



Effect of Plant Growth Regulators on Fruit-set and Quality of Guava

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ABSTRACT

Two plant growth regulators: β -NOA (50 and 80 ppm) and GA (200 and 250 ppm) were applied to emasculated flowers at anthesis to set parthenocarpic fruit, while in the control treatment fruit set was achieved by natural pollination. The application of β -NOA found ineffective in setting parthenocarpic guava. No significant differences were observed in the length and diameter of fruit between parthenocarpic and naturally pollinated seeded fruit at different days after anthesis. The mean fruit weight, TSS and ascorbic acid content of parthenocarpic fruit were similar to that of seeded fruit. Significant higher amount of total polyphenol was detected in the seeded fruit than the parthenocarpic fruit. Although 200 ppm GA showed comparatively better response to fruit growth, TSS and ascorbic acid content than 250 ppm GA but not in a statistical level.

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Introduction

Guava (*Psidium guajava* L.) is an important fruit throughout the tropics and subtropics due to its delicious taste and high nutritional value. In Bangladesh, guava took the 6th place in respect of area and production of fruits (BBS, 2010). Guava is often referred as the 'Apple of tropics' for its nutritive value. The fruit is rich in vitamin C, which is even 5 times higher than orange (Kumar, 2012). It is also rich in pectin, fiber and different minerals *viz.*, calcium, phosphorus and iron. Apart from vitamin and minerals, it contains high level of powerful antioxidant polyphenols which protect our body from oxidative stress. It has been used as a traditional medicine to treat ulcers, wounds and diarrhea in Phillipines and anorexia, diarrhea, digestive problems, inflammation and ulcers in Brazil (Gutierrez et al., 2008). Moreover, different parts of the tree *viz.*, leaves, bark, and fruit have a long history of medicinal uses. The plant is quite hardy and can grow in the homestead garden even without or little care.

The fruit have high nutritive value and sells at low prices, but is not quite popular to all classes of people, mainly due to its seediness; the seeds being numerous and hard. The number of the seeds varies in different varieties from 300 to 500 per fruit (Shanker, 1967). Therefore, it is important to develop seedless cultivar or to induce seedless fruit by the exogenous application of plant growth regulators (PGRs). The seedless parthenocarpic guava will increase the commercial value of the fruit as those will have no seeds, easy to consume and a minimal-waste. Gustafson (1936) first demonstrated the

application of auxin to tomato to set parthenocarpic fruit. Exogenous application of auxins, gibberellins and cytokinins, or mixtures of those has been reported to induce seedless fruits in eggplant (Olympios, 1976), tomato (Kojima et al., 2003), pepino (Ercan and Akilli, 1996), strawberry (Archbold and Dennis, 1985), grape (Rao et al., 1962) and apple (Costa et al., 2004). In guava, Balasubramanyam and Rangaswamy (1960) and Islam and Siddique (1973) reported that the application of gibberelin induces seedless fruits in guava. However, selection of effective growth regulators, optimal concentrations and spray intervals are vital to induce seedless fruits. Besides, the quality of seedless guava has not been described in details. So the present investigation was formulated to induce seedless guava by PGRs and to determine its physicochemical properties.

Materials and Methods

Experimental Site

The experiment was carried out at the Agroforestry farm and Environmental Science, Hajee Mohammad Danesh Science and Technology University, Dinajpur. The experiment was conducted from November 2014 to March 2015.

Plant Material

Eight years old guava cv. Mukundapuri was chosen in the present investigation. The fruits of this cultivar are pear to round shape, nearly smooth and medium in sized.

Crop husbandry and crop protection measures were taken according to Bangladesh Agricultural Research Institute (BARI) recommendation.

Application of Plant Growth Regulators

Individual flowers were tagged on the day of anthesis and in the absence of hormone application the fruits were considered to be formed from natural pollination. To obtain parthenocarpic fruits, anthers were emasculated approximately 24 h before anthesis to prevent self-pollination, and flowers were then sprayed with the PGR to ensure fruit set. A hand sprayer was used to apply PGR and the flowers were tagged to show the date of application of the PGR. Application of PGR was performed in the morning between 8 to 9 am.

Design of the Experiment

Two plant growth regulators: Gibberellic acid (GA) and β -naphthoxyacetic acid (NOA) were used. The concentration i.e., 200 ppm GA, 250 ppm GA, 50 ppm β -NOA and 80 ppm β -NOA were applied, while naturally pollinated fruits were the control. The experiment was arranged in the randomized complete block design with four replications. The total numbers of plants were 4, representing 4 replications. For each treatment, 15 fruits were treated as per the experimental design. After fruit-set, the diameter and length of the individual fruit were recorded at 30, 60 and 90 days after anthesis (DAA), and also at harvest. To avoid competition among fruits on the same branch only 2 to 3 fruits were allowed to set.

Harvest

The fruits were harvested at their harvest maturity stage when those were green and medium hard in texture. Fruits were harvested at 110 days after anthesis, starting from mid February until mid March.

Length of Fruit

The length of fruit was recorded individually from the proximal end of the fruit (site of the calyx) to the distal end (point of abscission of the style) using a meter rule and recorded in centimeters. Length was measured at 30, 60, 90 days after anthesis and at harvest too.

Fruit Diameter

The diameter of individual fruit was recorded across the widest part of the fruit using an electrical digital caliper (ROHS, Germany) at 30, 60, 90 days after anthesis and at harvest.

Weight of Fruits

Individual fruit weight was measured in grams at harvest using an electronic balance (G & G, T100, Germany).

TSS

Fruits were peeled, and the pericarp (skin) and mesocarp tissues (flesh) were separated. Mesocarp tissue was then gently squeezed and a few drops of juice were used to determine the total soluble solids (TSS) with a digital refractometer (Hanna Instruments, Romania).

Analysis of Ascorbic Acid

Ascorbic acid content ($\text{mg } 100 \text{ g}^{-1}$ fresh weight) was determined by the spectrophotometric procedure of Bajaj and Kaur (1981). The absorbance at 760 nm was measured with a UV/VIS spectrophotometer (PG Instrument Ltd. Model T60, UK). Ascorbic acid concentration was quantified using the standard curve of L-ascorbic acid and expressed as $\text{mg } 100 \text{ g}^{-1}$ fresh weight.

Analysis of Total Phenols

Total phenolic compounds were quantified using the Folin-Ciocalteu reagent (FC) and the colorimetric method of Singleton and Rossi (1965). Extraction was performed according to Velioglu *et al.* (1998) using a homogenizer (VELP Scientifica, Europe). The absorbance was measured at 765 nm using a UV/VIS spectrophotometer (PG Instrument Ltd. Model T60, UK). Phenol content was estimated from a standard curve of gallic acid and results were expressed as the mg of gallic acid equivalents (GAE) of 100 g^{-1} fresh fruit.

Statistical Analysis

One factor analysis of variance (ANOVA) was conducted for all variables using the Statgraphics Plus Version 2.1 statistical program (STSC, Inc., 1987). The means were compared using Fisher's Least Significant Difference (LSD), while the Student t-test was used to compare pairs of means.

Results and discussion

In the present investigation, the application of β -NOA (50 and 80 ppm) failed to set any parthenocarpic fruit of guava. Therefore, the results discussed here refer only to treatments with 200 ppm GA, 250 ppm GA and the control.

Length and Diameter of Fruits

The length and diameter of fruits were recorded at different DAA until harvest. No significant differences were observed in both the length and diameter of parthenocarpic and seeded fruits at different DAA (Fig. 1). However, the parthenocarpic fruit treated with GA grew rapidly and attained their maximum length and diameter earlier than the seeded fruits of guava. On the other hand, virtually no differences were found in the length and diameter of guava fruits treated with 200 and 250 ppm GA. The length and diameter of both seeded and parthenocarpic fruits showed an initial phase of rapid growth between 30 to 60 DAA followed by a slower increase (Fig. 1). It was also observed that the diameter increased faster than the length in all the treatments. Although fruit induced by 200 ppm GA had a higher length and diameter than 250 ppm GA, however that difference was insignificant (Fig. 1). The patterns of development of seeded and parthenocarpic fruits of guava were similar. However, parthenocarpic fruits showed comparatively faster growth than the seeded ones, so the enlargement of fruits may be due to a result of cell expansion as a result of the application of GA.

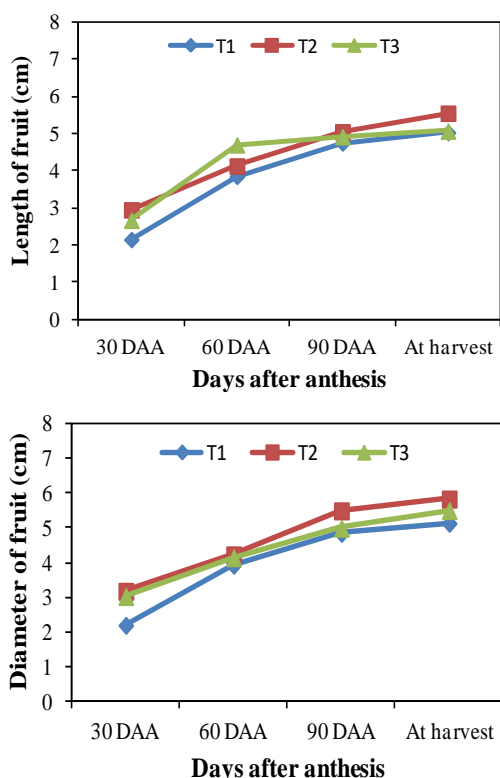


Fig 1 Length (A) and Diameter (B) of fruit of guava cv. Mukundapuri at 30, 60, 90 DAA and at harvest as influenced by natural pollination (···◆···), 200 ppm BA (--■--) and 250 ppm GA (—*—). Vertical bars indicate LSD value according to Fisher’s least significant difference test ($P \leq 0.05$).

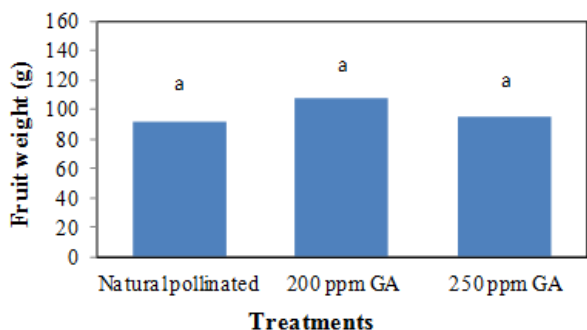


Fig. 2 Mean fruit weight (g) of guava cv. Mukundapuri as influenced by natural pollination, 200 ppm GA and 250 ppm GA. Means of each cultivars accompanied by the same letter are not significantly different according to Fisher’s least significant difference test ($P \leq 0.05$).

Table 1 Total soluble solid (TSS), ascorbic acid content ($\text{mg } 100 \text{ g}^{-1}$) and total phenol content ($\text{mg GAE } 100 \text{ g}^{-1}$ fw) in the fruit of guava cv. Mukundapuri produced by natural pollination (T_1), 200 ppm GA (T_2) and 250 ppm GA.

Treatment	TSS	Ascorbic acid	Total phenol
T_1	10.54 a	231.62 a	289.19 a
T_2	11.88 a	248.55 a	261.62 b
T_3	11.09 a	244.09 a	270.09 b
Lsd	1.74	18.24	20.13

Weight of Fruits

The mean weight of individual guava fruit was measured at harvest and GA were found to have no significant effect on fruit weight (Fig. 2). The highest mean fruit weight was 108.23 g and 91.32 g, respectively in GA induced fruit, whereas the lowest (82.72 g) was in the naturally pollinated fruit. The application of auxin has been shown to increase fruit size of cherry (Stern et al., 2008) and strawberry (Thompson, 1969). The higher mean weight of parthenocarpic fruits apparently results from the promotive effect of GA on fruit growth and development by securing maximum length and diameter compared to the natural pollinated fruits.

Total Soluble Solid (TSS)

The TSS was measured at harvest and varied significantly between seeded and parthenocarpic fruits, although parthenocarpic fruit showed a comparatively higher TSS than the seeded fruits (Table 1). This result is in full accordance with those of Belkbir *et al.* (1998) who found that NAA did not affect the sugar level of pepper.

Ascorbic Acid Content

The ascorbic acid content of guava fruit was measured at harvest. It was observed that the seeded fruits have slightly higher ascorbic acid than the fruits treated with 200 and 250 ppm GA, but the differences were statistically insignificant (Table 1). In tomato, Rotino *et al.* (2005) also did not find any significant difference in ascorbic acid between hybrid ‘Alfresh 1000’ and the transgenic parthenocarpic tomato cv. ‘UG82’. On the contrary, significantly higher ascorbic acid was detected in parthenocarpic guava treated with 200 ppm GA (Islam and Siddique, 1973).

Total Phenolics Content

The total phenol content of guava fruit was quantified at the middle position of fruit after harvest. The result shows significant differences between seeded and parthenocarpic fruits; higher phenolics was detected in the seeded fruits than the parthenocarpic fruit (Table 1). However, no significant difference was found in the fruits treated with 200 and 250 ppm GA (Table 1). In the present study it is revealed that the total phenolics of the fruit decreased after application of GA. Similarly application of auxin decreased total phenolics in strawberry (Roussos et al., 2009).

Conclusion

The application of GA at the time of anthesis is beneficial for obtaining parthenocarpic guava, but β -NOA is ineffective for this purpose. Most of the parameters were not significantly affected by the application of GA except total phenolic content. Though the parthenocarpic guava has no seeds so this fruit will be appreciated much more by the consumers. However, further experiment is needed for the induction of seedless fruit of guava in different cultivars with GA in different seasons.

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