Efficacy of foliar application of micronutrients onbio-chemicalattributes of guava(*Psidiumguajava* L.) cv.AllahabadSafeda

Abstract

To assess the efficacy of foliar application of micronutrients, *i.e.* Zinc as a Zinc Sulphate, Copper as Copper Sulphate and Boron as Boric acid on biochemical attributes of guava (*Psidiumguajava* L.) cv. Allahabad Safeda fruits during 2019-20, a field experiment was carried out at Horticultural Research Farm- II of the Department of Horticulture, School of Agricultural Science and Technology, Babasaheb Bhimrao Ambedkar University, Lucknow, India on 12-year-old guava plants. The experiment was conducted in randomized block design (RBD) with three replications. Using a digital hand refractometer, biochemical parameters such as total soluble solids were estimated at room temperature. The ascorbic acid, total sugars, reducing sugar, and non-reducing sugar content in the fruit sample were estimated using OPSTAT software, the gathered data were statistically analyzed.The foliar application of zinc sulphate@ 0.4% showed better quality of fruits in terms of TSS (11.78^0 Brix), Acidity (0.4%), Total Sugars (6.34%), sugar acid ratio (15.91) while the application of Boric acid@ 0.4% resulted in maximum value of ascorbic acid (173.373mg/100g) pulp and pectin (1.650) respectively.

Keywords:micronutrients, bio-chemical attributes, foliar application

Introduction

The guava *(Psidiumguajava* L.) is a fruit that is excellent for table purpose because of its flavor, nutritional value and pectin content. It is also a fruit that is used in processing to make a variety of high-quality products, including jam, jelly, canned fruit products, fruit butter, toffee, cheese and guava nectar. It is an inexpensive and abundant source of pectin and vitamin C (Agnihotri *et al.* 1962). Guava is now being recognized as 'super food' is getting very much attention in the agro-food business due to the attractive characteristics of the fruit, such as health promoting bioactive components, functional elements, i.e. rich in ascorbic acid content (upto 300 mg/100g) and good source of pectin which ranges from 0.5 to 1.8 percent (Mora*et al.*, 2023).The most well-liked fruit cultivated in tropical, sub-tropical, and some arid regions of India is the guava (*Psidiumguajava* L.), also known as the apple of the tropics. It belongs to Myrtaceaefamily.It can tolerate some drought, but only a small amount of frost. The guava is an important fruit because it is being hardy and can be grown in alkaline or poorly drained soils with a pH of 8.5(Thind& Mahal, 2021). It can also withstand temperatures up to 46^0 degrees Celsius and less than 25 millimeters of rainfall per year. The guava is a highly cross-pollinated crop that bears flowers and fruits during the current growing season. It is pollinated by honey bees and andirona insects(Saroj et al., 2019). The guava fruit develops from an inferior ovary and has a double sigmoid growth curve. The guava fruits have many seed berries and changes color from dark green to yellowish green in about 4-5 months. Although natural and artificial triploids (2n=33) and aneuploids exist, triploids typically produce fruit without seeds. The common guava is a diploid (2n=22)(Mohammed, 1974). The guava plant produces flowers twice or sometimes thrices in a year in northern India. The name of the spring bloom is "AmbeBahar." "MrigBahar" refers to the monsoon or June flowering, while "Hast Bahar" is the third flowering, which occurs in October- November. While the fruit of theAmbeBahar and MrigBahar crops ripens from July to September and November to February, respectively, the fruit of the Hast Bahar tree ripens in the spring, which is also referred to as the summer crop(Sachin et al., 2015).Its low-calorie profile of essential nutrients is generally broad. The vitamin C content of a single guava (*P. guajava*) fruit is approximately four times that of an orange. 80–82% water, 0.71% protein, 0.5% fat, 11–13% carbohydrates, and 2.4% vitamin C are found in guava fruits. Additionally, 100 grams of red guava have 80.8 grams of water, 68 kcal of energy, 2.55 grams of protein, 0.95 grams of fat, 14.32 grams of carbohydrates, 5.4 grams of total dietary fiber, 8.92 grams of sugar, 25 µ grams of total carotene, 1.39 grams of ash, 374 µ grams of β-carotene, 5.204 µ grams of lycopene (Chen *et al.*, 2007), and 87 mg of vitamin C (Mahmud, 2009).The fruit is a good bulk laxative because it is high in soluble dietary fiber (5.4g per 100 g of fruit), flavonoids like beta-carotene, lycopene, lutein, and cryptoxanthin, and vitamin A. Guavas can be eaten raw or processed into a fruit bar, dehydrated goods, juice, nectar, pulp, jam, jelly, and slices in syrup. They can also be added to other fruit juices or pulps (Leite*et al.*, 2006).

The practice of foliar feeding fruit plants with nutrients has gained a lot of attention recently. It is a cost-effective and practical solution to avoid issues with nutrient availability and to supplement soil fertilizers. While micronutrients like zinc, boron, copper and molybdenum have a specific function in the growth and development of plants, the production of high-quality produce and the uptake of major nutrients, macronutrients like nitrogen, phosphorus, and potash are essential for boosting plant vigor and productivity. Deficiencies in macro and micronutrients show up as stunted growth, low yield, dieback, and sometimes even as plant death. Furthermore, applying these nutrients topically could result in Platebetter outcomes. The benefits of foliar fertilization include uniform distribution of nutrients, low application rates, and fast nutrient uptake. According to Zaman and Schumann (2006), nutrient application through foliage can be 10–20 times more effective than nutrient application through soil. Key components of plant growth and development are micronutrients. These components are crucial for a number of enzymatic processes, including synthesis. Sometimes their severe deficiencies present an irreversible problem (Kumar, 2002).

In addition to aiding in the uptake of major nutrients, micronutrients are involved in every stage of plant metabolism, including the development of cell walls, respiration, photosynthesis, chlorophyll synthesis, enzyme activity, hormone synthesis, nitrogen fixation, and reduction (Das, 2003). Rainy season guavas have poor fruit quality, which can be enhanced with foliar application of a more appropriate nutrient schedule. Fruits sprayed with calcium chloride and borax have better quality characteristics in addition to increased size. Micronutrients like boron are part of the cell membrane and are necessary for fruit set, pollen tube growth, ovule development, and cell division.

In extending the shelf life and maintaining the quality of guava, calcium salts like lactate, chloride, and nitrate (0.5–3.5%) have demonstrated encouraging results (Hiwale and Singh, 2003; Selvan and Bal, 2005; Mahajan *et al.*, 2011; Barche*et al.*, 2015). While the significance of these components in enhancing plant physiological activities has been established, crop-specific agroclimatic conditions necessitate standardization of dosage, timing and application method. Thus, in order to increase guava fruit yield and quality, the current study was conducted to assess the effects of calcium and boron, both separately and in combination.

Materials and Methods

The experiment was carried out at Horticultural Research Farm BBAU in Lucknow India, in the years 2018-2019. The climate at the experimental site was subtropical. The orchard's soil was clay loam, which has good airflow and drainage. The loose texture of the soil was ideal for the growth of plant roots. 6 x 6 m apart, uniform 12 year-old guava plants, available in the university's research farm were chosen for the study. The application of nutrients and other orchard management techniques were carried out in accordance with the guava recommended package of practices. 22 treatments total, viz., T□- Zinc sulphate (0.2%) , T_2Zinc sulphate (0.3 %), T_3- Zinc sulphate (0.4 %), T_4- Copper sulphate (0.2 %), T_5- Copper sulphate (0.3%), T_6 -Copper sulphate (0.4 %), T_7, -Boric acid (0.2 %), T_8- Boric acid (0.3%). T_9, -Boric acid (0.4 %), T_{10} -Zinc sulphate + copper sulphate (0.2 %), T_{11} -Zinc sulphate + copper sulphate (0.3 %), T_{12} Zinc sulphate + copper sulphate (0.4 %), T_{13}- Zinc sulphate + boric acid (0.2 %), T_{14} -Zinc sulphate + boric acid (0.3 %), T_{15} -Zinc sulphate + boric acid (0.4 %), T_{16} Copper sulphate + boric acid (0.2 %), T_{17}- Copper sulphate + boric acid (0.3 %), T_{18} -Copper sulphate + boric acid (0.4 %), T_{19} Zinc sulphate + copper sulphate + boric acid (0.2 %), T_{20}- Zinc sulphate + copper sulphate+ boric acid (0.3 %), T_{21}- Zinc sulphate + copper sulphate+ boric acid (0.4 %), T_{22}- Control spray of tap water, were sprayed (foliar feeding) during first week of August (fruit initiation) and second week of September (fruit development) during 2018-19.The experiment was conducted in randomized block design (RBD) with three replications. Using a digital hand refractometer, biochemical parameters such as total soluble solids were estimated at room temperature. By titrating the fruit pulp extract with 0.1N NaOH and using phenolphthalein indicator, titrable acidity was determined (Ranganna, 2010). By using the technique outlined by Ranganna (2010), the ascorbic acid, total sugars, reducing sugar, and non-reducing sugar content in the fruit sample were estimated using OPSTAT software, the gathered data were statistically analyzed in accordance with Gomez's (1984) methodology.

Results and discussion

The data showed that different treatments significantly increased fruit yield compared to the control. The combination of zinc sulphate + copper sulphate (0.3%) and borax (0.4%) produced the highest yield (42.20 kg/tree) (T9). These micronutrients enhance the fruit's weight, width, and length. The findings of Rajput and Chand (1976), Trivedi *et al.* (2012) in the case of guava, closely align with these results.

The content of fruits TSS, sugar acid ratio, acidity and total sugars were all significantly impacted by foliar feeding of micronutrients. The 0.4% zinc sulphate treatment had the highest total soluble solids (11.78 Brix), which was higher than the control. It is a well-established fact that zinc plays a specific role in the synthesis of metabolites, the hydrolysis of complex polysaccharides into simple sugars, and the quick transfer of minerals and photosynthetic products from other plant parts to developing fruits. According to Kumar and Bhusan (1980), foliar $ZnSO_4$ application raised the TSS contents by boosting the photosynthetic activity of the plants, which in turn led to an increase in sugar production.Increase in total soluble solids and total sugars might be that Zn helps in the enzymatic reactions like transformation of carbohydrates, activity of hexokinase and formation of cellulose and change in sugar are considered due to its action on zymohexose and boron helps in sugar transport which may be possible to improve TSS and total sugars (Mahesh &Devputra, 2017).With an increase in micronutrient concentration, fruit acidity generally decreased across all treatments. With the application of 0.4% zinc sulphate spray, the lowest fruit acid (0.4%)was observed. Under 0.4% zinc sulfate treatment, the highest reduction in acid content (0.4%) was also achieved, according to Lal and Sen (2001), guava fruits acid content decreased when zinc sulphate was applied topically. As a primary substrate for respiration, an increase in membrane permeability that permits the storage of acids in respiring cells may be the cause of the decline in malic acid during fruit ripening (Kliewer 1971).

When zinc sulphate is applied topically at a higher concentration than other nutrients and their combinations, the overall sugar content is increased. The present results indicate that, in comparison to all other treatments, the 0.4% concentration of zinc sulphate treatment produced noticeably higher total sugars (6.34%) in guava fruits. Compared to the control, this treatment's increase in total sugars was superior. It agrees with the guava research conducted by Singh and Brahmachari (1999) and Kundu and Mitra (1999). The active synthesis of triptophan in the presence of zinc, the precursor of auxin, may be the cause of a significant rise in sugar contents following foliar feeding of zinc sulphate. This, in turn, increases the rate of chlorophyll synthesis, which in turn speeds up photosynthetic activity (Skoog, 1940).

It became known that the effects of spraying micronutrients alone or in combination were promising. According to the present study, the trees treated with 0.4% zinc sulphate treatment had the highest sugar/acid ratio (15.91). The sugar/acid ratio increased by 80.44% compared to the control. The current results are further supported by the guava-related research of Kundu and Mitra (1999) and Lal and Sen (2001).

The pectin content of Allahabad Safeda guava fruits is significantly influenced by micronutrient sprays, either separately or in combination. It was found that when the concentration of micronutrient sprays rose from 0.2% to 0.4%, the pectin content rose as well. The pectin content of the 0.4% boric acid treatment was found to be superior (1.650%), increasing by 163.96% compared to the control. Additionally, Pandey *et al.*(1988) reported that foliar application of boron improved the pectin content of guava fruits. According to Lee and Kim (1991), boron has been linked to the plant system in a number of ways and has been found to enhance the production of cellulose and pectin in fruits, which may be the cause of the fruits' higher pectin content. Because boron helps photosynthates move from leaves to young fruits, which are partially used for the synthesis of pectic substances, it increases the amount of pectin in the fruits (Whiting 1970).

As the concentration of micronutrient application in all treatments increased, so fruits vitamin C content also increased. The vitamin C content of the fruits of trees treated with boric acid was found to have significantly increased. Under a 0.4% concentration of boric acid treatment, the maximum content of vitamin C (173.3 mg per 100 g) was observed with a 21.22% increase over control.The higher ascorbic acid content was due to the increased in total sugars content owing to the efficient translocation of available photosynthates to fruit pulp rather than to other parts. (Baranwal*et al.* 2017).It might be attributed to the fact that boron directly affects the photosynthesis activity of plant and helps in sugar transport. Besides, the boron also plays an important role in activating the synthesis of ascorbic acid. These results are in agreement with the findings of (Awasthi and Lal 2009) and (Yadav *et al.* 2011) in guava.In guava, Kate*et al.*, (2020),Singh *et al.* (2001) also observed that fruits treated with boron spray had higher vitamin C contents. An appropriate supply of hexose sugars through photosynthetic activity may be the cause of the higher ascorbic acid (vitamin C) levels during the early stages of fruit growth. The main and active chemical component of guava fruit that gives it its therapeutic qualities is ascorbic acid, or vitamin C. These properties are influenced by temperature, soil, plant nutrition, and genotype (Poojan*et al.*, 2020).

Table-1 Chemical attributes of Various treatment on Guava tree

Treatments	**TSS (°Brix)**	**Acidity (%)**	**Total sugar(%)**	**Sugar/acid ratio**	**Vitamin C (mg/100 g)**	**Reducing sugar (%)**	**Non Reducing sugar (%)**	**Pectin (%)**
Zn (0.2%)	10.48	0.43	5.56	13.00	148.36	3.40	3.20	1.03
Zn (0.3%)	11.26	0.42	5.85	14.00	153.30	3.33	3.20	1.16
Zn (0.4%)	11.78	0.40	6.34	15.91	156.40	3.43	3.43	1.21
Cu (0.2%)	10.30	0.44	5.26	11.81	156.03	3.40	3.22	0.82
Cu (0.3%)	10.40	0.44	5.56	12.54	162.40	3.40	3.21	0.84
Cu (0.4%)	10.58	0.44	5.73	12.95	166.04	3.36	3.22	0.95
B (0.2%)	10.48	0.43	5.54	12.81	165.28	3.34	3.16	1.24
B (0.3%)	11.00	0.43	5.64	12.14	168.54	3.35	3.15	1.62
B (0.4%)	11.52	0.42	5.85	13.99	173.37	3.43	3.23	1.65
Zn+Cu (0.2%)	10.26	0.48	5.23	10.92	148.15	3.40	3.16	0.81
Zn+Cu (0.3%)	10.40	0.46	5.33	11.52	151.16	3.41	3.20	0.83
Zn+Cu (0.4%)	10.45	0.46	5.64	12.31	154.15	3.34	3.20	0.92
Zn+B (0.2%)	10.40	0.45	5.43	11.98	153.21	3.34	3.20	1.02

Zn+B (0.3 %)	10.53	0.45	5.62	12.46	157.28	3.32	3.15	1.13
Zn+B (0.4%)	11.25	0.44	5.80	13.15	161.42	3.35	3.20	1.16
Cu+B(0.2%)	10.40	0.51	5.12	10.07	160.62	3.37	3.22	0.95
Cu+B (0.3%)	10.33	0.48	5.22	10.69	167.02	3.41	3.20	0.97
Cu+B (0.4%)	10.26	0.46	5.44	11.76	170.40	3.40	3.22	1.02
Zn+Cu+B(0.2%)	10.26	0.44	5.32	13.09	163.10	3.36	3.20	0.99
Zn+Cu+B(0.3%)	10.53	0.39	5.61	12.83	168.08	3.32	3.20	1.06
Zn+Cu+B(0.4%)	10.93	0.43	5.75	13.33	170.24	3.34	3.20	1.11
Control	9.53	0.55	4.86	8.83	143.18	2.84	2.81	0.62
S Em. ±	0.09	0.0080	0.008	0.143	0.077	0.011	0.01	0.007
CD at 5%	0.258	0.022	0.024	0.260	0.221	0.031	0.029	0.012

Conclusion- Foliar application of zinc sulphate@ 0.4% was the best treatment among the all treatments for improving quality of guava fruits viz., TSS (11.78^0 Brix), Acidity(0.4%), Total Sugar(6.34%) , Sugar Acid Ratio (15.91) and the application of Borax@ 0.4% improved qualities with ascorbic acid 173.373mg/100g pulp and pectin 1.650) in the environmental conditions of Horticultural Research Farm of Babasaheb Bhimrao Ambedkar University, Lucknow (India). Therefore, it may be concluded that foliar spray of zinc sulphate(0.4%) and borax (0.4%) can be recommended to the guava growers for obtaining better quality of winter season guava fruits.

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