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Response of foliar application of micronutrients and plant growth regulator on Physio-chemical attributes of guava (*Psidium guajava* L.) cv. Shweta and Lalit

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Abstract
The present investigation entitled "Response of foliar application of micronutrients and plant growth regulator on physio-chemical attributes of guava (*Psidium guajava* l.)" was conducted on guava plants grown of about 6 six year old in the sodic soil condition at Main Experimental Station, Department of Fruit Science, Acharya Narendra Deva University of Agriculture & Technology Kumarganj Ayodhya (U.P) during the year 2019-20 to study the response of foliar application of micronutrients and plant growth regulators on physio-chemical attributes of guava. The experiment contains of two foliar applications after flowering in August and at the pea stage in October of zinc sulfate 1.0% (N_1) Borax 1% (N_2), NAA 50ppm (N_3), and Control (N_0) on the two cultivar Shweta (V_1) and Lalit (V_2) with three replication. The data was recorded and analysed by using Factor Randomised block design (F.R.B.D). Under the investigation, guava fruits were studied for the parameter of fruit weight, fruit size (length and width), fruit volume Total soluble solids, Reducing sugars, Non-reducing sugar, and Total sugars, Acidity, and Ascorbic acid. During the investigation, the result concluded that maximum weighted fruit in treatment N_2V_1, while, highest volume fruits were observed in treatment N_1V_1 and size of fruit in the treatment N_3 V_1. The total soluble solids, Reducing sugars, non-reducing sugar were significantly highest in treatments N_3V_2, N_2 V_2, N_1 V_2 respectively. The maximum acidity was recorded in the treatment N_2V_2 and ascorbic in treatment N_3 V_1; therefore, concluded that application of FYM+NPK (400g: 300g: 250g) + Borax (1%) in cv. Lalit improved physiochemical attributes of the fruit.

Keywords: Guava, micronutrients, borax, Shweta, Lalit, FYM

Introduction
Guava (*Psidium guajava* L.), is one of the most important tropical and sub-tropical fruit crop of India, which belongs to the family Myrtaceae. It is native of tropical America, stretching from Mexico to Peru and gradually become a commercial significance level of fruit crop in a several countries. It is cultivated in India since early 17th century and gradually become a crop of commercial significance. Guava is fourth important fruit in area and production after mango, banana and citrus. It is cultivated throughout the tropical and subtropical region. At present, guava had got well established market in more than 60 countries of the world. India, guava is commercially grown in throughout the country particularly Maharashtra, Uttar Pradesh, Bihar, Orissa, Punjab, Uttarakhand, Gujarat, Madhya Pradesh, and west Bengal. Utter Pradesh is considered as the most important guava producing state of India, in which Allahabad (Prayagraj) region has the reputation of growing the best quality guava in the country as well as all over the world**.** It is cover around 3.7% (2.7 lakh ha) of total area under fruit crops and contributes 3.3% (41.07 MT) of total fruit production (NHB 2017-18) [11].

The guava is shallow rooted shrub or small tree. It grows 3-10m in height. The bark is smooth, reddish brown, peeling off in the flakes. The upper surface of leaves is glabrous and finely pubescent beneath. Flowers are axillary, solitary or in 2-3 flowered cymes. Fruit is a berry, globose, ovoid or pyriform. The skin (Exocarp) is pale green to yellow, mesocarp fleshy, of varying thickness, white yellow, pink or red, stone cells usually present. Seeds embedded in pulp, usually numerous, yellowish colour.

Nutritive value of guava is very high. Therefore, it is an ideal fruit for nutritional security. Guava is one of the cheapest and good source of vitamin-C (210-305mg/100g fruit pulp) and pectin (0.5-1.8%) but has low energy (66cal/100g). the ripe fruits contain 12.3-26.3% dry matter, 77.9-86.9% moisture, 0.51-1.02% ash,0.10-0.70% crude fat, 0.82-1.45% crude protein and 2.0-7.2% crude fiber. The fruit fruits is also rich in minerals like Phosphorus (22.5-40.0 mg/100g pulp), Calcium (10.0-30.0 mg/100g pulp) and Iron (0.60-1.39 mg/100g pulp),

Pantothenic acid, Thiamine (0.03-0.07 mg/100g pulp), Riboflavin (0.02-0.04 mg/100g pulp) and Vitamin – "A" (Mitra and Bose, 2001) [10].

In northern India, guava flowers twice or sometimes thrice in a year. The spring flowering is called "Ambe Bahar", June or monsoon flowering is called "Mrig Bahar" and third flowering which come in October is called "Hast Bahar". Ambe Bahar fruits ripen from July to September and Mrig Bahar fruits ripen from November to February however, Hast Bahar fruits ripen in spring season which is also known as summer season.

Guava trees are prolific bearer and to maintain its vigour, growth and productivity for a long time, it needs proper nourishment. Without proper management, continuous fruit production reduces nutrient reserves in the soil and thus, affects crop growth and productivity adversely. Replenishment of lost quantities of the nutrients is, therefore, necessary to maintain the fertility status of the soil and to get good crop in the following years. Therefore, a careful management is required to produce a profitable crop which includes cultural practices and obviously the fertilization and nutrition of orchard. Nutrition is most important factor affecting growth, yield and quality of a crop. Unless, it is maintained at an optimum level, higher yield and better fruit quality cannot be maintained. However, the increasing cost of fertilizers and their adverse effects on soil all over the world have made it necessary to think in terms of supplementing the soil with alternative sources which render soil more productive and better quality fruits.

Micronutrients such as zinc sulphate play important role in improving the quality of fruits. It is one of the essential element for the formation of chlorophyll and hence useful towards photo synthetic activity. It is also a constituent of some enzymes. Zinc activates enzymes that are responsible for the synthesis of certain proteins. It is used in the formation of chlorophyll and some carbohydrate, conversion of starches to sugars and its presence in plant tissue helps the plant to withstand cold temperatures. Zinc is essential in the formation of auxins, which helps with growth regulation and improves quality of fruits. Sarkar *et al.* (2009) [16] suggested application of zinc 0.5% and 1.0% significantly improve TSS, Sugars and reduced the acidity in fruit sprayed in litchi cv. Bombai. foliar application of zinc sulphate (1.0 per cent) along with boric acid (1.0 per cent) was found effective to improve the fruit weight of guava cv. Pant Prabat. Kumar *et al.,* (2010) [6], Goswami *et al*. (2012) [5] reported that spraying of zinc sulphate 0.4 per cent twice *viz* 45 and 25 days before harvesting improved the Physico-chemical properties of guava cv. Sardar.

The foliar application of micronutrients and plant growth regulators plays a vital role in improving the quality and comparatively more effective for rapid recovery of plants. The foliar feeding of fruit tree has gained much importance in recent years, as micronutrients applied through soil are needed in higher quantity because some amount leaches down and some become unavailable to the plant due to complex soil reactions. The yield parameter like average fruit weight, number of fruits per tree and yield per tree are increased by the spray of micronutrients.

Material and Methods

The present investigation was carried out at MES, Horticulture, Department of Fruit Science; Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.) during year 2019-20 on 6 six year old guava plants which were planted at spacing 6x6 m. Geographically, It is situated at 26.47º North latitude, 82.12º East longitude and altitude of 113 meter from sea level. The site is located in typical saline alkaline belt of gangetic plains of eastern Uttar Pradesh.

Factorial Randomized Block Design with three replication was applied in the layout of experimental trial in the month of May, 2019, with the allocation of eight treatment combinations from two factors (i) two varieties (Shweta (V_1) and Lalit (V_2)) (ii) Micronutrients ($ZnSO_4$ (1%) (N_1) and Borax (1%) (N_2)) and plant growth regulator (NAA@ 50ppm (N_3)). Foliar spray was done twice in the month of August after flowering and in October at pea size stage. The observations were recorded for fruit weight, fruit size, total soluble solids, Titrable acidity, Ascorbic Acid, Reducing Sugars, Non-reducing sugar and Total sugars.

Total soluble solids of the fruits were measured by Erma Hand Refractometer (Tokyo, Japan) of the reading 0-32^0 Brix and correction was done at 20 ^{0}C. A small piece of fruit crushed and placed it on the prism of refractometer and value was read against the light. The ascorbic acid and titrable acidity was estimated as per the method prescribed by AOAC (2000) [2]. The total sugar Percentage was determine by 'Fehling solution method' expressed in percentage

Statistical analysis of data obtained on different traits of experiment were subjected to statistically analyze as per suggested by Panse and Sukhatme (1985) [12] and result were evaluated at 5% level of significance. The objective of present study was to determine best response of foliar application of micronutrient and plant growth regulars on the guava cv. Shweta and Lalit

Results and Discussion

Perusal of the data presented in table-1 clearly indicates that the fruit size of different variety with respect of length and width was noted significant, Variety Shweta (V_1) has maximum fruit size (6.93 cm and 7.35 cm) as compared to Lalit (V_2) which has minimum fruit size (6.16 cm and 6.20 cm) further, nutrients also significantly influenced fruit size. The maximum fruit size (6.91 cm and 7.36 cm) was recorded with the application of NAA 500ppm (N_3) followed by borax 1% (N_2) and minimum fruit size (5.60 cm and 6.16)was recorded water spray (N_0); However the The interaction between variety and nutrients on fruit size was found non-significant. The increase in fruit size (length and breadth) might be due to the optimum supply of plant nutrients and growth regulators in right amount during the entire crop growth period causing vigorous vegetative development of the plant, ultimately leading to production of more photosynthates (Awasthi and Lal 2009) [3]. The application of NAA might have a role in increasing the auxin level of fruits, which in turn, might have helped in the development of fruit components as there is a direct correlation between auxin content and fruit growth. Increased level of carbohydrates stimulated cell division and cell elongation resulting in larger fruits. The improved fruit size in terms of length and breadth by plant growth regulators has also been reported by Babu and Singh (1998), Mahendra *et al.* (2007) [8], Sharma *et al.* (2005) [17] in kagzi lime, Kumar *et al.* (2014) [7] in phalsa and Meena *et al.* (2005) [9] in guava.

Average fruit weight of the varieties was recorded at par

Maximum fruit weight (93.95g) was noted with Lalit (V_2) and minimum fruit weight (91.08g) was noted with Shweta (V_1) whereas the effect of different nutrients and plant growth regulator was significant with respect to fruit weight. Maximum fruit weight (101.50g) was recorded with borax (N_2) followed by zinc sulphate (N_1) whereas, minimum fruit weight (84.17g) was recorded with water spray (N_0). Further, the interaction of variety and micronutrients and plant growth regulator significantly influenced the fruit weight. The maximum fruit weight (106.33g) was noted with (N_2V_1). The minimum fruit weight (80.33g) was measured with (N_3 V_1). The results are very close to the findings of Kumar *et al.*, (2010) [6], Singh *et al.* (2012) [19], Waskela *et al.* (2013) [22] and Venu *et al.* (2014) [21]

The different varieties have significant effect on the fruit volume, the maximum fruit volume (120.00) was noted with (V_1) and minimum fruit volume (112.50) was noted (V_2); However the effect of nutrients and plant growth regulator was non-significant with respect to fruit volume. The interaction effect of variety and nutrients on fruit volume was found significant. The maximum fruit volume (150.00) was recorded with foliar application of zinc sulphate on Shweta variety (N_1V_1) whereas; minimum fruit volume (90.00 cm^3) was recorded with foliar spray of water in variety Shweta (N_0V_1)

Total soluble solids of guava fruit was significantly influenced by the variety. Lalit (V_2) has Higher TSS (17.03 ^{0}Brix) as compared to Shweta(V_1). Micronutrients and plant growth regulator were also significantly influenced the TSS of the fruit. Foliar application of NAA 500ppm was most beneficial in term of TSS (18.12 ^{0}Brix) than the other micronutrients water sprayed fruit recorded least TSS (14.82 ^{0}Brix). The interaction between the variety and the PGR and Micronutrients also has significant effect on the TSS. Application of NAA 500ppm (N_3) on the Lalit (V_2) variety was proven best (18.15 ^{0}Brix) whereas, lowest TSS was recorded with water spray on Shweta The increase in total soluble solids might be due to the fact that growth regulators being helpful in the process of photosynthesis led to the accumulation of oligosaccharides and polysaccharides in higher amount. Besides this, they also regulate the enzymatic activity and the enzymes quickly metabolized the starch into soluble sugars and early ripening in response to growth substances. Similar observations were recorded by Prasad *et al.* (2005) [13], Kumar *et al.* (2010) [6], Sharma and Singh (2005) [17] in different fruits.

Reducing sugars was noted non-significant in terms of variety as well as nutrients. Maximum content of reducing sugars (4.49%) was recorded in variety Lalit (V_2) however the application of borax 1% has improved the value (4.58%). The interaction between variety and nutrients on reducing sugar (%) found non-significant. The maximum reducing sugar (4.66%) was noted with foliar spray of borax 1% in variety Lalit (N_2V_2). The minimum reducing sugar (4.15%) was measured with (N_0V_1)

Among the variety as well as nutrients the non-reducing sugar was found at par where the maximum content (2.34%) was recorded in variety Lalit. Maximum non-reducing sugar (2.40%) was recorded with foliar application of $ZnSO_4$ 1%. The interaction between variety and nutrients was also noted non-significant in respect of non-reducing sugar content of guava fruits cv. Lalit maximum non reducing sugar (2.65%) was noted with (N_1V_2). The minimum non reducing sugar (2.08%) was measured with application of water spray in Shweta (N_0V_1)

Total sugars non significantly influenced by different variety in guava. The maximum total sugars (6.82%) was noted with (V_2). The minimum total sugars (6.42%) was recorded in variety Shweta (V_1). Nutrients were also found non-significant regarding of total sugars. Maximum total sugars (6.87%) were recorded with the borax 1% (N_2).The interaction between variety and nutrients on total sugars percentage found non-significant. The maximum total sugars (7.20%) was noted with foliar spray of $ZnSO_4$ 1% on the cv. Lalit(N_1V_2). The minimum total sugars (6.23%) were recorded with water spray in Shweta (N_0V_1).

Titrable acidity of guava was found non-significant with variety. The maximum acidity (0.23%) was noted in cv. Shweta (V_1) as compared to cv. Lalit (0.22%) but both were at par. Nutrients were also found non-significant effect on acidity of guava. Maximum acidity (0.25%) was recorded with the application of borax 1% (N_2) and minimum acidity (0.21%) was recorded with foliar spray of $ZnSO_4$ 1% (N_1).The interaction between variety and nutrients on acidity was found non-significant. The maximum acidity (0.26%) was noted with application of borax 1% on the cv. Lalit (N_2V_2). The minimum acidity (0.19%) was measured with foliar spary of water on cv. Lalit (N_0V_2). The lower acidity might be due to an early ripening of fruits caused by the treatment, where acid might have been used during respiration or fastly converted into sugars and their derivatives by reactions involving reverse glycolytic pathways or might have been used in respiration or both (Agnihotri *et al* 2013) [1]. Similar results were obtained by Ruby and Brahmachari, (2001) [15] in litchi. The findings of Singh *et al* (2017) [20] are also in line with the present studies.

Varieties significantly influenced the ascorbic acid content in guava fruits. The maximum ascorbic acid (389.00mg/100g pulp) was noted with cv. Shweta (V_1) whereas minimum (335.41 mg/100g pulp) was noted in cv. Lalit (V_2). Nutrients also gave significant influence on ascorbic acid content of guava fruits. Maximum ascorbic acid (408.54 mg/100g pulp) was recorded with foliar spray of NAA 500ppm (N_3) and minimum ascorbic acid (326.06 mg/100g pulp) was recorded with nutrients (N_0) control. The interaction effect of variety and nutrients was found significant for ascorbic acid content. The maximum ascorbic acid (409.33 mg/100g pulp) was noted with foliar spary of NAA 500ppm in cv. Shweta (N_3V_1) whereas minimum (274.44 mg/100g pulp) was measured with water spray on cv. Lalit (N_0V_2). The increase in ascorbic acid content might have resulted owing to biosynthesis of ascorbic acid from sugar or inhibition of oxidative enzymes or both due to favourable metabolic activity involving certain enzymes and metabolic ions under the influence of plant growth regulators and micro-nutrients (Rajput *et al.* 2016). An increase in ascorbic acid content might be due to perpetual synthesis of glucose-6-phosphate throughout the growth and development of fruits which is thought to be the precursor of vitamin C. The research findings of El-Sherif *et al.* (2000) [4] also advocated the same in guava fruits cv. Sardar. The earlier findings of Singh *et al.* (2004) [18] in guava and Sarkar *et al.* (2009) [16] in litchi are also in consonance with the present results.

Table 1: Response of foliar application of micronutrients and PGR on Physical attribute of fruit guava cv. Shweta and Lalit

Treatment	Fruit Length (Cm)	Fruit Width (Cm)	Fruit Volume (Cm^3)	Fruit Weight (G)
N_0	5.60	6.16	112.50	84.17
N_1	6.88	6.79	121.67	93.90
N_2	6.79	6.80	111.67	101.50
N_3	6.91	7.36	119.17	90.50
S.Em±	0.15	0.24	3.26	1.55
CD at 5%	0.34	0.53	NS	3.46
V_1	6.93	7.35	120.00	91.08
V_2	6.16	6.20	112.50	93.95
S.Em±	0.10	0.17	2.30	1.10
CD at 5%	0.24	0.38	5.12	NS
N_0 V_1	5.67	6.40	90.00	85.33
N_0 V_2	5.53	5.92	135.00	83.00
N_1 V_1	7.23	7.32	150.00	92.33
N_1 V_2	6.53	6.26	93.33	95.47
N_2 V_1	7.35	7.54	120.00	106.33
N_2 V_2	6.23	6.06	103.33	96.67
N_3 V_1	7.45	8.14	120.00	80.33
N_3 V_2	6.36	6.57	118.33	100.67
S.Em±	0.21	0.34	4.61	2.20
CD at 5%	NS	NS	10.24	4.89

Zinc sulfate 1.0% (N_1) Borax 1% (N_2), NAA 50ppm (N_3), Control (N_0), Shweta (V_1) and Lalit (V_2)

Table 2: Response of foliar application of micronutrients and PGR on Chemical attributes of fruit guava cv. Shweta and Lalit

Treatment	Total Soluble Solids (^{0} Brix)	Titrable Acidity (%)	Ascorbic Acid (Mg/100 G Pulp)
N_0	14.82	0.22	326.06
N_1	15.96	0.21	336.23
N_2	16.03	0.25	377.99
N_3	18.12	0.23	408.54
S.Em±	0.14	0.01	0.98
CD at 5%	0.31	NS	2.19
V_1	15.43	0.23	389.00
V_2	17.03	0.22	335.41
S.Em±	0.10	0.00	0.69
CD at 5%	0.22	NS	1.54
N_0 V_1	13.23	0.25	377.67
N_0 V_2	16.41	0.19	274.44
N_1 V_1	15.20	0.21	381.45
N_1 V_2	16.72	0.21	291.00
N_2 V_1	15.21	0.24	387.55
N_2 V_2	16.84	0.26	368.43
N_3 V_1	18.09	0.23	409.33
N_3 V_2	18.15	0.22	407.75
S.Em±	0.20	0.01	1.39
CD at 5%	0.45	NS	3.09

Zinc sulfate 1.0% (N_1) Borax 1% (N_2), NAA 50ppm (N_3), Control (N_0), Shweta (V_1) and Lalit (V_2)

Table 3: Response of foliar application of micronutrients and PGR on Sugars of fruit guava cv. Shweta and Lalit

Treatment	Reducing Sugars (%)	Non- Reducing Sugar (%)	Total Sugars (%)
N_0	4.29	2.16	6.45
N_1	4.42	2.40	6.82
N_2	4.58	2.29	6.87
N_3	4.26	2.13	6.39
S.Em±	0.10	0.09	1.43
CD at 5%	NS	NS	NS
V_1	4.28	2.15	6.43
V_2	4.49	2.34	6.83
S.Em±	0.07	0.06	0.04
CD at 5%	NS	NS	NS
N_0 V_1	4.15	2.08	6.23
N_0 V_2	4.43	2.23	6.66
N_1 V_1	4.29	2.14	6.43
N_1 V_2	4.55	2.65	7.20
N_2 V_1	4.50	2.26	6.76
N_2 V_2	4.66	2.32	6.98
N_3 V_1	4.19	2.10	6.29
N_3 V_2	4.32	2.15	6.47
S.Em±	0.14	0.13	0.74
CD at 5%	NS	NS	NS

Zinc sulfate 1.0% (N_1) Borax 1% (N_2), NAA 50ppm (N_3), Control (N_0), Shweta (V_1) and Lalit (V_2)

Conclusion

Based on the results, It may be concluded from the results obtained in present investigation that Lalit variety (V_2) and nutrients in (N_2) (Borax (1%) was found to be most effective to improve growth parameters and physical parameter such as fruit length, fruit width, fruit weight and fruit volume. Among the over treatment cv. Lalit (V_2) and nutrients in (N_2) (Borax (1%) gave better result such as total sugars, reducing sugars, non-reducing sugar, ascorbic acid, acidity. Therefore, Lalit variety (V_2) and nutrients in (N_2) Borax (1%) can be recommended to obtained higher quality production of guava fruit in the Indo-gangetic plains of eastern Uttar Pradesh.

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