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Effect of foliar feeding of micronutrients and plant growth regulators on flowering and physical parameter of Guava (*Psidium guajava* L.) cv. Allahabad Safeda under agroecological: Condition of north Bihar

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Abstract
Guava (*Psidium guajava* L.) belongs to the family Myrtaceae. Guava fruit is a rich source of Vit. C and contain 0.5- 1.8% pectin. The origin of Guava is Tropical America and it was introduced to India through Portuguese in the early 17thcentury. Zinc is basic constituent for protein and auxin manufacture and plays important role in production of seeds and proper fruit maturity. The foliar spray of micronutrient and PGR plays an important role in improving the fruit quality. Plant growth regulators like auxins, GA3 and cycocel obtain widely used to improve the fruit quality. A field experiment was conducted during 2018-19 at Guava block of model farm of DR. RPCAU, Pusa, Samastipur, Bihar on 7 year old plants of uniform size and vigour planted at (4 m × 4m) were selected for the study. Experiment was laid out under Randomized Block Design with three replications and 9 treatments, to know effect of foliar feeding of micronutrients and plant growth regulators on flowering and physical parameter of Guava. The minimum days to first flowering (36.33), maximum number of flowers (7.66) per shoot, highest fruit set per cent (92.33) and fruit retension (55.00) were found with 60 ppm GA3. The maximum fruit length (8.4 cm), fruit width (6.25 cm), fruit weight (110.25 g) and volume (116 ml), yield (46.0 kg/plant) were recorded under 0.4% Borax and specific gravity (1.10 g/ml) were recorded under 0.6% Zinc Sulphate.

Keywords: guava, ga3, naa, zinc sulphate, borax, flowering and physical parameters

Introduction
Guava (*Psidium guajava* L.), belongs to family Myrtaceae. This family contains 140 genera and 3000 species which are widely distributed throughout the world. Guava is 4th valuable fruit crop of India in terms of area and production after mango, banana and citrus. The origin of Guava is Tropical America and it was introduced to India through Portuguese in the early 17th century is a rich source of Vit. C (300-350 mg/100g) and contain 0.5 - 1.8% pectin. (Mitra and Bose, 2001) [2]. The fruit of Guava is also used for preparation of processed products such as jam, jelly and nectar. Jelly puree of guava is very attractive purplish red colour and it has pleasant taste and aroma. And the inflorescence of guava is solitary or cymes of two or three flowers. Guava bears fruits laterally on the shoot of present season growth in the axils of leaf. In guava flowering buds are mixed type. The flowering period of guava is ranged from 25-45 days depends upon the type of cultivar, season and growing condition. The guava is capable of withstanding strong winds. It required 500 to 1000 mm annual average rainfalls to getting higher production in the tropics. It could survive in light soil with pH 4.5-8.5 and can also thrives in calcareous soil. The optimum temperature for its good growth is 15-46 ºC. The ample temperature for good flowering and fruiting is reported 23 ºC-27 ºC. It can tolerate up to 46.1 ºC temperature and it is more resistant to drought. In subtropical climate, there are three distinct periods of flowering and fruiting namely Ambe bahar (February to March flowering and fruits ripens in July- August), Mrig bahar (June to July flowering and fruit ripens October to December) and Hasta bahar (October to November flowering and fruits ripens in February to April) (Shukla *et al.*, 2008) [1]. The foliar spray of micronutrient and PGR plays an important role in improving the fruit quality. The application of micronutrient through soil is needed highest quantity of micronutrient because certain amount leaches down and some become unavailable to the plant due to complex soil reactions. The yield parameters of guava such as weight of fruit, no. of fruits per tree and yield per tree have increased by the spraying of micronutrients like zinc and boron. Zinc is basic constituent for protein and auxin manufacture, and plays important role in production of seeds and proper fruit maturity.

Zinc also play important role in size and specific gravity of fruit. Zinc improves the growth of shoots at terminal end, shoot diameter and no. of leaves on every shoot. Boron acts as regulator of potassium/calcium ratio in the plant and helps in combination of nitrogen and sugar translocation in plant. Boron also plays an important role in viability of pollen and good fruit set (Hada, 2013). The function of GA_3 induce flowering and increases fruits setting (%) and fruit retention (%) of the tree and by the application of naphthalene acetic acid (NAA). Plant growth regulators like auxins, GA3 and cycocel obtain widely used to improve the fruit quality. In view of the fact that the demand of fruit is increasing in the market, thereby to achieve higher yield of good quality fruit with longest storage life has become the priority.

Materials and Methods

It required 500 to 1000 mm annual average rainfalls. On The high rainfall of this region was received from south-west monsoon from June to October. 7 - year- old uniform guava plants of Allahabad Safeda cultivar planted at 4 x 4 m a part growing in Guava block of model farm of DR. RPCAU, Pusa, Samastipur, Bihar were taken for the investigation. The stock solution was adjusted by dissolving 1 ml of naphthalene acetic acid in one litre of water obtained 1000 ppm and this solution was used for preparing solutions of 150 and 250 parts per million for spray and dissolving one gram of gibberellic acid in 50 ml of alcohol and volume was made up to one litre by adding distilled water to obtain 1000 parts per million. This solution was used for preparing solution of 30 and 60 parts per million for spray. The volume of liquid for spraying a tree was assessed to two litres. The amount of micronutrients (zinc or boron) @ 1gram/ litre was used to make the solution concentration of 0.1%. Then as well, Zinc sulphate at the rate of 4 gram/litre and 6 gram/ litre make a saluting of 0.4% and 0.6%, respectively. T_1 (control), T_2 (60 ppm GA3), T_3 (30 ppm GA3), T_4 (150 ppm NAA), T_5 (250 ppm NAA), T_6 (0.4% Zinc Sulphate), T_7 (0.6% Zinc Sulphate), T_8 (0.2% Borax) and T_9 (0.4% Borax) and the spraying of micro nutrients and plant growth regulators were done before flowering (fourth week of July) and second after fruit set (first week of September) during 2019. The experiment was laid out in R.B.D. with three replication. Observations recorded to be number of flowers per shoot, days to first flowering, fruit set, fruit retention, fruit length, fruit width, fruit weight, fruit volume, specific gravity, fruit yield per plant (kg/plant) and yield (q/ha). The data so obtained were analysed statically.

Results and Discussion

The data related to days to first flowering are presented in table 1. Perusal of the data revealed significant variation on the days to first flowering due to all variables. Analysis of table indicated that differences due to micronutrient and plant growth regulator application produced significant variation on the first flowering. Treatment T2 (60 ppm GA3) took minimum 36.33 days to first flowering among all treatments and Treatment T1 (control) took maximum 42.33 days to first flowering among all treatments T2 (36.33). The result of the present research revealed that days to first flowering was not significantly influenced. While, significant variation were observed for number of flowers per shoot.

The data related to no. of flowers per shoot recorded during experiment are presented in table 1. An investigation of the data indicated significant variation due to micronutrient and plant growth regulators spray on the production of number of flowers per shoot. The treatment T2 (60 ppm GA3) exhibited significantly highest number of flowers per shoot (7.66) over rest of the treatment, which was closely followed via T3 (7.33), T4 (7.33) and T5 (7.00). The treatment T1 (control) produced lowest number of flowers (5.33.) when compared to rest of the treatments. It might be due to spray of various concentration of growth promoting substances i.e. GA3. This results are in conformity with the finding of Tiwari *et al.* (1992) [4], Kundan and Mitra (1997) [3] in Guava.

It is clear from data that result of various treatments were very remarkable in fruit set (%). The maximum (92.33%) fruit set was recorded with T2 (60 ppm GA3) which was statistically at par with T3 (88.33%) and the minimum (65.00%) fruit set was recorded in T1 (control). The maximum setting of fruit in proportion to concentration of growth substance like Gibberellic acid in high quantity may be because of assimilation and translocation of hormones, food substances and other factors stimulating formulation of fruits to tissue of ovary in greater amount. These results are related to the finding of Yadav *et al.* (2011) [5].

The data related to different levels of micronutrient and plant growth regulator improved fruit retention as contrast to control. The highest fruit retention (55.00%) was found with T2 (60 ppm GA3) whereas, it was lowest (38.33%) in T1 (Control). Nevertheless, T3, T4, T5 and T6 remain statistically at par. The maximum fruit retention in response to high application of PGR like Gibberellic acid treatment can possibly due to translocation of hormones, food substances and other factors stimulating fruit formulation to tissue of ovary in greater amount. These results are similar to the finding of Yadav *et al.* (2011) [5].

In which the fruit size (cm) measured in terms of fruit length was considerably influence by the micronutrient and plant growth regulator treatments. The data indicates that the mean fruit length values under various treatments ranged between 8.40 cm to 6.25 cm. The maximum fruit length (8.40 cm) was recorded with treatment 0.4% Borax (T9), which was significantly higher over all the treatment including Control (T1). However, treatments 0.6% Zinc Sulphate (T7) and 0.2% Borax (T8) were found to be statistically at par with 0.4% Borax (T9) resulting into 7.90 cm and 8.23 cm fruit length, respectively. The minimum fruit length (6.25) was recorded with control (T1) treatment. These results are in line with Kundu & Mitra (1999) [6] and Chaitanya *et al.* (1997) [7] on guava. An increase in fruit size (length and width) of fruits on account borax application could be attributed to its involvement in the cell division, cell elongation and moisture content of the fruits. Active salt absorption, maintenance of water relation, cellular differentiation & photosynthesis, all has been suggested as a functions of Boron. (Josan, 1991) [8].

The highest fruit width (6.25 cm) was observed with treatment 0.4% Borax (T9), which was significantly higher over all the treatments except Control (T1). However, treatments 0.2% Borax (T8) and 0.6% Zinc Sulphate (T7) and 0.4% Zinc Sulphate (T6) were found to be statistically at par with 0.4% Borax (T9) resulting into 6.20 cm, 6.18 cm and 6.16 cm fruit width, respectively. The minimum fruit diameter (5.88) was also recorded with control (T1) treatment. These results are in line with Kundu & Mitra (1999) [6] and Chaitanya *et al.* (1997) [7] in Guava. An increase in size (fruit length and fruit diameter) of fruits on account of Borax acid application could be attributed to its involvement in the cell division and cell elongation of the fruits. In which the active

salt absorption, maintenance of water relation, cellular differentiation and photosynthesis, all has been suggested as a functions of boron. (Josan, 1991) [8].

Significantly higher fruit weight (110.25g fruit-1) was observed with the treatment 0.6% Zinc Sulphate (T7). However, the minimum fruit weight (98.06 g fruit-1) was reported in the control treatment (T1). This enhancement in fruit weight of guava may be due to the fact that mineral nutrients (Boron or Borax) appeared to have indirect role in hastening the process of cell division and cell elongation due to which size, weight and volume would have improved and it is also directly to higher enlistment of food and mineral from other parts of the plants towards the developing fruits that are extremely Active metabolic sink. The similar results have also been reported by Rajput & Chand (1976), Pal *et al.* (2008) and Singh *et al.* (2004) in guava fruit.

Improvement on fruit volume due to micronutrient and plant growth regulator. Significantly higher fruit volume (ml) was recorded under treatment T9 (116.0) which was statistically at par with treatment T8 (115.77) followed by T7 (113.62) and T6 (112.09). However, the minimum (83.04) fruit volume (ml) was recorded under T1 among all the treatment. This increase in volume of guava fruits may be due to the fact that mineral nutrients (Boron) appeared to have indirect role in hastening the process of cell division and cell elongation due to which fruit size, fruit weight and fruit volume would have improved. The similar results have also been reported by Rajput & Chand (1976) and Pal *et al.* (2008) in guava.

The specific gravity (g/ml) was found significantly higher (1.10) with 0.6% Zinc Sulphate (T7) which was statistically at par with treatment (T6) 0.6% Zinc Sulphate, (T8) 0.2% Borax and (T9) 0.4% Borax. However, the significantly lowest value (0.98) was noted in case of control (T1) treatment because of the effect of the Zinc Sulphate on the internal quality of the fruits, which affects the fruit weight and volume of the guava fruits. The specific gravity of the fruit depends on fruit density which may be affected by total seeds contents of the fruit, rainfall and cultural practices. The similar results are in close conformity with the finding of Banik *et al.* (1997) [12].

An investigation of data obviously indicated that every treatments considerably increased fruit yield as compare to control. The highest (46.00 kg/plant) fruit yield as recorded with T2 (60ppm GA3), while minimum (35.43 kg/plant) fruit yield was prominent in T1 (control). However, T3 remain statistically at par with treatment T2 (60 ppm GA3). The increase yield under this growth regulators treatment was associated with increase the number of fruit, low percentage of fruit drop, more fruit retention and increased fruit size and weight. The equivalent result is in conformity with the earlier reported by Shawky *et al.* (1978) [13] and Shikhmany and Reddy (1989) [14] in grape.

Table 1: Effect of micronutrient and plant growth regulators on flowering, fruit set (%) and fruit retention (%) of Guava cv. Allahabad Safeda.

Treatment	Days to first flowering	No. of flowering per shoot	Fruit set (%)	Fruit retention (%)
T1- Control	42.33	5.33	65.00	38.33
T2- 60 ppm GA3	36.33	7.66	92.33	55.00
T3- 30 ppm GA3	37.00	7.33	88.33	51.33
T4- 150 ppm NAA	37.66	7.33	71.33	51.00
T5- 250 ppm NAA	37.00	7.00	76.00	5.33
T6- 0.4% Zinc Sulphate	38.00	6.00	66.66	51.00
T7- 0.6% Zinc Sulphate	41.00	6.66	70.00	48.66
T8- 0.2% Borax	40.00	6.33	67.66	38.66
T9- 0.4% Borax	39.00	6.00	69.00	42.00
SE(m)	1.68	3.35	3.10	1.98
CD (5%)	N/A	1.06	9.40	5.99

Table 2: Effect of foliar feeding of micronutrient and plant growth regulators on fruit length, fruit width, fruit weight, fruit volume and specific Gravity of Guava cv. Allahabad Safeda.

Treatment	Fruit length (cm)	Fruit Width (cm)	Fruit weight (g)	Fruit volume (ml)	Specific Gravity (g/ml)	Yield (kg/plant)
T1- Control	6.25	5.88	98.06	83.04	0.98	35.43
T2- 60 ppm GA3	6.66	6.04	106.85	102.69	1.06	46.00
T3- 30 ppm GA3	6.53	6.15	103.26	103.47	1.01	44.33
T4- 150 ppm NAA	6.48	6.10	105.48	101.38	1.04	42.33
T5- 250 ppm NAA	6.70	6.16	108.48	108.38	1.05	43.23
T6- 0.4% Zinc Sulphate	7.53	6.16	109.48	112.09	1.08	40.76
T7- 0.6% Zinc Sulphate	7.90	6.18	108.78	113.62	1.10	41.16
T8- 0.2% Borax	8.23	6.20	108.76	115.77	1.07	38.06
T9- 0.4% Borax	8.40	6.25	110.25	116.00	1.08	41.83
SE(m)	0.22	0.06	2.36	3.21	0.01	1.21
CD (5%)	0.67	0.19	7.15	9.71	0.03	3.66

Conclusion

The flowering parameters of fruit with respect Days to first flowering, Number of flowers per shoot, Fruit Set (%), fruit retention (%) and yield were obtained maximum with the foliar spray of 60 ppm GA3 (T2) and the physical parameter of fruit with respect fruit length (cm), Fruit Width (cm), Fruit Weight (g), Fruit Volume (ml) and Specific Gravity (g/ml) were obtained maximum with the foliar spray of 0.4% Borax (T9) Therefore, the foliar spray of 60 ppm GA3 (T2) and 0.4% Borax (T9) can be advocated to guava growers for serving higher yield and better of quality of fruits.

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