena PM. Yields attributes of ber (*Ziziphus mauritiana*) cv. Gola as influenced by foliar application of ferrous sulphate and borax. Agriculture Science Digest. 2008; 28(3):219-221.
19. Ngullie CR, Tank TV, Bhanderi DR. Effect of salicylic acid and humic acid on flowering, fruiting, yield and quality of mango (*Mangifera indica* L.) cv. Kesar. Adv. Res. J. Crop Improvement. 2014; 5(2):136-139.
20. NHB. Horticulture Statistics at a Glance. Ministry of Agriculture and Farmer Welfare, Horticulture statistics division, Government of India, 2016-17, 1-481.
21. Nicholas D, Embree C. Blossom end fruitlet thinners affected affect crop load, fruit weight, seed number and return bloom of Northern Spy Apple. Hort. Sci. 2004; 39(6):1309-1312.
22. Ram S. Hormonal control of fruit growth and fruit drop in mango cv. Dashehari. Acta Hort. 1983; 134:169-178.

23. Ranganna S. Manual of analysis of fruits and vegetable products, Tata Mc Graw Hill Publication Company Ltd., New Delhi, India, 1977.
24. Raskin I. Role of Salicyclic acid in plant. Ann. Rev. Plant Physiol and Plant Mol. Biology. 1992b; 43:439-463.
25. Reddy VR, Sharma RR. Effect of pre-harvest application of salicylic acid on the post-harvest fruit quality of the Amrapali mango (*Mangifera indica* L.). Indian J Agric. Sci. 2016; 86(6):727-31.
26. Sharma R, Tiwari R. Effect of growth regulator sprays on growth, yield and quality of guava under malwa plateau condition. Anna. Plant and soil research. 2015; 17(3):287-291.
27. Singh B, Usha K. Salicylic acid induced physiological and biochemical changes in wheat seedlings under water stress. Plant Growth Regul. 2003; 39(2):137-141.
28. Singh NK, Prasad J, Singh HK. Effect of micronutrients and PGRS on yield and physico-chemical characteristics of Aonla fruits in cv. NA-10. Ind. J Hort. 2007; 64(2):216-218.
29. Singh VK, Saini JP, Misra AK. Response of salicylic acid on flowering, floral malformation, fruit set, yield and associated bio-physical and biochemical characters of mango. Indian J Hort. 2001; 58(3):196-201.
30. Tirkey NR, Kanpure RN, Kachouli BK, Bhandari J, Patidar DK. Effect of plant growth regulators and micronutrients on fruit yield and quality of guava cv. Allahabad Safeda. International Journal of Chemical Studies. 2018; 6(4):2295-2298.
31. Tripathi VK, Shukla PK. Effect of plant bioregulator on growth, yield and quality of strawberry cv. Chandar. J Asian Hort. 2006; 2(4):260-263.
32. Trivedi N, Singh D, Bahadur VM, Collis JP. Effect of foliar application of zinc and boron on yield and fruit quality of guava (*Psidium guajava* L.). Hort. Flora Res. Spectrum. 2012; 1(3):281-283.
33. Yadav HC, Yadav AL, Yadav DK, Yadav PK. Effect of foliar application of micronutrients and GA3 on fruit yield and quality of rainy season guava (*Psidium guajava* cv.) L-49. Plant Archives. 2011; 11(11):147-149.