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Effect of Plant Growth Regulators on Fruit Yield and Quality of Guava (*Psidium guajava*) cv. Allahabad *Safeda*

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Pre-harvest foliar application of growth promoters like NAA (Naphthalene Acetic Acid), GA_3 (Gibberellic Acid) and Triacontanol can be effectively used to improve yield and quality attributes of guava fruits. NAA (100-200 ppm), GA_3 (25-75 ppm) and Triacontanol (5-15 ppm) applications were reported to bring improvement in yield and quality of guava fruits in comparison to control. The results of experiment revealed that foliar application of NAA 200 ppm recorded maximum fruit size (53.14cm^2), fruit weight (138.53gm), specific gravity (1.17gm/cm^3) and minimum seed weight (5.19gm) followed by NAA 150 ppm. The quality of fruits in terms of total soluble solids (11.47%), reducing sugar (4.48%), ascorbic acid (239.03g/100gpulp) and total sugar (7.43%) were also significantly higher with treatment NAA 200 ppm followed by NAA 150 ppm. Moreover, an application of NAA 200 ppm significantly reduced acidity (0.20%).

Keywords: Ascorbic acid; Guava; NAA; GA_3; Plant Growth Regulators; Triacontanol**.**

Guava (*Psidium guajava* L.) plants, a member of family Myrtaceae, bear climacteric fruits and is usually known as apple of the tropics or the poor man's fruit. Its origin is in tropical America and adopted well for commercial cultivation throughout tropics due to its hardy nature, prolific bearing, high ascorbic acid content (Negi and Rajan, 2007). Guava fruit contains 82.50 per cent water, 2.45 percent reducing sugar, 2.23 percent non-reducing sugar, 9.73 percent total soluble solids, 0.48 percent ash and 260 mg vitamin-C per 100 gm of fruit pulp as well as good amount of iron, calcium and phosphorus. These constituents may differ with the cultivar, stage of maturity and season. Guava ripe rapidly and being highly perishable, it can be stored for 2 to 3 days under ambient condition (Bassetto *et al.* 2005).

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The quality of guava fruit is greatly affected by temperature and humidity. The development of sweetness, color and aroma depends on low temperature and dry atmosphere, due to which the fruit quality of winter fruits is better than rainy. Rainy season crop has high production but quality is poor due to insipidness (Singh *et al.* 1996) and infestation of pest (Rawal and Ullasa, 1988). Though the fruit quality of winter season crop is better, but fruits remain small in size; becomes too hard and lack ripening due to low temperature. Thus, there is need of standardization of practices to bring further improvement in fruit yield and quality in winter season. Growth regulator like GA_3 and NAA affects flower and fruit setting, cell growth, apical dominance, geotropism and photoperiod. GA_3 had the highest fruit retention and yield followed by Amcotone, activated dry yeast and NAA in both winter and rainy seasons. The growth regulators spray in addition increases fruit weight, total soluble solids (TSS), fruit weight, carotene, reducing sugars, total sugars and vitamin-C and decreased tannin and fruit acidity. The Triacontanol is present as a natural component of plant wax and bee wax (Abubakar *et al*. 2013). The pre-harvest sprays of growth regulators and minerals are the new practices nowadays adopted for higher fruit production and improved fruit quality (Dutta and Banik, 2007 and El-hilali *et al.* 2003). All these chemicals have positive impact on number of seeds per fruit, fruits per plant, fruit setting and fruit set percent. Thus, study was carried to identify the effectiveness of growth regulator (NAA, GA_3, Triacontanol) to improve yield and quality attributes of guava cv. Allahabad Safeda in winter season.

MATERIALS AND METHODS

The investigation was carried out during 2014-15 on three year old trees of Allahabad Safeda guava planted at a distance of 3x3 m apart at Guava orchard, located at main Experiment Station of Lovely Professional University, Phagwara, Punjab. The trees were sprayed with NAA 100ppm (T_1), NAA 150ppm (T_2), NAA 200ppm (T_3), GA_3 25ppm (T_4), GA_3 50ppm(T_5), GA_3 75ppm (T_6), Triacontanol 5ppm (T_7), Triacontanol 10ppm (T_8) and Triacontanol 15ppm (T_9) and result was compared with control (T_0). Ten fruits were randomly selected from each replication and average fruit weight, seed weight per fruit, average fruit size and specific gravity were recorded. The chemical parameters like total soluble solids in ^{0}Brix was determined by using hand refractometer and was expressed in percent, titratable acidity was determined as citric acid by titrating against N/10 NaOH alkali solution and was expressed in percent, ascorbic acid or Vitamin-C present in fruit was determined by using dye 2,6 dichlorophenol indophenol (DCPIP) through visual titration method and was expressed in g per 100g of pulp whereas reducing, non-reducing and total sugar were estimated by Lane and Eynon's method and were expressed in percent (AOAC, 2000). Significance of differences among various treatments was analyzed by using RBD for each parameter at $P \leq 0.05$ as advocated Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Physical attributes of guava fruits

The observations recorded on response of pre-harvest application of various plant growth promoters on physical attributes or yield related attributes of guava fruit have been presented in Table-1. The result revealed that the growth regulators have significant effect on fruit size and majority of treatments differ significantly from one another. The fruit size with respect to length and breadth significantly increased with foliar application of plant growth regulators in

Table 1. Physical properties of guava fruits as function of pre-harvest application of plant growth regulators

Treatment names	Treatments	Fruit size (cm^2)	Fruit weight (g)	Seed weight (g)	Specific gravity (g/cm^3)
Control (Water spray)	T_0	28.43	72.12	6.57	0.90
NAA 100 ppm	T_1	46.7	118.30	5.68	1.13
NAA 150 ppm	T_2	50.49	132.80	5.42	1.14
NAA 200 ppm	T_3	53.14	138.53	5.19	1.17
GA_3 25 ppm	T_4	41.83	93.90	6.2	0.99
GA_3 50 ppm	T_5	44.59	103.10	6.06	1.03
GA_3 75 ppm	T_6	48.69	122.07	5.93	1.12
Triacontanol 5 ppm	T_7	29.75	78.37	6.5	0.93
Triacontanol 10 ppm	T_8	32.45	82.07	6.39	0.97
Triacontanol 15ppm	T_9	38.89	93.20	6.29	1.03
Mean		41.49	103.45	6.02	1.04
SEm±		0.421	2.7871	0.0488	0.026
CD at 5%		1.25	5.855	0.102	0.077

comparison to control (28.43 cm^2) and varied from 29.75 cm^2 in Triacontanol 5ppm (T_7) to 53.14 cm^2 in NAA 200 ppm (T_3). The results further indicated that mean value of all concentrations of NAA also had the highest fruit size which was 1.7 times more than control. The highest fruit size (53.14 cm^2) was obtained from application of NAA 200 ppm (T_3) followed by T_2 (NAA 150 ppm) and T_6 (GA_3 75 ppm). The improvement in size of guava fruits due to pre-harvest foliar application of various concentration of NAA might be result of enhanced internal physiology during fruit development which induced efficient utilization of resources like water, nutrients and other vital compounds. Jain and Dashora (2011) also observed maximum diameter 7.30 cm due to pre-harvest application of 200 ppm NAA in guava. In a similar study, Dutta and Banik (2007) reported increased fruit size, weight and yield in sardar guava when NAA and GA_3 with nutrients were applied before fruit setting and again 3 weeks after fruit setting. The current findings are also in agreement with the results proposed by Ranjan *et al*. (2003) who confirmed that stimulated cell division and cell elongation due to application of NAA and GA_3 may be the reason behind increased fruit size.

The fruit weight was reported to be varied from 78.37g in triacontanol 5ppm (T_7) to

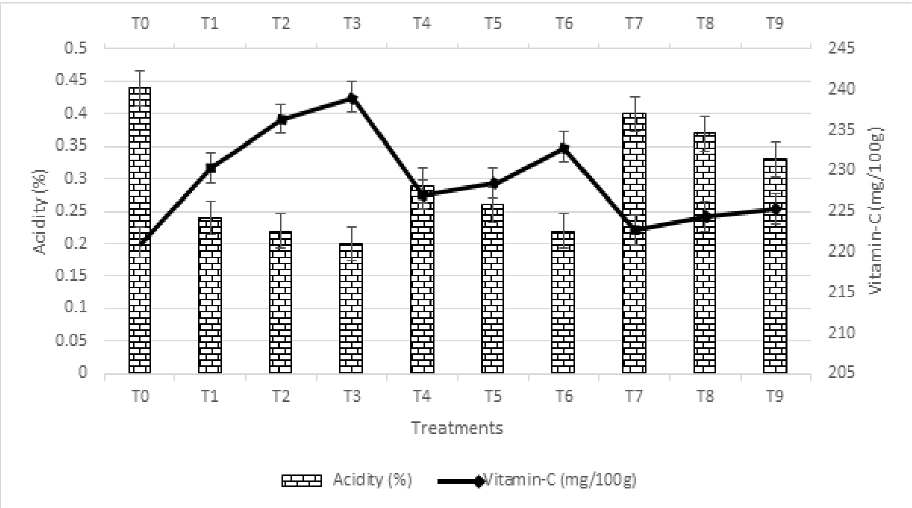

Fig. 1. Variation in acidity (%) and vitamin-C content of guava fruit due to pre-harvest application of growth regulators

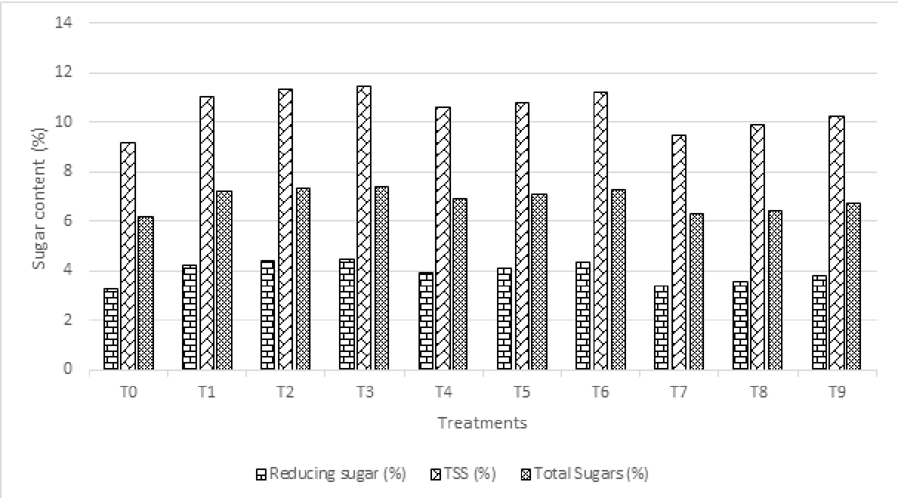

Fig. 2. Variation in Sugar content of guava fruits as function of pre-harvest application of growth regulators

138.53 gm in NAA 200 ppm (T_3) in comparison to minimum (72.11g) in control (T_0). On comparing all the treatments, it is clear that the mean value of concentration of NAA induced maximum fruit weight which was 1.8 times more than control. The maximum fruit weight (138.53g) was recorded due to application of NAA 200ppm (T_3) followed by 132.8g from NAA 150ppm (T_2) and 122.07g from GA_3 75ppm (T_6). This increased fruit weight with increased NAA concentration might be due to the fact that NAA mediated higher level of metabolites from the leaves towards fruits which resulted in heavier fruits than other treatments. The results are in accordance with findings of Bhosle *et al.* (2002) and Meena (2008). The application of NAA induced cell elongation by enlargement of vacuoles and loosening of cell wall which caused increase in fruit weight, fruit number and yield (Agrawal and Dikshit, 2008) and is being confirmed by the findings of Yadav *et al*. (2001) in guava fruits.

All the treatments have significantly reduced seed weight in comparison to control (T_0). It is clear from the data that the minimum seed weight (5.19 g) was recorded with chemical spray of NAA 200 ppm (T_3) followed by NAA 150 ppm (T_2) and NAA 100ppm (T_2). The maximum seed weight (6.57 g) was observed with T_0 while all the treatments showed reduction in seed weight as compared to control (T_0). This reduction in seed weight with NAA applications might be due to reduction in number of healthy seeds especially at higher NAA concentrations. The outcomes of the current investigations are in line with the results obtained by Lewin and Monselise (1976) who reported reduced number of healthy seeds with NAA application. Similarly, Agnihotri *et al*. (2013) had also reported minimum seed weight due to treatment with 300 ppm NAA.

All the treatments significantly improved specific gravity in comparison to control (T_0). The highest specific gravity (1.17 g/cm_3) was reported with application of NAA 200 ppm (T_3) followed by 1.14 g/cm_3 in NAA 150ppm (T_2), 1.13 g/cm_3 in NAA 100ppm (T_1) and 1.12 g/cm_3 in GA_3 75ppm (T_6). The decrease in specific gravity of fruits during ripening might be due to conversion of insoluble starch into soluble sugars. Thus, pre-harvest application of plant growth hormones reduced the weight loss and respiration losses which were helpful in maintaining higher value of specific gravity (Godge and Kale, 1991).

Chemical attributes of guava fruits

The observation pertaining to chemical composition of guava fruits influenced by pre-harvest foliar spray of different plant growth regulators like NAA, GA_3 and Triacontanol are presented in Figure-1 and 2. The acidity was significantly decreased with foliar spray of NAA, GA_3 and Triacontanol. It is clear from the data that the maximum acidity (0.43%) was observed with control (T_0) whereas the minimum acidity (0.20%) was recorded with NAA 200 ppm (T_3) followed by 0.22% in T_2 (150 ppm NAA). Thus, with increase in NAA concentrations the titratable acidity was decreased which may be due to early ripening of fruits caused by treatment, where acid might have been used during respiration or rapidly converted into sugars. Similarly, Agnihotri *et al*. (2013) had recorded minimum acidity (0.27%) in guava under foliar application of 300 ppm NAA. The findings of current investigations are in accordance with the findings of Dubey *et al*. (2002); Xiao *et al*. (2005) and Garasiya *et al*. (2013).

The vitamin-C content in fruits varied from 221.15 mg/100gmpulp in control (T_0) to 239.03 mg/100gm pulp in NAA 200 ppm (T_3). The result further indicated that all concentrations of NAA and GA_3 had high value of vitamin-C content in comparison to mean value (228.79 mg/100g). The improvement in the ascorbic acid content of guava fruits might be due to increased synthesis of metabolites which can stimulate the synthesis of the ascorbic acid precursor (Orzorek and Angell, 1974). Similarly, Jain and Dashora (2011) reported maximum ascorbic acid (205.18 mg/100g pulp) due to application of 200 ppm NAA treatment. This result is in accordance with the result obtained by Garasiya *et al*. (2013) in guava fruits.

The TSS (Figure-2) of fruits significantly increased with foliar application of growth regulators, viz., NAA, GA_3, Triacontanol. The minimum total soluble solids (9.17^0 Brix) were recorded in control (T_0) whereas, the maximum total soluble solids (11.47^0 Brix) were observed in guava fruits treated with NAA 200 ppm (T_3). The increase in TSS might be due to synthesis of auxin which in turn increased synthesis of metabolites and their rapid translocation from other parts of plants to developing fruits. Thus, NAA treated fruits acted as a strong sink for drawing metabolites from the leaves. Similarly, Rajput and Singh (1977) estimated higher percentage of total soluble solids from the fruits treated with NAA over control.

Total sugar (Figure-2) content in fruits significantly increased from 6.22 % in control (T_0) to 7.43 % in NAA 200 ppm (T_3) while reducing sugar was ranged from 3.28 % in control (T_0) to 4.48 % in NAA 200 ppm (T_3). Higher quantity of soluble carbohydrates in the cell sap and higher glucose concentration in fruits treated with NAA was due to marked increase in carbon assimilation, thereby favoring better electrolytic composition. Kassem *et al*. (2010) and Chaudhary *et al*. (1990) revealed that reducing sugar content significantly increased with foliar application of NAA which confirms the findings of present investigation and is in agreement with the results obtained by Garasiya *et al*. (2013) in guava fruit.

CONCLUSION

The present investigation clearly reflects the ability of pre-harvest application of NAA 200 ppm and 150 ppm as an efficient technique to improve the physico-chemical attributes of guava fruits. GA_3 75 ppm and NAA 100 ppm are also effective to enhance the yield related attributes of guava fruits in winter season.

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