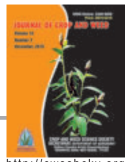
Journal of Crop and Weed, 19(1): 88-94 (2023)

ISSN- O : 2349 9400 ; P : 0974 6315



http://cwssbckv.org
www.cropandweed.com

# Effect of foliar application of micronutrients on plant growth, yield and fruit quality of Thai guava (*Psidium guajava* L.)

*T. MONDAL, [1]T. SARKAR, M. ALAM, S. K. SARKAR, K. H. RATHOD AND F. K. BAURI

*Department of Fruit Science, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia -741252*
*[1]School of Agriculture, Swami Vivekananda University, Barrackpore, West Bengal, India*

*Received : 29.12.2022 ; Revised : 13.01.2023 ; Accepted : 15.02.2023*

**DOI:** https://doi.org/10.22271/09746315.2023.v19.i1.1665

## ABSTRACT

*The present experiment was carried out during 2019 and 2020 at Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal to assess the impact of various micronutrients on plant growth, yield and fruit quality of Thai guava (Psidium guajava L.) of two years age during rainy seasons. The experiment was laid out in RBD with three replications. Nine treatments ($T_1$=$ZnSO_4$@0.3%, $T_2$=$ZnSO_4$@0.5%, $T_3$=$Na_2B_4O_7$@0.2%, $T_4$= $Na_2B_4O_7$@0.3%, $T_5$= $CuSO_4$@0.2%, $T_6$= $CuSO_4$@ 0.3%, $T_7$= $FeSO_4$@ 0.2%, $T_8$= $FeSO_4$@ 0.3%, $T_9$= control-water spray) were imposed twice, first spray during flowering and second spray three weeks after first spray. Results of the study revealed that all the micronutrients significantly improved plant growth parameters, yield and fruit quality of Thai guava. $ZnSO_4$ @0.5% was found to be the most beneficial treatment for plant growth parameters, fruit weight (264.98g), fruit length (8.19cm) and fruit diameter (7.14cm) which ultimately increased the yield tree$^{-1}$(6.08 kg tree$^{-1}$). Various quality attributes like TSS (11.03 °brix), TSS/acid ratio (57.3), ascorbic acid (181.99mg 100g$^{-1}$ pulp) total sugars (7.87%) as well as fruit set (69.56%) and number of fruits tree$^{-1}$ (24.66) were improved and fruit drop and acidity (0.20%) were reduced with the foliar application of $Na_2B_4O_7$@ 0.3%. Therefore, it may be suggested that the application of micronutrients ($ZnSO_4$ @0.5% and $Na_2B_4O_7$@ 0.3%) may be acclaimed for improving plant growth, yield and fruit quality of guava in the inceptisol of the Gangetic plains of West Bengal, India.*

***Keywords*:** Fruit quality, guava, micronutrients, yield

Guava (*Psidium guajava* L.) is the fourth most important fruit crop of India, popularly known as 'poor man's fruit' as well as 'apple of tropics' (Rai *et al.,* 2012). It belongs to the family Myrtaceae, contains about 150 species. Cultivated guava was originated in Tropical America (Nimisha *et al.,* 2013). It was introduced to India during the early 17th Century by the Portuguese (Prakash *et al*., 2002) and gradually become a crop of commerce all over the country. In India, it is widely grown on an area of 292 thousand hectares with total production of 4361 thousand MT and a productivity 14.93 MT per hectare (National Horticultural Board, 2019-20). In India, guava is considered as an ideal fruit crop to meet nutritional security. The guava fruit is third highest source of vitamin C (200-300 mg/100gm of fruit pulp) after Barbados cherry (1000-4000mg/100gm pulp) and Aonla (600mg/100gm fruit) fruit (Yadav *et al.*, 2011). Guava fruits are high source of dietary fibre (48.55-49.42%) and extractable polyphenol (2.62-7.79%) (Jimenez *et al.*, 2001). The fruit quality of guava is greatly influenced by humidity and temperature. The rainy season fruits are insipid, watery and infested by several diseases and pests than in winter season (Singh *et al.*, 2000). Due to plentiful fruiting in the rainy season, there is great opportunity to improve the fruit quality through adoption of the best management practices of rainy season guava by the foliar application of micronutrients. Generally, horticultural crops are responded well to the foliar application of micronutrients compared to soil application (Fernandez *et al.,* 2013). Through foliar spraying, micronutrients can be applied more safely as it is required by plants in small amounts, which can be absorbed through the stomata of the leaf and in some instances through the cuticles. As absorption of nutrients through the stomata of the leaf is considerably quicker than through roots, it is the method of choice for supplying to plants (Stiles, 1982). Producing high-quality fruit is becoming a significant problem for the fruit trade to compete in both domestic and international markets. So, foliar application of micronutrients could be the new exploitable technology which may produce guava of unrivalled quality.

Guava responds well to applied micronutrients, particularly zinc (Zn), boron (B), copper (Cu) and irone (Fe) for improving growth, yield and fruit quality (Singh and Chhonkar, 1983). Zinc is important for auxin synthesis which improved cell division and development. Bronzing of guava is a major nutritional

*Email: tanmoymondalbckv@gmail.com*

How to cite : Mondal,T., Sarkar,T., Alam, M., Sarkar, S. K., Rathod, K. H. and Bauri,F. K. 2023. Effect of foliar application of micronutrients on plant growth, yield and fruit quality of Thai guava (*Psidium guajava* L.). *J. Crop and Weed*, 19(1): 88-94.

disorder due to zinc deficiency. Boron is much more required for pollen germination and pollen tube growth which improve fruit setting percentage. Copper is essential for photosynthesis. Plants need iron to activate several enzymes and to produce chlorophyll. So, the objective of the present experiment was to determine the efficacy of micronutrients on plant growth, physico-chemical quality of fruits, yield and yield attributing parameters of young guava plant, under the subtropical humid agro-climate zone of West Bengal.

## MATERIALS AND METHODS

The investigation was carried out during 2019 and 2020 in the plantation of Thai guava cultivar at the Horticultural Research Station, Bidhan Chandra Krishi Viswavidyalaya, Mondouri, Nadia, West Bengal. The experimental site is located under the subtropical humid agro-climate region of West Bengal having $22.43^0$ N latitude and $88.34^0$ E longitude, with an altitude of 9.75 m above mean sea level under new alluvial agro-climatic zone having short and mild summer and winter. The average temperature per day ranged from 14 to 36°C. The soil of the field was sandy loam (64.8% sand, 24.8% clay and 10.4% silt) in texture having soil pH value of 6.0 and was high in available P (26.05 kg $ha^{-1}$) and available K (287.50 kg $ha^{-1}$), low available N (168.80 kg $ha^{-1}$), medium in organic carbon (0.55%), very low in available B (0.059 mg $kg^{-1}$), low inZn content (0.67 mg $kg^{-1}$) and high in Cu in content ( 0.31 mg $kg^{-1}$ ). The experiment plants were two-year-old vegetatively propagated Thai guava plants planted with a spacing of 4m × 4m. Nine treatments ($T_1$=$ZnSO_4$@0.3%, $T_2$=$ZnSO_4$@0.5%, $T_3$=$Na_2B_4O_7$@0.2%, $T_4$= $Na_2B_4O_7$ @0.3%, $T_5$= $CuSO_4$@0.2%, $T_6$= $CuSO_4$@ 0.3%, $T_7$= $FeSO_4$@ 0.2%, $T_8$= $FeSO_4$@ 0.3%, $T_9$= control-water spray) were imposed twice, first spray during flowering (20th March,2019) and second spray at three weeks after first spray (11th April,2019), which was repeated in 2020.

Thirty fully matured leaves from each direction at the third pair from the base were collected to measure leaf area with the help of leaf area meter in each treatment. Number of new shoots were recorded after second spraying of micronutrient up to the end of growing season. Four branches were selected from each plant of nine treatment and the flower number were calculated from each branch of experiment plant. Fruit set was recorded after 20 days of anthesis. Data on the fruit drop was recorded under each treatment after 30 days of fruit setting.

Days for first harvesting were recorded by date of fruit set to date of harvest. Fruit number ($plant^{-1}$)was recorded from each replication at each harvest. After the final harvest the number of fruits of every harvesting was counted and average was worked out. Total number of marketable fruits were recorded from each replication at each harvest by eliminating the misshapen, unattractive fruits. The total number of marketable fruits and the treatment's average fruit weight were multiplied to determine the yield $plant^{-1}$. The yield $hectare^{-1}$ was calculated by yield $plant^{-1}$ multiplied with number of plants per hectare and expressed in t $ha^{-1}$. From each replication, three random fruits were selected to measure fruit length and diameter with the help of electronic callipers. The fruit weight and volume were measured at 30 days after fruit set, 60 days after fruit set and at fruit maturity. The specific gravity of fruits was determined by ratio of the fruit weight and the fruit volume.

The total soluble solids (TSS) of fruit juice was estimated with the help of digital refractometer which was calibrated in °Brix. Vitamin C of the fruit was determined by using 2, 3 dichloropyenolindophenol dye titration method (A.O.A.C., 1984) and it was expressed as mg/100g of fruit pulp. Total titratable acidity content of fruit juice was estimated by titrated against 0.1 N NaOH as described in A.O.A.C. (2000). The total sugar and reducing sugar content of fruits were determined using a freshly prepared combination with equal volumes of Fehling's solutions A and B by copper reduction method (AOAC, 2000) using methylene blue as an indicator and expressed in percentage value. Non-reducing sugar content was calculated by deducting the reducing sugar from total sugar. To calculate TSS/acid ratio, total soluble solids percent (TSS) was divided by acidity percent. The investigation was laid out in a Randomized Block Design (RBD), comprising of nine treatments each replicated thrice. The data obtained from the investigation were analyzed statistically with Duncan's new multiple range test by SPSS software (version 25).

## RESULTS AND DISCUSSION

### *Growth parameters*

The application of different micronutrients significantly improved the growth parameters of guava compared to the control (Table 1). The highest number of new shoots per branch (9.67) was observed under $T_2$ ($ZnSO_4$ @ 0.5%) while the minimum new shoots per branch (6.00) was recorded in $T_9$ (control). Significant increase in number of new shoots per branch over the control was recorded in both the concentration of ZnSO4, $Na_2B_4O_7$ @ 0.2% and $FeSO_4$ @0.3%. The leaf area under different treatments did not vary significantly, though highest leaf area (51.12 $cm^2$) was recorded in $T_2$ ($ZnSO_4$ @0.5%), while the lowest leaf area (46.29 $cm^2$) was observed in $T_9$ (control). The present finding was

**Table 1: Effect of micronutrients on plant growth parameters of young Thai guava**

| Treatment | Leaf area ($cm^2$) | No. of new shoot branch$^{-1}$ |
|---|---|---|
| $T_1$ ($ZnSO_4$ @0.3%) | 49.29±2.01$^{ab}$ | 8.66±1.52$^{ab}$ |
| $T_2$ ($ZnSO_4$ @0.5%) | 51.12±2.14$^{a}$ | 9.66±0.57$^{a}$ |
| $T_3$ ($Na_2B_4O_7$ @0.2%) | 49.16±0.22$^{ab}$ | 8.66±0.57$^{ab}$ |
| $T_4$ ($Na_2B_4O_7$ @0.3%) | 50.20±1.94$^{ab}$ | 7±1$^{bc}$ |
| $T_5$ ($CuSO_4$ @0.2%) | 47.62±4.68$^{ab}$ | 7.33±0.57$^{bc}$ |
| $T_6$ ($CuSO_4$ @0.3%) | 47.803±1.04$^{ab}$ | 7±1$^{bc}$ |
| $T_7$ ($FeSO_4$ @0.2%) | 48.38±0.97$^{ab}$ | 7.33±1.15$^{bc}$ |
| $T_8$ ($FeSO_4$ @0.3%) | 48.55±3.24$^{ab}$ | 8±1$^{ab}$ |
| $T_9$ (Control) | 46.29±0.23$^{b}$ | 6±1$^{c}$ |

Mean(±) standard deviation

Note: Treatments with similar letters mean no significant variation in the parameters

in conformity with previous studies by Sau *et al.* (2016), Hada *et al*. (2014) and Waskela *et al*. (2013) in guava. According to Reed (1946), zinc plays a crucial role in the basic process of respiration and cellular mechanism. The increased photosynthetic activity might have an impact on vegetative development.

***Fruiting characters***

The application of micronutrients significantly enhanced fruit set percentage and reduced the fruit drop percentage (Table 2). Application of $T_4$ ($Na_2B_4O_7$@ 0.3%) recorded maximum fruit set (69.56%) and minimum fruit was observed in control (61.26%). The fruit drop was recorded minimum (40.18%) with $T_4$ ($Na_2B_4O_7$@ 0.3%), while maximum fruit drop (61.06%) was noted in control. Micronutrient application exerted significant influence on early maturity of fruit over control. ZnSO4@0.5% ($T_2$) showed the shortest first harvesting period of 97.33 days, whereas control showed the longest first harvesting period of 109.67 days. Yadav *et al.* (2011) reported that fruit set, as well as fruit retention percentages, were increased by boron spray in guava. Because boron is essential for improving pollen viability, pollen tube growth and fertilization, which had a healthy fruit set, foliar applications of boron prevent fruit drop (Wojcik *et al.,* 2008). During the early stages of fruit development, enhanced auxin synthesis delayed the development of the abscission layer (Skoog,1940) which enhanced the number of fruit plant$^{-1}$.

***Yield parameters***

The observation of the experiment revealed that all the treatments considerably enhanced fruit yield compared to the control (Table 2). The highest number of fruits tree$^{-1}$ (24.67) was noted with $T_4$ ($Na_2B_4O_7$ @0.3%) which was followed by $T_3$ ($Na_2B_4O_7$@0.2%) with 24.33 number of fruits tree$^{-1}$, while the lowest number of fruits tree (16.67) was recorded in control. Micronutrient application significantly improved the out look of fruit i.e., marketable quality. With $T_4$ ($Na_2B_4O_7$@0.3%), the greatest proportion of marketable fruits tree$^{-1}$ was recorded (23.67), whereas the lowest number (13.33) was reported in the control condition. The maximum (6.09 kg tree$^{-1}$) fruit yield was recorded with $T_2$($ZnSO_4$ @0.5%) which was followed by $T_1$($ZnSO_4$ @0.3%) with value of 5.93, while minimum fruit yield (2.75kg tree$^{-1}$) was noted in control. Application of micronutrient significantly increased the yield of guava. Application of $T_2$ ($ZnSO_4$@0.5%) recorded maximum fruit yield (3.80 t ha$^{-1}$) over control (1.73 t ha$^{-1}$). The findings showed that zinc had an additive effect on yield because it was actively involved in enzyme regulation, plant metabolism, and maintaining the ideal balance of nutrients and growth substances in cells. Protein and auxin synthesis, proper maturity of fruits and seed production are the major function of zinc.

***Fruit physical parameters***

Fruit size was improved in all the treatments as compared to the control (Table 3). The highest fruit length (8.19 cm) and fruit diameter (7.14 cm) were recorded with $T_2$ ($ZnSO_4$@ 0.5%), while minimum fruit length (7.01 cm) and fruit diameter (5.94 cm) were noted in control. The increase in fruit length and fruit diameter was significantly higher in $T_1$ ($ZnSO_4$ @0.3%), $T_3$ ($Na_2B_4O_7$ @0.2%) and $T_4$ ($Na_2B_4O_7$ @0.3%). The higher length and diameter of fruit was due to the response of zinc and boron. It may be due to the effect of plant metabolism as boron is essential for cell division and elongation. Zinc is an essential micronutrient for the proper fruit maturation, formation of seeds, and auxin and protein synthesis. These results are in close

**Table 2: Effect of micronutrients on fruiting and yield parameters of young Thai guava plant**

| Treatment | Fruit set (%) | Fruit drop (%) | Days to harvest | Number of fruit plant$^{-1}$ | No. of marketable fruit plant$^{-1}$ | Yield (kg plant$^{-1}$) | Yield (ton ha$^{-1}$) |
|---|---|---|---|---|---|---|---|
| $T_1$ ($ZnSO_4$ @0.3%) | 68.02±1.67$^{a}$ | 45.66±0.47$^{c}$ | 98±1$^{d}$ | 23.33±1.52$^{abc}$ | 22.66±0.57$^{abc}$ | 5.93±0.15$^{ab}$ | 3.70±0.09$^{ab}$ |
| $T_2$ ($ZnSO_4$ @0.5%) | 68.26±0.90$^{a}$ | 43.36±0.86$^{d}$ | 97.33±1.15$^{d}$ | 24±1$^{abc}$ | 23±1$^{ab}$ | 6.08±0.26$^{a}$ | 3.79±0.16$^{a}$ |
| $T_3$ ($Na_2B_4O_7$ @0.2%) | 69.06±4.84$^{a}$ | 40.7±0.95$^{e}$ | 97.66±1.52$^{d}$ | 24.33±0.57$^{ab}$ | 23.33±0.57$^{a}$ | 5.52±0.35$^{b}$ | 3.44±0.22$^{b}$ |
| $T_4$ ($Na_2B_4O_7$ @0.3%) | 69.56±4.39$^{a}$ | 40.18±1.00$^{e}$ | 97.66±0.57$^{d}$ | 24.66±0.57$^{a}$ | 23.66±1.52$^{a}$ | 5.48±0.13$^{b}$ | 3.42±0.08$^{b}$ |
| $T_5$ ($CuSO_4$ @0.2%) | 65.63±0.57$^{a}$ | 50.33±1.70$^{b}$ | 104±1$^{b}$ | 22±1$^{bc}$ | 20.33±1.52$^{d}$ | 4.50±0.33$^{c}$ | 2.81±0.20$^{c}$ |
| $T_6$ ($CuSO_4$ @0.3%) | 66.06±1.07$^{a}$ | 49.8±1.80$^{b}$ | 103±1$^{bc}$ | 21.66±2.08$^{c}$ | 19.66±1.52$^{d}$ | 4.44±0.34$^{c}$ | 2.77±0.21$^{c}$ |
| $T_7$ ($FeSO_4$ @0.2%) | 67.36±0.73$^{a}$ | 46.63±1.15$^{c}$ | 101.33±1.52$^{c}$ | 23±1$^{abc}$ | 20.66±1.52$^{cd}$ | 4.66±0.34$^{c}$ | 2.91±0.21$^{c}$ |
| $T_8$ ($FeSO_4$ @0.3%) | 67.45±0.45$^{a}$ | 47.35±0.77$^{c}$ | 101±2.64$^{c}$ | 22.66±1.52$^{abc}$ | 21±1$^{bcd}$ | 4.82±0.23$^{c}$ | 3.00±0.14$^{c}$ |
| $T_9$ (Control) | 61.26±0.97$^{b}$ | 61.06±0.51$^{a}$ | 109.66±1.52$^{a}$ | 16.66±1.52$^{d}$ | 13.33±0.57$^{e}$ | 2.75±0.12$^{d}$ | 3.70±0.09$^{d}$ |

Mean(±) standard deviation

Note: Treatments with similar letters mean no significant variation in the parameters

conformity with the results of Singh *et al*. (2017) and Rawat *et al.* (2010).

***Fruit physical parameters at different stages***

The fruit weight and volume as affected by different micronutrient treatments recorded at 30 days after fruit set, 60 days after fruit set and at fruit maturity has been presented in Table 4-5. At 30 days after fruit set, maximum fruit weight (28.48 g) and fruit volume (24.57 cc) were recorded with the treatment $T_2$($ZnSO_4$ @ 0.5%). However, the minimum fruit weight (20.03g) and fruit volume (16.83 cc) were recorded under $T_9$ (control). At 60 days after fruit set, maximum fruit weight (70.51 g) and fruit volume (24.57 cc) were recorded with the treatment $T_2$ ($ZnSO_4$ @ 0.5%). However, significant minimum fruit weight (50.57g) and fruit volume (16.83 cc) were recorded with $T_9$ (control). At maturity, maximum fruit weight (264.98 g) and fruit volume (260.00 cc) were recorded with the treatment $T_2$ ($ZnSO_4$ @ 0.5%) followed by $T_1$ ($ZnSO_4$ @ 0.3%) with fruit weight of 261.85g and fruit volume of 68.50 cc. However, significant minimum fruit weight (206.69 g) and fruit volume (196.67 cc) were recorded with $T_9$ (control). The specific gravity of guava fruits was relatively constant in any specific stage of development and non-significant changes were recorded over control (Table 5). Boron and zinc were appeared to have an indirect function in boosting the process of cell division and cell elongation, which would have improved size, weight, and volume of guava fruit. This result is closely related with the finding of Yadav *et al.* (2017) and Pal *et al.* (2008).

***Biochemical properties***

Data demonstrate (Table 5) that various levels of micronutrients significantly increased total soluble solids (TSS), total sugar, reducing sugar, non-reducing sugar, ascorbic acid, and sugar-acid ratio and reduced the acidity as compared to control. The highest TSS (11.03 °Brix), ascorbic acid (181.99 mg/100g), total sugar (**7**.87%**),** reducing sugar (4.28%), non-reducing sugar (3.63%) and TSS: acid (57.3) was recorded with $T_4$ ($Na_2B_4O_7$ @0.3%), while minimum TSS (8.16 °Brix), ascorbic acid (162.8 mg $100^{-1}$g pulp), total sugar (5.78%), non-reducing sugar (2.76%) and TSS: acid (25.28) were noted in control. The lowest titratable acidity content (0.20%) was recorded with $T_4$ ($Na_2B_4O_7$ @0.3%) which was followed by $T_3$ ($Na_2B_4O_7$ @0.2%) with a value of 0.21%, while it was highest (0.32%) in control.

The increase in TSS and total sugar of fruit on account of sodium tetraborate application could be attributed to fact that boron helps in the transportation,

**Table 3: Effect of micronutrients on fruit physical parameter of Thai guava**

| Treatment | Fruit length (cm) | Fruit diameter (cm) |
|---|---|---|
| $T_1$ ($ZnSO_4$ @0.3%) | 8.02±0.13$^{ab}$ | 6.59±0.28$^{abc}$ |
| $T_2$ ($ZnSO_4$ @0.5%) | 8.19±0.13$^{a}$ | 7.14±0.35$^{a}$ |
| $T_3$ ($Na_2B_4O_7$ @0.2%) | 7.63±0.24$^{abc}$ | 6.50±0.30$^{bcd}$ |
| $T_4$ ($Na_2B_4O_7$ @0.3%) | 8.1±0.55$^{ab}$ | 7.02±0.21$^{ab}$ |
| $T_5$ ($CuSO_4$ @0.2%) | 7.11±0.33$^{c}$ | 6.19±0.38$^{d}$ |
| $T_6$ ($CuSO_4$ @0.3%) | 7.13±0.16$^{c}$ | 6.22±0.542$^{cd}$ |
| $T_7$ ($FeSO_4$ @0.2%) | 7.33±0.21$^{c}$ | 6.39±0.25$^{cd}$ |
| $T_8$ ($FeSO_4$ @0.3%) | 7.55±0.47$^{bc}$ | 6.48±0.34$^{bcd}$ |
| $T_9$ (Control) | 7.01±0.38$^{c}$ | 5.93±0.05$^{d}$ |

Mean(±) standard deviation

metabolism and accumulation of sugars in fruits. Fruits may have a lower acidity as a result of increased sugar accumulation, improved sugar translocation in fruit tissues, and formation of organic acids from sugars (Saha *et al*., 2019). The higher ascorbic acid content of fruit might be due to the role of boron which helped the inhibition of oxidative enzymes or biosynthesis of ascorbic acid from sugars or both. Boron enhances nitrogen uptake and thus helps the process of photosynthesis, which ultimately leads to the accumulation of carbohydrates and helps in increasing the sugar content of the fruits (Movchan and Soboroikova, 1972). The total sugar increment also might have been possible due to the accumulation of polysaccharides and oligosaccharides in greater amounts in nearly every treated plant. This finding is also closely similar to the finding of Bhoyar and Ramdevputra (2017) and Sau *et al.* (2018).

## CONCLUSION

The foliar application of $ZnSO_4$ @0.5% was determined to be the most superior treatment for plant growth, improved in leaf area, number of new shoots per branch, average weight and volume of fruit, specific gravity, reduction in time for harvesting, fruit length and fruit diameter which resulted in more yield tree$^{-1}$. Different quality attributes like TSS, ascorbic acid content of fruit, total sugar, reducing sugar and non-reducing sugar content, TSS/acid ratio and fruit set, number of fruits tree$^{-1}$ and fruit yield (kg tree$^{-1}$ and t ha$^{-1}$) were enhanced with reduced fruit drop and acidity when applied with $Na_2B_4O_7$@ 0.3%. Therefore, it may be concluded that the application of micronutrients ($ZnSO_4$ @0.5% and $Na_2B_4O_7$@ 0.3%) along with a recommended dose of NPK may be acclaimed for improving plant growth, yield, and fruit quality of guava in the inceptisol of the Gangetic plains of West Bengal, India.

## ACKNOWLEDGEMENT

We sincerely acknowledge the Department of Fruit Science, Bidhan Chandra Krishi Viswavidyalaya for providing facilities and support for carrying out this experiment successfully.

## REFERENCES

A.O.A.C. 1984. Official Method of Analysis. Association of Official Analytical Chemists. Washington, D.C, U.S.A.

A.O.A.C. 2000. Official Method of Analysis of AOCO International (17th edno). Gaithersburg, MD, USA: AOCO International.

Bhoyar, M. G. and Ramdevputra, M. V. 2017. Effect of foliar spray of zinc, iron and boron on quality of guava (*Psidium guajava* L.) cv. Sardar L-49. *Trends Biosci.*, **10**:8109-8111.

Hada, T. S., Singh, B. K., Veer, Karma, V. and Singh, S. P. 2014. Effect of different levels of boron and zinc on flowering, fruiting and growth parameter of winter season guava (*Psidium guajava* L.) cv. L-49. *Asian J. Hort.*, **9**: 53-56.

Movchan, V.G. and Soboroikova, I.G. 1972. The fertilization and uptake of mineral nutrients by vines growing in the southern Chernozan. *Agrochimica*, **5**:123-130.

NHB, 2019-20. Online Statistical databased of National Horticultural Board, Ministry of Agriculture, Govt. of India.

Nimisha, S., Kherwar, D., Ajay, K. M., Singh, B. and Usha, K. 2013. Molecular breeding to improve guava *(Psidium guajava* L.): current status and future prospective. *Sci. Hortic.*, **164**:578-588.

Prakash, D. P., Narayanaswamy, P. and Sondur, S. N. 2002. Analysis of molecular diversity in guava using RAPD markers. *J. Hortic. Sci. Biotechnol.*, **77**: 287-293.

**Table 4: Effect of micronutrients on fruit physical parameters at different stages of Thai guava**

| Treatment | Fruit weight (g) | | | Fruit volume (cc) | | | Specific gravity (g/cc) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 30 days after fruit set | 60 days after fruit set | At maturity | 30 days after fruit set | 60 days after fruit set | At maturity | 30 days after fruit set | 60 days after fruit set | At maturity |
| $T_1$ ($ZnSO_4$ @0.3%) | 27.26±3.41$^{ab}$ | 69.12±1.72$^{a}$ | 261.85±7.88$^{a}$ | 24.33±4.07$^{a}$ | 68.5±2$^{ab}$ | 257.16±26.81$^{ab}$ | 1.09±0.05$^{a}$ | 1.00±0.00$^{a}$ | 1.01±0.08$^{a}$ |
| $T_2$ ($ZnSO_4$ @0.5%) | 28.47±2.12$^{a}$ | 70.50±1.66$^{a}$ | 264.98±27.99$^{ab}$ | 24.56±2.99$^{a}$ | 69.5±1.41$^{a}$ | 260±25.98$^{a}$ | 1.16±0.11$^{a}$ | 1.01±0.01$^{a}$ | 1.016±0.03$^{a}$ |
| $T_3$ ($Na_2B_4O_7$ @0.2%) | 26.04±2.78$^{abc}$ | 65.64±3.12$^{ab}$ | 233.44±2.87$^{c}$ | 21.46±2.05$^{ab}$ | 59.83±3.32$^{bc}$ | 208.83±17.06$^{c}$ | 1.20±0.01$^{a}$ | 1.09±0.01$^{a}$ | 1.11±0.09$^{a}$ |
| $T_4$ ($Na_2B_4O_7$ @0.3%) | 27.86±2.41$^{ab}$ | 70.16±1.70$^{a}$ | 235.13±4.80$^{bc}$ | 23.9±0.96$^{a}$ | 68±2.45$^{ab}$ | 220.23±13.40$^{abc}$ | 1.16±0.11$^{a}$ | 1.02±0.01$^{a}$ | 1.06±0.04$^{a}$ |
| $T_5$ ($CuSO_4$ @0.2%) | 22.33±2.83$^{cd}$ | 56.27±0.88$^{cd}$ | 221.73±3.00$^{c}$ | 18.86±2.20$^{bc}$ | 49.6±3.55$^{d}$ | 223.66±22.80$^{abc}$ | 1.2±0.28$^{a}$ | 1.13±0.06$^{a}$ | 1.01±0.04$^{a}$ |
| $T_6$ ($CuSO_4$ @0.3%) | 23.04±2.56$^{bcd}$ | 59.73±1.28$^{bc}$ | 226±25.05$^{c}$ | 20.96±1.76$^{abc}$ | 60.25±3.18$^{abc}$ | 216.26±15.47$^{bc}$ | 1.09±0.08$^{a}$ | 1.00±0.03$^{a}$ | 1.03±0.03$^{a}$ |
| $T_7$ (FeSO4 @0.2%) | 23.56±3.50$^{bcd}$ | 57.6±1.73$^{c}$ | 228.56±7.27$^{c}$ | 22.9±3.00$^{ab}$ | 53.56±2.18$^{cd}$ | 221.93±7.78$^{abc}$ | 1.02±0.02$^{a}$ | 1.07±0.017$^{a}$ | 1.02±0.07$^{a}$ |
| $T_8$ ($FeSO_4$ @0.3%) | 26.69±1.28$^{abc}$ | 60.47±4.39$^{bc}$ | 229.75±4.52$^{c}$ | 22.5±0.78$^{ab}$ | 59.76±10.60$^{bc}$ | 207.9±15.54$^{c}$ | 1.17±0.02$^{a}$ | 1.08±0.19$^{a}$ | 1.10±0.06$^{a}$ |
| $T_9$ (Control) | 20.03±0.81$^{d}$ | 50.57±9.48$^{d}$ | 206.68±25.25$^{c}$ | 16.83±1.60$^{c}$ | 47±2.82$^{d}$ | 196.66±40.72$^{c}$ | 1.19±0.07$^{a}$ | 1.05±0.15$^{a}$ | 1.06±0.11$^{a}$ |

Mean(±) standard deviation

Note: Treatments with similar letters mean no significant variation in the parameters

**Table. 5: Effect of micronutrients on biochemical properties of guava**

| Treatment | TSS (ºBrix) | Total sugars (%) | Reducing sugar (%) | Acidity (%) | Non-reducing sugar (%) | Ascorbic acid (mg $100^{-1}$ pulp) | TSS: Acid |
|---|---|---|---|---|---|---|---|
| $T_1$ ($ZnSO_4$ @0.3%) | 10.3±0.75$^{ab}$ | 6.77±0.69$^{bc}$ | 3.61±0.36$^{ab}$ | 0.25±0.02$^{bc}$ | 2.99±0.06$^{b}$ | 174.40±1.50$^{ab}$ | 41.30±2.02$^{cd}$ |
| $T_2$ ($ZnSO_4$ @0.5%) | 10.43±0.60$^{ab}$ | 6.81±0.30$^{bc}$ | 3.84±0.51$^{ab}$ | 0.24±0.01$^{bcd}$ | 2.82±0.05$^{cd}$ | 178.57±5.60$^{ab}$ | 43.49±2.44$^{bc}$ |
| $T_3$ ($Na_2B_4O_7$ @0.2%) | 10.53±0.30$^{ab}$ | 7.32±0.15$^{ab}$ | 4.23±0.24$^{a}$ | 0.20±0.01$^{cd}$ | 2.93±0.12$^{bc}$ | 178.86±5.37$^{ab}$ | 51.11±3.14$^{ab}$ |
| $T_4$ ($Na_2B_4O_7$ @0.3%) | 11.03±0.50$^{a}$ | 7.87±0.70$^{a}$ | 4.28±0.76$^{a}$ | 0.2±0.05$^{d}$ | 3.40±0.01$^{a}$ | 181.99±12.21$^{a}$ | 57.3±12.80$^{a}$ |
| $T_5$ ($CuSO_4$ @0.2%) | 8.66±0.76$^{d}$ | 6.48±0.24$^{cd}$ | 3.9±0.2$^{ab}$ | 0.28±0.03$^{b}$ | 2.45±0.04$^{f}$ | 167.64±2.48$^{bc}$ | 31.05±1.21$^{ef}$ |
| $T_6$ ($CuSO_4$ @0.3%) | 9.03±0.50$^{cd}$ | 6.51±0.12$^{bcd}$ | 3.7±0.26$^{ab}$ | 0.27±0.01$^{b}$ | 2.67±0.08$^{de}$ | 169.45±1.72$^{bc}$ | 33.64±2.91$^{def}$ |
| $T_7$ ($FeSO_4$ @0.2%) | 9.86±0.35$^{bc}$ | 6.68±0.16$^{bc}$ | 3.56±0.35$^{ab}$ | 0.26±0.01$^{b}$ | 2.96±0.07$^{bc}$ | 171.57±7.64$^{abc}$ | 38.00±2.42$^{cde}$ |
| $T_8$ ($FeSO_4$ @0.3%) | 10.16±0.65$^{ab}$ | 6.75±0.55$^{bc}$ | 3.65±1.18$^{ab}$ | 0.25±0.01$^{bc}$ | 2.95±0.12$^{bc}$ | 173.67±5.75$^{abc}$ | 40.89±3.65$^{cd}$ |
| $T_9$ (Control) | 8.16±0.76$^{d}$ | 5.78±0.37$^{d}$ | 3.02±0.19$^{b}$ | 0.32±0.00$^{a}$ | 2.627±0.10$^{e}$ | 162.8±1.94$^{c}$ | 25.42±2.70$^{f}$ |

Mean(±) standard deviation

Rai, M. K., Phulwaria, M., Gupta, A. K., Shekhawat, N. S. and Jaiswal, U. 2012. Genetic homogeneity of guava plants derived from somatic embryogenesis using SSR and ISSR markers. *Plant Cell Tissue Organ Cult.*, **111**: 259-264.

Rawat, V. R. Y. T. J., Tomar, Y. K. and Rawat, J. M. S. 2010. Influence of foliar application of micronutrients on the fruit quality of guava cv. Lucknow-49. *J. Hill Agric.*, **1**:75-78.

Reed, H.S. 1946. Effect of zinc deficiency on phosphate metabolism of the tomato plants. *Amer. J. Bot.*, **33**: 778-784.

Saha, T., Ghosh, B., Debnath, S. and Bhattacharjee, A. 2019. Effect of micronutrients on growth, yield and quality of strawberry (*Fragaria ananassa* Duch.) cv. Winter Dawn in the Gangetic Alluvial region of West Bengal. *J. Crop Weed.*, **15**:92-95.

Sau, S., Sarkar, S. and Ghosh, B. 2016. Correlation and path analysis studies for growth and yield contributing traits in guava as affected by micronutrients. *Ann. Plant Soil Res.*, **18**: 370-374.

Sau, S., Sarkar, S., Ghosh, B., Ray, K., Deb, P. and Ghosh, D. 2018. Effect of foliar application of B, Zn and Cu on yield, quality and economics of rainy season guava cultivation *Curr. J. Appl. Sci. Technol,*, **28**:1-10.

Singh, Y. K., Singh, S. S., Prasad, V. M., Singh, R. K. and Yadav, A. 2017. Assess the effect of different levels of micronutrient on fruit set and yield of guava (*Psidium guajava* L.) cv Allahabad Safeda. *J. Pharmacogn. Phytochem.*, **6**:1470-1475.

Singh, P.N. and Chhonkar, V.S. 1983. Effect of zinc, boron and molybdenum as foliar spray on chemical composition of guava fruit. *Punjab Hort. J.,* **23**: 34-37.

Skoog, F. 1940. Zinc-Auxin in plant growth. *Horti. Abstr.,* **11**: 332.

Waskela, R.S., Kanpure, R.N., Kumawat, B. R. and Kachouli, B.K. 2013. Effect of foliar application of micronutrients on growth, yield and quality of guava (*Psidium guajava* L.) cv. Dharidar. *Int. J. Agric. Sci.,* **9**: 551-556.

Wojcik, P., Wojick, M. and Klamkowski, K. 2008. Response of apple tree to boron fertilization under conditions of low soil boron availability. *Sci. Hortic.*, **116**:58-64.

Yadav, A., Verma, R. S., Ram, R. B., Kumar, V. and Yadav, R. K. 2017. Effect of foliar application of micronutrients on physical parameters of winter season guava (*Psidium guajava* L) cv. Lalit. *Plant Arch.*, **17**:1457-1459.

Yadav, H.C., Yadav, A.L., Yadav D.K., Yadav, P.K. and Yadav, R.S. 2011. Effect of foliar application of micronutrients and $GA_3$ on fruit yield and quality of rainy season guava (*Psidium guajava* L.) cv. L-49. *Plant Arch.*, **11**:147-149.