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EFFECT OF FOLIAR SPRAY OF MICRONUTRIENTS AND PLANT GROWTH REGULATORS ON YIELD AND QUALITY ATTRIBUTES OF GUAVA (*PSIDIUM GUAJAVA* L.) CV. L-49

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ABSTRACT

Guava (*Psidium guajava* L.), botanically, guava belongs to the family Myrtaceae. This fruit is a native of tropical America and extensively grown in South Asian countries. The fruit quality of winter season is far better than that of rainy season. PGRs play a significant role in many physiological phenomena. Various type of PGR like NAA,GA_3 and Borax have been reported to be used for improving the flowering, fruit size and quality of fruit as well as yield. These are used in vegetative propagation, artificial induction of seed lessness. A field experiment was conducted during 2020-2021 at Horticulture Research Farm-1, BBAU, Lucknow on 11- year- old guava plants, effect of foliar spray of Micronutrient and plant growth regulators on physical parameter of guava (*Psidium guajava* L.) cv. L-49". Experiment was laid out in Randomized Block Design with three replications revealed that yield (q/ha) Specific gravity of fruit, Total soluble solids (^{0}Brix), Acidity, Ascorbic acid, total sugar, reducing sugar, non – reducing sugar and were maximized when foliar spray was done with Borax 0.5%+GA_3 40 ppm, respectively.

Key words : Micronutrients, PGPR, Yield, Quality.

Introduction

The guava plant (*Psidium guajava* L.), Guavas are botanically classified as members of the Myrtaceae family. Its fundamental chromosomal number is 11 (2n 2x = 22). The most significant, highly productive, tasty, and nutrient-dense fruit, sometimes referred to as the “apple of the tropics” and the “poor man’s apple,” is farmed commercially throughout India’s tropical and subtropical areas. Its fruits are available all year round, with the exception of the summer. After citrus, mango, and banana, it holds a prominent position among the significant fruits cultivated in the nation and is ranked as the fourth most important fruit in terms of area and production. India has been cultivating it since the early 1700s. Because of its increased adaptation to a wider range of soil types and agroclimatic conditions, its high nutritional properties, low cultivation costs, and prolific bearing have made it more popular among fruit growers (Das *et al*., 1995). Originating in tropical America, this fruit is widely cultivated in South Asian nations. Maharashtra, Madhya Pradesh, Bihar, and Uttar Pradesh are the states that cultivate guavas the most. Guavas are significant because they are resilient fruits that can be cultivated in both poorly drained and poorly alkaline soil. Without irrigation, it can be cultivated on soil with a pH of 4.5 to 8.5. It can withstand temperatures higher than 46°C. Tropical and subtropical climates both suit guava as well (Gaur *et al*., 2016). The guava crop, however, has three separate flowering and fruiting seasons. According to Shukla *et al*. (2009), there are three different flowering seasons: Ambe (February–March), Mrig (June–July) and Hastabahar (October–November). The corresponding fruiting seasons for these bahar are

July–August, October–December, and February–April. The fruit contains low energy (66 calories per 100g), a low protein content (1%) and high moisture and dry matter (83%) content, but it is an excellent source of vitamin C (210 mg/100g) and pectin (0.60%). The fruit also contains high levels of vitamins, minerals, and riboflavin, as well as phosphorus (24–37 mg/100 g), calcium (14–30 mg/ 100 g), and iron (0.6–1.4 mg/100 g) (Bose *et al*., 1990).

Humidity and temperature have a big impact on guava fruit quality. This explains why fruit throughout the winter is far higher quality than during the rainy season. It has been observed that high summer temperatures combined with low humidity increase fruit drop and decrease fruit set. Because of these conditions—low temperatures and a dry atmosphere—the winter fruit's quality is significantly superior to that of the rainy season in terms of sweetness, colour, and scent development. The crop grown during the rainy season is coarse, of low quality, and has a lower market value. Because of the crop's heavy flowering and fruiting during the rainy season, it is necessary to control fruiting by applying micronutrients topically to the winter crop. The application of micronutrients in modifying development, flowering fruiting, fruit quality and fruit output of various fruits has received the majority of attention in recent years.

Zinc is a crucial component of several enzyme systems that control different metabolic reactions connected to the water-plant relationship. Auxin and protein synthesis, seed formation and appropriate maturation all depend on zinc. In addition, it boosts fruit yield and size. According to Price *et al.* (1972), zinc is necessary to increase the number of leaves per shoot, terminal shoots and shoot diameter in guava trees.

A component of cell membrane, borax is necessary for cell division. It assists in the plant's uptake of nitrogen and the translocation of sugar, and it regulates the ratio of potassium to calcium in the plant. Plants can access more nitrogen when they use borax. It contributes to the production of the components of the cell wall. It is essential for healthy fruit set and pollen viability. It causes both primary and lateral roots to grow more elongated (O' Kelley, 1957). Of them, GA3 improves fruit retention while NAA boosts fruiting and encourages flowering. Early and uniform ripening is induced by the ripening hormone ethrel (Jensen *et al.*, 1975). Research has shown that several nutrients, when combined with plant growth regulators can enhance economic production, making harvesting easier (Pandey *et al.*, 1988). Therefore, in order to maximise the output of high-quality guava fruits, it is required to standardise the most effective combination.

An essential auxin group growth regulator, NAA lowers fruit drop and enhances fruit set and quality, particularly TSS. Fruit's acid content is raised and its acidity is decreased with the application of NAA, TSS, and ascorbic acid. NAA decreases the fruit's seed count. Additionally, it encourages flowering and causes a greater fruiting (Sharma and Tiwari, 2015). Maximum production in the winter because of the rainy season crop's severe defoliation and deblossoming. The phytotoxic effect of greater NAA concentrations on guava leaves may be to blame for the defoliation and burning that followed, which reduced the amount of photosynthates that support fruit growth.

The application of PGR in horticulture is growing in popularity in the present period. PGRs are important for a wide range of physiological processes. Plant growth regulators have been widely used in support of the fruit sector. Vegetative propagation, artificial induction of seed lessness, increased fruit set, prevention of pre-harvest drop, flowering regulation, fruit size regulation, growth inhibition, flower and fruit thinning, and various PGR types such as NAA, 2-4-D, 2,4,5-T, GA_3 and TIBA have been reported to be used to improve fruit quality, yield and flowering.

Materials and Methods

The present investigation entitled "Effect of foliar application of micronutrient and plant growth regulators on Growth, yield and quality of guava (*Psidium guajava* L.)was carried out at the Horticultural Research Farm-1 of the Department of Horticulture, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya Vihar, Rae Bareli Road, Lucknow - 226 025 (U.P.), India during the year 2020-2021.The soil of the experimental field was medium black with good drainage and uniform texture with medium NPK status. The details of the treatment were T_1- Control, T_2- $ZnSO_4$ 0.5%, T_3- Borax 0.5%, T_4- NAA 40 ppm, T_5- GA_3 40 ppm, T_6- $ZnSO_4$ 0.5%+Borax 0.5%, T_7- $ZnSO_4$ 0.5%+NAA 40 ppm, T_8- $ZnSO_4$ 0.5%+GA_3 40 ppm, T_9- Borax 0.5%+NAA 40 ppm, T_{10} - Borax 0.5%+GA_3 40 ppm T_{11} - $ZnSO_4$ 0.5 % + Borax 0.5% + NAA 40 ppm, T_{12} - $ZnSO_4$ 0.5 % + Borax 0.5% + GA_3 40 ppm. Experiment was laid out in Randomized Block Design with three replications.

Fruit yield (q/ha)

The fruit weight was recorded at each harvesting under each treatment and total fruit yield per ha. was calculated at the final harvesting and expressed in q. per hectare.

Specific gravity

The specific gravity was determined by fruit weight dividing by fruit volume using following formula:

$$\text{Specific gravity} = \frac{\text{Weight of fruit}}{\text{Volume of fruit}}$$

Total soluble solids (TSS ^{0}Brix)

The total soluble solids of the crushed fruit sample and extracted juice were determined by using a Hand refractometer of 0-32^O (brix) range. The value was corrected at 20^{0}C and expressed as per cent TSS of guava fruits (Rangana, 2010)

Acidity (%)

Known quantity of the fruit pulp (5g) was mixed with small amount of distilled water and filtered through muslin cloth. Then requisite volume was made up to100 ml. Five ml aliquot was taken for titration against 0.1 N sodium hydroxide (NaOH) solution using 1-2 drops phenolphthalein as indicator. The results were calculated using following formula and expressed as per cent acid per 100 g fruit (Rangana, 2010).

$$\text{Acidity} = \frac{\text{Titrate value} \times \text{Normality of alkali} \times 64 \times \text{Volume made up}}{\text{Aliquot taken} \times \text{Volume of sample} \times 1000} \times 100$$

Ascorbic acid (mg/100gm pulp)

For determining the ascorbic acid, 5 gm fruit sample was crushed in pestle and mortar with 3 per cent metaphosphoric acid and filtered through muslin cloth in 50 ml volumetric flask. Then volume was made up of 50 ml with 3% HPO_3 (metaphosphoric acid) solution. Then 5 ml aliquot was titrated against 2, 6- dichloro-phenol-indophenol dye solution (Rangana, 2010). The end point was marked by appearance of light pink colour, which persisted at least for 15 seconds.

The ascorbic acid content was expressed mg/100g solid and calculated with help of following formula:

$$\text{Ascorbic acid} = \frac{\text{Titrate value} \times 100 \text{ factor} \times \text{volume made up} \times 100}{\text{Aliquot extract of taken for estimation} \times \text{volume of sample take for estimation}}$$

Total invert sugars (%)

Out of 100 ml sample prepared for reducing sugars analysis, 5 ml aliquot was taken and mixed with 3 drops HCl and kept for overnight. Next day 2-3 drops phenolphthalein indicator was added and neutralized with 30 per cent sodium hydroxide solution there after adding 5 ml of each Fehling's solution 'A' and 'B' to the neutralized aliquot the mixture was titrated against 1.0% glucose (Dextrose) in boiling stage using methylene blue as indicator. The appearance of light brick colour was marked as the end point. The result was calculated and expressed as per cent total invert sugars.

$$\text{Total invert sugars} = \frac{\text{Blank titrate value - Aliquot value} \times \text{volume made up}}{\text{Aliquot taken for estimation} \times \text{Weight of sample}} \times 100$$

Reducing sugar (%)

5 gram fruit sample was taken and crushed with small amount of distilled water. Then volume made up 100 ml with distilled water. 5 ml aliquot was taken into separate conical flask and 5 ml of each Fehling's solution, A and B were mixed with aliquot. There after mixture was heated and titrated against 1 per cent glucose (Dextrose) to the end point of brick colour appearance. A blank sample was also titrated against 1% glucose (Dextrose). The calculation for reducing sugars was done and result expressed as per cent of reducing sugar.

$$\text{Reducing sugar} = \frac{\text{Blank tit rate value - Aliquot value} \times \text{volume made up}}{\text{Aliquot taken for estimation} \times \text{Weight of sample}} \times 100$$

Non-reducing sugar (%)

Non-reducing sugar was calculated by deducting the quantity of reducing sugar from total invert sugars and multiplied by factors 0.95. The results were expressed as per cent of non-reducing sugar.

Non-reducing sugar (%) = [Total invert sugar (%) – Reducing sugars (%)] × 0.9

Total sugars (%)

Sum of reducing sugars and non-reducing sugar expressed in as total sugar.

Total sugar = Reducing sugar + non-reducing sugar

Results and Discussion

Yield parameter

Effect of foliar spray of micronutrients and plant growth regulators on yield q/h and specific gravity

The data recorded on yield of fruits were analysed statistically and the mean values presented all treatments increased the fruit yield over the control. The maximum fruit yield was obtained with the spray of Borax 0.5%+GA_3 40 ppm (T_{10}) followed by was noted in $ZnSO_4$ 0.5%+GA_3 40 ppm (T_8). While minimum fruit yield was found in control (T_1). The observations also indicated that all treatments enhanced the yield with greater degree

with higher concentrations. 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 due to higher concentration of plant growth regulators (NAA) that appears to have indirect role in hastening the process of cell division and cell elongation due to which size and weight of fruits would have improved Yadav (2002). The data pertaining to specific gravity of guava as that the foliar application of growth regulators and nutrient significantly increased specific gravity of guava fruit over control (T_1). The critical observation of the data showed that maximum specific gravity was found in treatment Borax 0.5%+GA_3 40 ppm (T_{10}). Followed by ZnSO4 0.5%+GA_3 40 ppm % (T_8). The minimum specific gravity was noticed in control (T_1). The increase in fruit size due to accelerated rate of cell division and cell enlargement and more intercellular space with the application of higher concentration of growth substances like NAA. Increase in fruit size was recorded with NAA in guava (Jain and Dashora, 2010). NAA increases fruit set by reducing fruit drop and thereby higher fruit yield (Hameed *et al.,* 2016) in Barhee date palm. Effect of GA in cell enlargement, cell division and increasing the number and size of fruits, which resulted in higher fruit yield (Adams *et al.,* 1983). Spray of micronutrients (B & Zn) hastens the process of cell division and cell elongation and also to their stimulatory effect on plant metabolism and production of auxins (Meena *et al.,* 2014)

Table 1 : Effect of foliar spray of micronutrients and plant growth regulators on yield and quality attributes of guava (*Psidium guajava* L.) cv. L-49.

Treatments	Yield (q/ha)	Specific gravity of fruit (ml)	Total soluble solids (°Brix)	Acidity (%)	Ascorbic acid (mg/100g pulp)	Total sugars (%)	Reducing sugar (%)	Non-reducing sugar (%)
T_1 Control	131.91	1.05	7.38	0.51	155.27	5.83	3.01	2.96
T_2 $ZnSO_4$ 0.5%	145.19	1.07	8.57	0.68	161.34	6.60	3.33	3.11
T_3 Borax 0.5%	154.88	1.07	10.00	0.61	166.18	6.42	3.47	2.98
T_4 NAA 40 ppm	152.14	1.07	8.16	0.69	163.52	6.26	3.62	3.19
T_5 GA_3 40 ppm	144.23	1.06	10.22	0.65	167.40	6.15	3.15	3.24
T_6 $ZnSO_4$ 0.5%+Borax 0.5%	161.79	1.06	9.87	0.63	167.51	6.29	3.35	3.19
T_7 $ZnSO_4$ 0.5%+NAA 40 ppm	162.11	1.06	11.30	0.58	165.40	6.39	3.55	3.29
T_8 $ZnSO_4$ 0.5%+GA_3 40 ppm	169.44	1.10	12.49	0.59	171.18	6.99	3.61	3.52
T_9 Borax 0.5%+NAA 40 ppm	158.68	1.09	10.61	0.72	169.59	6.69	3.52	3.41
T_{10} Borax 0.5%+GA_3 40 ppm	174.36	1.13	10.18	0.74	177.70	7.54	3.78	3.72
T_{11} $ZnSO_4$ 0.5% + Borax 0.5% + NAA 40 ppm	159.27	1.10	11.19	0.57	167.29	6.43	3.23	3.38
T_{12} $ZnSO_4$ 0.5% + Borax 0.5% + GA_3 40 ppm	160.36	1.10	10.49	0.52	165.81	6.31	3.18	3.37
S.Em. ±	1.08	0.007	0.32	0.03	0.56	0.10	0.15	0.14
C.D. at 5%	3.21	0.002	0.94	0.08	1.66	0.30	0.43	0.41

Chemical parameters

Effect of foliar spray of micronutrients and plant growth regulators on T.S.S., acidity, ascorbic acid, total sugar, reducing sugar and non-reducing sugar

The TSS content of guava fruits influenced by micronutrients and their concentrations was determined with the help of digital hand refractometer. The data obtained were processed statistically. It is obvious from the data presented in the treatments increased T.S.S significantly over control (T_1). The maximum T.S.S was found in treatment $ZnSO_4$ 0.5%+GA_3 40 ppm (T_8). Followed by $ZnSO_4$ 0.5%+NAA 40ppm (T_7). The result further revealed that higher concentration of all treatments proved effective to its lower concentrations. The lowest T.S.S was recorded under control (T_1). The acid content of fruits represented in the treatments showed significant reduction of acidity as compared to control (T_1). TSS content of fruit might be explained that GA_3 stimulated the functioning of number of

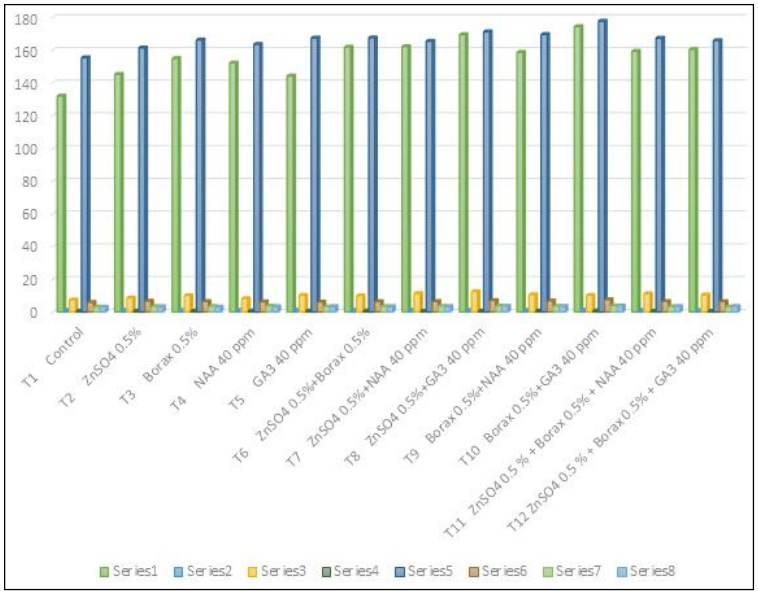

Fig. 1 : Effect of foliar spray of micronutrients and plant growth regulators on yield and quality attributes of guava (*Psidium guajava* L.) cv. L-49

enzymes in the physiological process, which probably caused and increased in TSS content of fruit as reported by Singh *et al*. (1998). The maximum acidity was observed with foliar application of Borax 0.5%+GA_3 40 ppm (T_{10}), followed by Borax 0.5%+NAA 40 ppm (T_9). The minimum acidity was noticed in control (T_1). It appears that acid under the influence of higher concentration of growth regulators might has either fastly been converted into sugar and their derivatives by reactions involving reverse glycolytic pathways or might have been used in respiration or both. These results are in accordance with the findings of Brahmachari *et al*. (1997). Ascorbic acid (vitamin C) of fruit at harvest was determined and the data obtained were analyzed statistically. It is the ascorbic acid content in guava fruit was significantly influenced with the foliar spray of all the treatments in comparison to untreated plant (T_1). The maximum ascorbic acid was recorded with higher concentration of Borax 0.5% + GA_3 40 ppm (T_{10}) followed by ZnSO4 0.5%+GA_3 40 ppm (T_8). The data also indicated that the higher concentration of nutrients gave better performance than its lower concentrations. The possible reason for increase in ascorbic acid of fruit by GA_3 treatment might be due to perpetual synthesis of glucose-6- phosphate throughout the growth and development of fruit which is thought to be the precursor of vitamin-C as reported by Kumar and Singh (1993). The growth regulators on biosynthesis of ascorbic acid from sugars or inhibition of oxidative enzymes or both. These results are in conformity with the findings of Brahmachari *et al*. (1997). It is evident from the data presented in the treatments increased the total sugars content of fruits significantly over control. The maximum sugar content of fruit was recorded with foliar application of Borax 0.5%+GA_3 40 ppm (T_{10}). Followed by ZnSO4 0.5%+GA_3 40 ppm (T_8) this was significantly superior to other treatments. The minimum value was found in control (T_1). The results, further, advocated that higher concentration of all treatments proved effective as compared to the lower concentrations respectively. Growth regulators also increase translocation of photosynthetic metabolites from other parts of the plant towards to developing fruits. This finding is in conformity with the result of Kumar *et al.* (2008) in guava. It is apparent from the maximum reducing sugar content was obtained with foliar application of Borax 0.5%+GA_3 40 ppm (T_{10}) followed by $ZnSO_4$ 0.5%+GA_3 40 ppm (T_8) which was significantly superior to other treatments. The minimum value was found in control (T_1). The reason for increase in the content of reducing sugar and non-reducing sugar might be due to delayed the ripening of fruit and provided a long period of fruits to be remained on tree during which they accumulated more carbohydrates within them as reported by Singh *et al*. (1986). The highest non-reducing sugar content (3.72%) was measured with the foliar application of Borax 0.5%+GA_3 40 ppm (T_{10}). followed by (3.52%) $ZnSO_4$ 0.5%+GA_3 40 ppm (T_8). Which was significantly superior to other treatments. The minimum value (2.96%) was found in control (T_1). The possible reason might be due to the fact that micronutrients and PGR help in the process of photosynthesis, which leads to the accumulations of oligosaccharides and polysaccharides in higher amount. Besides this they also regulate the enzymatic activity and the enzymes that metabolize the carbohydrates into simple sugars (Singh and Vashistha, 1997).

Conclusion

On the basis of present investigation, it can be concluded that the application of Borax 0.5% + GA_3 40 PPM (T_{10}) most effective in enhancing the yield q/h, specific gravity, acidity, ascorbic acid, total sugar, reducing sugar and also non reducing sugar proved that was s to be most beneficial treatment for guava and also find the TSS are most effective on application of $ZnSO_4$ 0.5% + GA_3 40 PPM (T_8). Most beneficial treatment is Borax 0.5% + GA_3 40 PPM (T_{10}) for the Guava. Thus, we can be recommended to growers for commercial cultivation of guava (*Psidium guajava* L.)

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