International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(6): 1132-1138

Received: 28-09-2019
Accepted: 30-10-2019

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Effect of micronutrients on guava (*Psidium guajava* L.): A review paper

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Abstract
Micronutrients provide special lubricants required for variety of energy transfer mechanism within the plants. They are as important as macronutrients for growth, yield and quality of fruits. They are required in traces. Micronutrients are involved in all metabolic and cellular functions. Micronutrients happen to improve quality, size, colour, taste and earliness of fruits thereby enhancing their market appeal, improve input use efficiency of NPK fertilizers and water. They provide disease resistance, thereby reducing dependence on plant protection chemicals, increase the post-harvest life of horticultural produce thereby avoiding wastage prevent physiological disorders and increase marketable yield.

Keywords: Micronutrients, guava, *Psidium guajava* L.

Introduction
Guava is most important fruit crop which is mostly grown in Uttar Pradesh, Bihar, Maharashtra, Gujarat, Madhya Pradesh, Andhra Pradesh, Tamil Nadu, Rajasthan, Karnataka, West Bengal, Orissa, Kerala and Punjab. It does equally well under tropical and sub-tropical climatic conditions. Guava claims superiority over several other fruits because of its commercial and nutritional value. It is a rich and cheap source of vitamin C (2 to 5 times more than fresh orange juice, 260mg/100g) and pectin (a polysaccharide substance). The ripe fruit contain 12.3-26.3% dry matter, 77.9-86.9% moisture, 0.511% ash, 0.10-0.70% crude fat, 0.82-1.45% crude protein and 2.0-7.2% crude fiber. The fruit is also rich in minerals like phosphorus, calcium, iron as well as vitamins like Niacin, Pantothenic acid, Thiamine, Riboflavin and Vitamine-A. Its fruits are available throughout the year except during the summer season.
The foliar application of micronutrients (Cu, Zn, B, Fe, Mn and Mo) plays a vital role in improving the quality and comparatively more effective for rapid recovery of plants. It has been noticed that guava suffers severely from deficiency of micronutrients specially boron which reduce the quality of fruits and hinder the development of fruits. Boron, zinc and iron increase the fruit set, reduce fruit drop and improve fruit quality in various fruit crops.

Effect of Micronutrients on Growth
Arora and Singh (1970) [2] sprayed 0.0%, 0.2% and 0.4% zinc sulphate solutions during July and observed significant improvement in growth, elongation of terminal shoot, leaf area per shoot and chlorophyll content of leaf in guava cv. Allahabad Safeda with 0.2% zinc sulphate. Bagali *et al.* (1993) [4] reported that two sprays of zinc sulphate, magnesium sulphate and boron either singly or combinations at 0.3% concentration enhanced the shoot length and number of leaves per shoot. Balakrishnan (2000) [5] reported that foliar spray of 1.0% Zinc sulphate resulted in increase in length of shoot over control. The micronutrients were applied individually at the concentration of 1% or in combination at 0.25 and 0.5% for Zn, Mg and Fe and 0.1 and 0.2% for Borax. The application of all micronutrients individually or in combination significantly increased the growth of guava as compared to the control. EI-Sherif *et al.* (2000) [16] observed that the foliar spray of K_2S0_4 (1.0% or 2%) and Zinc Sulphate (0.5% or 1%) on guava at full bloom stage significantly increased the shoot length. Balakrishnan (2001) [6] reported that the foliar spray of 0.5% $ZnSO_4$ significantly increased the length of shoot over control. Among the treatments, foliar sprays of 0.25% $ZnSO_4$+0.25%$FeSO_4$+0.25% $MgSO_4$+0.1%Borax at an interval of 60 days, significantly increased the vegetative growth of guava.

Chaturvedi *et al.* (2005) [12] noted that application of zinc sulphate (0.4%) in strawberry increased the number of leaves and plant height. Total number of runners also increased with same concentration of zinc sulphate. Sarolia *et al.* (2007) [34] discussed the effect of foliar application of 0.3, 0.4 and 0.5% Zinc Sulphate and Ferrous Sulphate with their possible combinations on guava cv. Sardar. It was observed that the maximum mean shoot length (26.05) and number of leaves (20.65) per shoot were recorded with the application of 0.5 per cent $ZnSO_4$ spray. The shoot length under 0.5 per cent $ZnSO_4$ was 16.22 per cent more over control. Abdollahi *et al.* (2010) [1] sprayed paclobutrazol (0, 100 mg l^-), boric acid (0, 150, 300 mg l^-) and zinc sulfate (0, 100, 200 mg l^-). The criteria measured were leaf number and leaf area. Zinc ($ZnSO_4$) had positive effect on criteria measured. Khan *et al.* (2012) [22] investigated influence of foliar application of boron (B) and zinc (Zn) on the tree growth of *Citrus reticulata* Blanco cv. Feutrell's Early. Trees were sprayed with boric acid and zinc sulphate either alone or in combination. Leaf size and vegetative growth significantly increased with application of 0.3% boric acid+0.5% zinc sulphate at the fruit set stage.

Effect on flowering and fruiting characters (Yield)

Bagali *et al.* (1993) [4] reported that two sprays of zinc sulphate, magnesium sulphate and boron increased fruit set per shoot, fruit retention per shoot, number of fruits per tree and fruit yield per tree in guava crop. Among the different treatments, foliar application of Zn and Mg singly increased the fruit yield significantly as 99.53kg and 87.90kg/ tree, respectively. Dahiya *et al.* (1993) [13] reported that foliar spray of Zinc Sulphate (0.4%) significantly increased the fruit set and fruit yield per tree in guava cv. L-49, as compared to control. Ingle *et al.* (1993) [20] reported that foliar application of borax (0.2%) and zinc sulphate (0.4%) increased fruit yield in guava cv. L-49. Singh *et al.* (1993) [36] sprayed $ZnSO_4$ (0.5%), $CuSO_4$ (0.3%) and borax (0.3%) or a combination of these chemicals on kazgi lime. Treatments were applied in mid-Aug. and early Sep. Fruit size and weight were increased by all treatments. The combination treatment had the greatest beneficial effect. Sharma *et al.* (1993) [35] found that GA_3 and zinc sulphate applications significantly improved the fruit set in guava. The highest fruit set (71.96%) was obtained under 0.6% $ZnSO_4$ and the lowest (69.81%) with 0.4%. Almost similar response of these treatments was observed in respect of fruit retention. Banik *et al.* (1997) [7] found that foliar application of zinc, iron and boron, each at 0.1, 0.2 and 0.4% significantly influenced flowering and fruiting of 30 years old mango cv. Fazali. Kundu and Mitra (1999) [24] sprayed guava tree with 0.3% Zn and observed high percentage of fruit set and yield per plant over control. Balakrishnan (2000) [5] reported the effect of foliar application of micronutrients on yield of guava. The spray of 1.0 per cent $ZnSO_4.7H_2O$ resulted in increased number of flowers per shoot, fruit set and fruit yield per plant over control. EI-Sherif *et al.* (2000) [16] reported that the foliar spray of K_2S0_4 (1.0% or 2%) and Zinc Sulphate (0.5% or 1%) on guava at full bloom stage significantly increased the fruit retention, fruit set and yield. Similarly, foliar spray of Zn (0.4%) significantly increased yield. Balakrishnan (2001) [6] reported that the foliar spray of 0.5% $ZnSO_4$ significantly increased the number of flowers per plant, fruit set and fruit yield per tree. Among the treatments, foliar sprays of 0.25%$ZnSO_4$+0.25% $FeSO_4$+0.25% $MgSO_4$+0.1% Borax at an interval of 60 days significantly increased the yield of guava. Bhatia *et al.* (2001) [9] reported that guava responded to Zinc sulphate up to 0.75% concentration on fruit yield per plant. They also carried out an experiment on guava in which K_2SO_4 (0.5, 1.0 and 1.5%), $ZnSO_4$ (0.5, 0.75 and 1.0%), H_3BO_3 (0.3, 0.5 and 1.0) and water (control) were sprayed on the trees and reported that all the nutrients increased yield which was maximum (73.0kg per tree) with H_3BO_3 1.0%. Lal and Sen (2002) [25] reported that foliar application of zinc sulphate (0, 2 and 4 g/plant) significantly influenced flowering, fruiting, yield attributes and yield of guava. Chaturvedi *et al.* (2005) [12] noted that application of zinc sulphate (0.4%) in strawberry increased the number of flowers and fruit set. Meena *et al.* (2005) [26] reported the combined effect of urea (2.0, 2.5 and 3.0%) and $ZnSO_4$ (0.5, 1.0 and 1.5%) as foliar sprays on the yield of pruned guava (cv. Sardar) under high-density planting system. The greatest number of fruits per plant (346.67) and yield of fruit (42.75 kg per plant) were recorded with the foliar application of 3.0% urea + 1.0% $ZnSO_4$. Mehaisen and EL-Sharkawy (2005) [27] studied the Baladi guava (*Psidium guajava* L.) (local cv.) trees of 9 years old planted in clay soil were treated with boron either at 0.25% or at 0.5% and zinc at the same concentrations at the start of petal fall. All treatments increased fruit set and yield and decreased fruit drop. Zinc (0.5%) was the most effective treatment in this concern. Prasad *et al.* (2005) [30] found that 0.8% borax significantly increased the number of flowers, fruit set, and fruit retention of guava cv. Allahbad Safeda. All the treatments increased yield under borax sprays followed by spraying of 3% urea. Dutta and Banik (2007) [15] revealed that foliar feeding of nutrients and plant growth regulators significantly increased crop yield. It is suggested to apply urea + K_2SO_4 + Zn + NAA for their beneficial effects on guava yield. Pal *et al.* (2008) [28] evaluated the effect of foliar application of nutrients on the yield. Treatments comprised urea at 1.0 or 2.0%; K_2SO_4 at 1.0 or 0.5%; borax at 0.2 or 0.1%; $ZnSO_4$at 0.4 or 0.2% and a control. Guava yield was maximum under 2.0% urea, which was closely followed by 1.0% urea. Awasthi and Lal (2009) [3] sprayed calcium nitrate at 1.0 and 1.5% (T_1 and T_2), boric acid at 0.2 and 0.3% (T_3 and T_4), zinc sulfate at 1.5 and 2.0% (T_5 and T_6) and control (T_7, water spray) on guava. In general, zinc sulfate showed the highest values for number of fruits per tree and yield. Abdollahi *et al.* (2010) [1] sprayed paclobutrazol (0, 100 mg l), boric acid (0, 150, 300 mg l^-) and zinc sulfate (0, 100, 200 mg l^-). The criteria measured were yield. Zinc ($ZnSO_4$) had positive effect on criteria measured. Foliar application of $ZnSO_4$ prior to flowering was recommend for increasing fruit yield of strawberry. Yadav *et al.* (2011) [42] reported the impact of foliar application of micronutrients and GA_3 on yield of guava fruit cv. L-49. The maximum fruit retention (57.27%), fruit yield (48.63 kg/tree) and minimum fruit drop (42.23%) was recorded with foliar application of Borax-04% followed by zinc sulphate 0.8%. Khan *et al.* (2012) [22] investigated the influence of foliar application of boron (B) and zinc (Zn) on the productivity of *Citrus reticulata* Blanco cv. Feutrell's Early. Trees were sprayed with boric acid and zinc sulphate either alone or in combination [(T_1=control (water spray), T_2=0.3% boric acid at fruit set stage, T_3=0.5% zinc sulphate at fruit set stage, T_4=0.3% boric acid+0.5% zinc sulphate at fruit set stage, T_5=0.5% zinc sulphate+0.3% boric acid at premature stage)] and the combined application of boric acid (0.3%) and zinc sulphate (0.5%) at fruit set stage effectively improved the productivity of Feutrell's Early. Trivedi *et al.* (2012) [39] evaluated the effect of zinc (Zn) and boron (B) micronutrients on the yield of guava and reported that foliar application of zinc sulfate (0.6%) and boric acid (0.5%) in combination after fruit set resulted in higher yield. Waskela *et al.* (2013) [40] studied the effect of micronutrients on growth, yield and quality of guava cv. Dharidar. Foliar application of zinc sulphate @ 0.75%, significantly increased the shoot length (13.44 cm), leaves per shoot (11.65), shoot diameter (0.52 cm), leaf area (71.60 cm^2), fruit length (7.06 cm), fruit width (7.09 cm), number of fruit /plant (164.80), fruit weight (187.18 g), yield per plant (30.90 kg), yield per hectare (85.89 q/h). Gaur *et al.* (2014) [17] obtained maximum fruit retention (57.27%), minimum fruit drop (42.43), the maximum fruit length (6.07 cm), width (5.92 cm) and fruit weight (98.48 g) with Borax (0.4%) application which was closely followed by higher concentration of Zinc sulphate (0.8%). Significantly maximum yield (48.63 kg/tree) was recorded with Boron 0.4% which was at par with Zinc sulphate 0.8%, Boron 0.2% and Potassium sulphate 0.2%. Goswami *et al.* (2014) [18] observed that the fruit length, diameter and volume were maximum under zinc sulphate 0.4% on guava cv. L-49. The maximum weight was observed under 0.4% boric acid and it was at par with zinc sulphate 0.4%. Hada *et al.* (2014) [19] studied the effect of different levels of boron and zinc on flowering, fruiting of winter season guava (*Psidium guajava* L.) cv. L-49. They revealed that maximum fruit set, fruit retention and number of fruits per tree was found in ($ZnSO_4$ 0.8% + borax 0.4%). Treatment ($ZnSO_4$ 0.8% + borax 0.4%) showed minimum fruit drop, minimum number of days taken for first flowering and minimum number of days taken for 50% flowering, while in control all these attributes was maximum, respectively. Jat and Kacha (2014) [21] studied the effect of zinc sulphate, the data indicated that the fruit retention (62.86%), fruit weight (153.89 g), highest number of fruits per plant (489.69) and yield of fruits (20984 kg/ha) were recorded in treatment Z_3 (0.6% $ZnSO_4$). It was found that application Z_3 (0.6% $ZnSO_4$) proved superior under Junagadh conditions in guava cv. Bhavnagar Red. Parmar *et al.* (2014) [29] record highest fruit weight and maximum fruit girth was registered with 0.6% zinc. Thus, it proved that 0.6% zinc sulphate was effective for the augmentation of growth and flowering attributes of guava. Rajkumar *et al.* (2014) [32] studied foliar application of zinc and boron on fruit yield and quality of winter season guava, cv. Pant Prabhat. Foliar application of zinc and boron (1%) had significant effect on fruit set and fruit retention (72.55%) and also showed least fruit drop (27.45%) with the same dose during both the years. Tiwari and Lal (2014) investigated the feasibility of foliar application of zinc and boron on fruit yield and quality of winter season guava. Foliar application of zinc and boron (1%) had significant effect on fruit set and fruit retention (72.55%) and also showed least fruit drop (27.45%) with the same dose during both the years. The highest dose of zinc and boron proved more effective in increasing the fruit length (6.39 cm), diameter (6.53 cm), weight (148.75 g) and volume (117.75 cm^3) of fruits. Baranwal *et al*. (2017) [8] conducted an experiment on guava which comprised nine treatment combinations of which three $ZnSO_4$ levels (0.50, 0.75, 1.00% solution) and three borax levels (0.2, 0.4, 0.6% solution) and one control of water spray. Among nutrient treatments, $ZnSo_4$ @ 0.75% or borax @ 0.4% spray increased fruit set percentage significantly over 0.50% $ZnSo_4$ or 0.2% borax spray, respectively but fruit retention percentage was recorded significantly highest with 1.00% $ZnSO_4$ or 0.6% borax solution spray. The spray of 0.6% borax solution produced biggest size of fruits with maximum weight and volume. Singh *et al.* (2017) [5] revealed that the application of B_3 (boric acid 0.8%) produced maximum yield, yield attributing traits and quality parameters of guava cv. Allahabad Safeda during both the years. Out of sixteen treatment combinations tried in this study, Z_3B_1 (0.8% zinc sulpahte + 0.4% boric acid) emerged as superior over all other treatment combinations in relation to physical characteristics and yield.

Effect on Physico-chemical composition of fruit

Effect on Physical character

Arora and Singh (1970) [2] sprayed 0.0%, 0.2% and 0.4% zinc sulphate solutions on guava during July and observed significant improvement in fruit weight and length. Bagali *et al.* (1993) [4] reported that two sprays of zinc sulphate, magnesium sulphate and boron singly and their combinations at 0.3% concentration gave positive effect on physical parameters of guava fruits. Dahiya *et al.* (1993) [13] reported that foliar spray of Zinc Sulphate (0.4%) significantly increased the breadth of guava fruit, weight per fruit as compared to control. Sharma *et al.* (1993) [35] found that GA_3 and zinc sulphate applications significantly improved the length and diameter of guava fruits. Chaitanya *et al.* (1997) [10] reported that foliar feeding of 0.3% $ZnSO_4$ and borax increased length and diameter of guava fruit cv. L-49. Raghava and Tiwari (1998) [31] reported that the pre-harvest spray of borax (0.6-1%) improved the quality of guava fruits in terms of size and weight. Kundu and Mitra (1999) [24] reported that spray of 0.3% $ZnSO_4$ on guava trees increased weight and diameter of fruit over control. Bhatia *et al.* (2001) [9] reported that guava responded to Zinc sulphate up to 0.75% concentration in respect of fruit weight. They further reported that spray of K_2SO_4 (0.5, 1.0 and 1.5%), $ZnSO_4$ (0.5, 0.75 and 1.0%), H_3BO_3 (0.3, 0.5 and 1.0) increased fruit weight over control. Das *et al.* (2001) sprayed the guava trees with 0.5 or 1.0% aqueous solution of Zinc Sulphate or with water (control) and reported that spray increased the weight of fruits but the specific gravity did not change much. Meena *et al.* (2005) [26] studied the combined effect of foliar application of urea (2.0, 2.5 and 3.0%) and $ZnSO_4$ (0.5, 1.0 and 1.5%) on the fruit quality and yield of pruned guava (cv. Sardar) under high-density planting system and reported that foliar application of 3.0% urea + 1.0% $ZnSO_4$ increased fruit size, weight and pulp/seed ratio. Mehaisen and EL-Sharkawy (2005) [27] studied the Baladi guava (*Psidium guajava* L.) (local cv.) trees of 9 years old planted in clay soil were treated with boron either at 0.25% or at 0.5% and zinc at the same concentrations at the start of petal fall. The physical characteristics of fruits were improved due to tested treatments, especially with high concentrations of both boron and zinc. Prasad *et al.* (2005) [30] found that 0.8% borax significantly increased the length and diameter of guava cv. Allahbad Safeda. All the treatments increased fruit weight and yield under borax spray followed by spraying of 3% urea. Dutta and Banik (2007) [15] studied the effect of foliar feeding of nutrients and plant growth regulators on physico-chemical quality of guava cv. sardar. Experimental results revealed that foliar feeding of nutrients and plant growth regulators significantly increased the fruit length, diameter and individual fruit weight. Maximum (6.24 cm) length of fruit was obtained with urea + K_2SO_4 + Zn + NAA followed by urea + K_2SO_4 + Zn. This treatment was also found effective in maximizing individual fruit weight. Pal *et al.* (2008) [28] evaluated the effect of foliar application of nutrients. Treatments comprised: urea at 1.0 or 2.0%; K_2SO_4 at 1.0 or 0.5%; borax at 0.2 or 0.1%; $ZnSO_4$ 0.4 or 0.2%; and a control.

Fruit size, in terms of both length and breadth, was significantly increased by foliar application of nutrients. The maximum value of both characters was recorded under 2.0% urea. However, 1.0% urea was at par with 0.4% $ZnSO_4$ for increasing the fruit size. The weight and volume were maximum under 2.0% urea followed by 1.0% urea and 0.4% $ZnSO_4$. Maximum specific gravity of fruit (1.19) was observed with 1.0% urea spray. Yadav *et al.* (2011) [42] investigated the effect of foliar application of micronutrients and GA_3 on physic-chemical characters of guava fruit cv. L-49. The maximam fruit length (6.07 cm), fruit width (5.92 cm) and fruit weight (98.48 kg) was recorded with foliar application of Borax-0.4 per cent followed by zinc sulphate 0.8%. Khan *et al.* (2012) [22] investigated the influence of foliar application of boron (B) and zinc (Zn), on *Citrus reticulata* Blanco cv. Feutrell's Early and found that there was a significant increase in fruit weight with application of 0.3% boric acid+0.5% zinc sulphate when sprayed at the fruit set stage. Trivedi *et al.* (2012) [39] evaluated the effect of zinc (Zn) and boron (B) on the yield and fruit quality of guava. The treatments comprised control (tap water; T_0), 0.5% boric Acid (T_1), 0.6% boric acid (T_2), 0.5% zinc sulfate (T_3), 0.5% zinc sulfate + 0.5% boric acid (T_4), 0.5% zinc sulfate + 0.6% boric acid (T_5), 0.6% zinc sulfate (T_6), 0.6% zinc sulfate + 0.5% boric acid (T_7) and 0.6% zinc sulfate + 0.6% boric acid (T_8). Data were recorded on fruit weight and fruit diameter. It was noted that the combined foliar application of zinc sulfate (0.6%) and boric acid (0.5%) before and after fruit set resulted in higher fruit weight, radial diameter, polar diameter and specific gravity. Waskela *et al.* (2013) [40] studied the effect of micronutrients on growth, yield and quality of guava cv. Dharidar. The combined spray of zinc sulphate @ 0.75% and magnesium sulphate @ 0.75% prove the best for the most of the physico-chemical and yield parameters of guava fruits, followed by zinc sulphate @ 0.75% and magnesium sulphate @ 1.0%. Rajkumar *et al.* (2014) [32] studied foliar application of zinc and boron on fruit yield and quality of winter season guava, cv. Pant Prabhat. Combination of zinc and boron resulted in higher fruit yield over control producing maximum yield (135.10 kg/tree) with the application of zinc sulphate and boric acid both at the rate of 1% each. Yadav *et al.* (2014) noted that maximum fruit set per cent (67.43) with foliar application of zinc sulphate + borax (0.6%) and zinc sulphate + copper sulphate + borax (0.5%) each. Therefore, zinc sulphate + borax (0.6%) and zinc sulphate + copper sulphate + borax (0.5%) each may be recommended to guava growers for obtaining better yield and quality during winter season crop of guava cv. Allahabad Safeda under Lucknow conditions. Chander *et al.* (2017) [11] carried out an experiment which consisting of 18 treatments having three levels of each Borax (0, 0.3 and 0.6 per cent), Zinc sulphate (0, 0.3 and 0.6 per cent) and two levels of Urea (0 and 1 per cent). Foliar spray of nutrients, borax @ 0.6 per cent, zinc sulphate @ 0.6 per cent and Urea @ 1 per cent were found significantly superior over control with respect fruiting characteristics, quality parameters and yield attributes of guava. In case of interaction effect of foliar spray of nutrients, the application of T_{17} treatment (borax @ 0.6 per cent + zinc sulphate @ 0.6 per cent + urea @ 1 per cent) was found significantly superior over control. This treatment resulted in maximum increase in fruit set per cent, fruit retention per cent, number of fruits per tree, fruit yield per plant and estimated yield per hectare.

Effect on bio-chemical characters

Arora and Singh (1970) [2] sprayed 0.0%, 0.2% and 0.4% zinc sulphate solutions on guava during July and observed significant improvement in Vit-C, pectin substances, TSS and total sugars. Dahiya *et al.* (1993) [13] reported that foliar spray of zinc sulphate (0.4%) on guava significantly increased the total soluble solids as compared to control. Singh *et al.* (1993) sprayed $ZnSO_4$ (0.5%), $CuSO_4$ (0.3%) and borax (0.3%) or a combination of these chemicals on kazgi lime. Treatments were applied in mid-Aug. and early Sep. Fruit size, weight and quality were improved by all treatments. The combination of treatment had the greatest beneficial effect. Raghava and Tiwari (1998) [31] reported that the pre-harvest spray of borax (0.6-1%) improved the quality of guava fruits in terms of TSS (total soluble solids), ascorbic acid and acidity. Kundu and Mitra (1999) [24] reported that guava tree sprayed with 0.3% Zn showed increased total soluble solids, ascorbic acid and reduced acid content in fruits. Balakrishnan (2000) [5] reported the effect of foliar application of micronutrients on quality of guava. Foliar spray of 1.0% $ZnSO_{4}.7H_2O$ resulted in increase in total soluble solids and ascorbic acid over control. EI-Sherif *et al.* (2000) [16] reported that the foliar spray of K_2S0_4 (1.0% or 2%) and Zinc Sulphate (0.5% or 1%) on guava at full bloom stage significantly increased the quality of fruit. Balakrishnan (2001) [6] reported that the foliar spray of 0.5% $ZnSO_4$ significantly increased total soluble solids and ascorbic acid. However the acidity remained unchanged. Among the treatments, foliar sprays of 0.25% $ZnSO_4$+0.25% $FeSO_4$+0.25% $MgSO_4$+0.1% Borax at an interval of 60 days significantly increased the fruit quality. Bhatia *et al.* (2001) [9] carried out an experiment on guava in which K_2SO_4 (0.5, 1.0 and 1.5%), $ZnSO_4$ (0.5, 0.75 and 1.0%), H_3BO_3 (0.3, 0.5 and 1.0) and water (control) were sprayed. The total soluble solids were more with H_3BO_3 followed by K_2SO_4 1.5%. Lal and Sen (2002) [25] determined the effects of different levels of Zinc (0, 2 and 4 g/plant) on the fruit quality of guava cv. Allahabad Safeda. The total soluble solids, ascorbic acid, as well as TSS: acid ratio in fruits linearly increased, whereas acidity decreased with increasing rates of Zn. Chaturvedi *et al.* (2005) [12] noted that application of zinc sulphate (0.4%) in strawberry increased ascorbic acid content, acidity and TSS content of fruits. Meena *et al.* (2005) [26] studied the combined effect of foliar application of urea (2.0, 2.5 and 3.0%) and $ZnSO_4$ (0.5, 1.0 and 1.5%) on the fruit quality of pruned guava (cv. Sardar) under high-density planting system. The greatest ascorbic acid content (148.68 mg/100 g pulp) was recorded with the foliar application of 3.0% urea + 1.0% $ZnSO_4$. Mehaisen and EL-Sharkawy (2005) [27] studied the Baladi guava (*Psidium guajava* L.) (local cv.) trees of 9 years old planted in clay soil were treated with boron either at 0.25% or at 0.5% and zinc at the same concentrations at the start of petal fall. Fruits chemical characteristics i.e., TSS, acidity, TSS/acid ratio and ascorbic acid were improved. Zinc (0.5%) was the most effective treatment in this concern. Dutta and Banik (2007) [15] studied the effect of foliar feeding of nutrients and plant growth regulators on physico-chemical quality of guava cv. Sardar. The bio-chemical constituents were also influenced by different spraying of nutrients and growth regulators. Maximum TSS (10.85 ^{0}B) was obtained with K_2SO_4 treatment followed by urea + K_2SO_4 + Zn + NAA. Reduction of titratable acidity was found under NAA alone on in combination with urea + K_2SO_4 + Zn. Plants treated with urea + K_2SO_4 + Zn + NAA showed maximum (135.42 mg 100 g-1 fruit) ascorbic acid content followed by NAA 50 ppm. Pal *et al.* (2008) [28] evaluated the effect of foliar application of nutrients on the quality of guava cv. Sardar in the winter season. Treatments comprised: urea at 1.0 or 2.0%; K_2SO_4 at 1.0 or 0.5%; borax at 0.2 or 0.1%; $ZnSO_4$ at 0.4 or 0.2% and a control. Total soluble solids, were maximum in 1.0% urea. However, 0.5% K_2SO_4 proved equally good. Maximum reduction in acidity was recorded under 0.2% $ZnSO_4$ which was at par with 0.1% borax. Ascorbic acid content was significantly increased by all treatments over the control except 1.0% K_2SO_4. Maximum value (277.76 mg/100 g fruit) was observed upon application of 0.2% $ZnSO_4$, which was at par with 0.4% concentration. Awasthi and Lal (2009) [3] sprayed different concentrations of calcium nitrate, boric acid and zinc sulphate on guava and reported that boric acid gave the highest values for total soluble solids. Abdollahi *et al.* (2010) [1] sprayed paclobutrazol (0, 100 mg $^{-}$l), boric acid (0, 150, 300 mg $^{-}$l) and zinc sulfate (0, 100, 200 mg l-) on selva strawberry cultivar. The criteria measured were total soluble solids, acidity and vitamin C. Zinc (ZnSO4) had positive effect on criteria measured. Foliar application of ZnSO4 prior to flowering was recommended to increase the fruit quality of strawberry. Rawat *et al.* (2010) reported that the guava cv. Lucknow-49 (Sardar) to improve the quality of fruits by foliar application of micronutrients i.e. zinc, copper and boron (0.2, 0.3 and 0.4%) alone and in combination of two and three, with control. TSS, total sugars, sugar-acid ratio and seed weight significantly improved whereas significant reduction in acidity was exhibited with the foliar application of zinc sulphate (0.4%) concentration. Application of boron (0.4%) concentration significantly increased the vitamin C and pectin content of the L-49 guava fruits. Thus, micronutrient spray with 0.4% zinc sulphate and 0.4% boric acid were beneficial for improvement of fruit quality in guava. Yadav *et al.*, (2011) [42] investigated the effect of foliar application of micronutrients and GA_3 on physicochemical characters of guava fruit cv. L-49. The maximum total soluble solids (11.70^0Brix), ascorbic acid (172.00 mg/100 g), acidity (0.30%) were recorded with foliar application of borax 0.4% followed by zinc sulphate 0.8%. Khan *et al.* (2012) [22] investigated the influence of foliar application of boron (B) and zinc (Zn), on the fruit quality of *Citrus reticulata* Blanco cv. Feutrell's Early. and reported that the application of 0.3% boric acid+0.5% zinc sulphate at pre-mature stage significantly enhanced the concentration of ascorbic in the Feutrell's Early fruit juice. In conclusion, the combined application of boric acid (0.3%) and zinc sulphate (0.5%) at fruit set stage effectively improved the fruit quality of Feutrell's Early Madarin. Trivedi *et al.* (2012) [39] evaluated the effect of zinc (Zn) and boron (B) fertilizers on the fruit quality of guava. The treatments comprised control (tap water; T_0), 0.5% boric Acid (T_1), 0.6% boric acid (T_2), 0.5% zinc sulfate (T_3), 0.5% zinc sulfate + 0.5% boric acid (T_4), 0.5% zinc sulfate + 0.6% boric acid (T_5), 0.6% zinc sulfate (T_6), 0.6% zinc sulfate + 0.5% boric acid (T_7) and 0.6% zinc sulfate + 0.6% boric acid (T_8). Data were recorded on total soluble solids (TSS), titratable acidity and ascorbic acid content. It was shown that that the combined foliar application of zinc sulfate (0.6%) and boric acid (0.5%) before and after fruit set resulted in higher TSS, acidity, ascorbic acid, and sugar/acid ratio. Gaur *et al.* (2014) [17] obtained that maximum TSS with minimum acidity (0.3%) and higher total sugar were recorded with foliar application of Borax 0.4 per cent along with highest ascorbic acid content of guava fruit cv. L-49. Goswami *et al.* (2014) [18] observed that the zinc sulphate 0.4% in guava significantly improved the physico-chemical quality, viz., total soluble solids, acidity, ascorbic acid, reducing, non-reducing and total sugar at harvest. Rajkumar *et al.* (2014) [32] studied foliar application of zinc and boron on fruit yield and quality of winter season guava, cv. Pant Prabhat. The best quality of fruits in terms of TSS (12.99^0B), pectin content (1.85%), total sugar (9.87%), reducing sugar (5.93%) and non-reducing sugar (3.94%) and ascorbic acid (291.29 mg/100 g pulp) was also recorded with highest doses of zinc and boron in combinations. Boron and zinc individually and in combinations reduced the total titrable acidity of fruits. Application of zinc and boron gave better sugar/ acid and TSS/ acid ratio of guava fruits. Kumar *et al.* (2015) showed an increasing trend towards plant height (12.17% with 0.03% Zn two weeks after fruit set), fruit weight (150 g with 0.03% B two weeks after fruit set), volume (147.67 with 0.03% B two weeks after fruit set) and yield (52.50 kg/tree with 0.01% Zn two weeks after fruit set). Similarly, pulp/seed ratio (94.88 with 0.5% K two weeks after fruit set), TSS (11.50^0Brix with 0.5% K on fruit set) and total sugars (7.36% with 0.5% K two weeks after fruit set) also increased by foliar fertilization while it showed a trend towards decreasing per cent fruit drop (5.90% with 0.03% Zn two weeks after fruit set) and acidity content (0.26% with 0.5% K two weeks after fruit set). The seed hardness (11.48 kg with 0.01% B on fruit set) showed non uniform pattern. The stage of spray also affected the growth, yield and quality of guava fruits. Results indicated that foliar fertilization when done two weeks after fruit set influenced plant growth and fruit quality. Baranwal *et al.* (2017) [8] conducted an experiment on guava which comprised nine treatment combinations of which three $ZnSO_4$ levels (0.50, 0.75, 1.00% solution) and three borax levels (0.2, 0.4, 0.6% solution) and one control of water spray. Borax spray @ 0.6% solution attained significantly maximum values of 8.25% total sugar, 12.04^0 brix, and 186.92 mg Ascorbic acid per 100g guava fruit. Singh *et al.* (2017) revealed that the all characters of guava cv. Allahabad Safeda were influenced significantly due to different levels of Zinc and boron during both the years. The application B_3 (boric acid 0.8%) produced maximum yield, yield attributing traits and quality parameters during both the years. Out of sixteen treatment combinations tried in this study, Z_3B_1 (0.8% zinc sulpahte + 0.4% boric acid) emerged as superior over all other treatment combinations in relation to physical characteristics and yield. Yadav *et al.* (2018) observed in guava cv. Allahabad Safeda that the total soluble solid, acidity, ascorbic acid, reducing sugar, non-reducing sugar, total sugars were maximum when foliar spray was done with 1% zinc sulphate and 1% borax, respectively.

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