

Original Research Article

Effect of Micronutrients on physico-chemical parameters of fruit and yield of Guava (*Psidium guajava* L.) cv. L-49.

Abstract

A field experiment entitled “Effect of Micronutrients on physico-chemical parameters of fruit and yield of Guava (*Psidium guajava* L.) cv. L-49.” was carried out at Horticulture Research Farm, Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Vidya-Vihar, Rae Bareilly Road, Lucknow 226 025 (U.P.) during the summer season of 2019-20. The experiment consisted of eight treatment combinations having Zn, Mn and Fe ~~concentration~~ concentrations of 0.5, 0.5 and 0.4 % respectively, in Randomized Block Design with three replications. There was a significant effect of micronutrients (Zn, Mn and Fe) on physico-chemical parameters of fruit and yield of guava respectively, alone and in combination over control. The main objectives of the present investigation were to ~~be find~~ find out the effect of Zn, Fe, and Mn on flowering, fruiting, physico- chemical composition of Guava fruit and yield.

Key wordsKeywords: Guava, Micronutrients, Physico-Chemical Parameters, Yield, Zn, Mn and Fe

Introduction

Guava (*Psidium guajava* L.) “Apple of the tropics” is an important fruit crop of the country, not because of its large area and production but due to its wider edapho-climatic adaptability, hardly to various biotic and abiotic stresses, precocious and prolific bearing habit, quality fruit with high nutritive value, medicinal attribute, use both as fresh fruit and after processing in different ~~value added~~ value-added products and considered as a multipurpose tree due to its utility as ~~a~~ fruit, fuel, fodder, timber and it is a highly remunerative crop. It is a very rich source of vitamin C and A along with minerals like iron, calcium, and phosphorus. Guava is ~~one of the~~ the most important fruit crop in India after Mango, Banana and Citrus (Ray 2002). It also contains substantial quantities of carbohydrates, sugars and pectin. Owing to excellent taste and flavour, high nutritional value and wide availability at a moderate price the fruit is often called ~~as~~ “Poor man’s apple”. The conventional products of guava are jelly, jam, pulp, concentrate, juice, cheese, toffee, dehydrated guava and canned guava.

Guava is commercially grown ~~in~~ throughout the country, particularly in Maharashtra, Uttar Pradesh, Bihar, Orissa, Punjab, Uttarakhand, Gujarat, Madhya Pradesh, and ~~west~~ West Bengal. Uttar Pradesh is considered ~~as~~ the most important ~~guava producing~~ 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

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over the world. It covers around 3.7% (2.7 lakh ha) of ~~the~~ total area under fruit crops and contributes 3.3% (41.07 MT) of total fruit production (NHB 2017-18).

The spring flowering is called “Ambe Bahar”, June or monsoon flowering is called “Mrig Bahar” and ~~the~~ third flowering which ~~come comes~~ 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 ~~the~~ spring season which is also known as ~~the~~ summer season.

The fruit is an excellent source of vitamin C (210 mg/100g) and pectin (0.60 %) but has low energy (66 cal /100g), protein content (1%) and ~~has~~ dry matter (17%) and moisture (83%). The fruit is also rich in minerals like phosphorus (24–37mg/100g), calcium (14-30 mg/100g) and iron (0.6-1.4mg/100g) as well as vitamins like niacin, pantothenic acid, thiamine, riboflavin and vitamin A (Bose *et al.*, 1990).

Foliar application is based on the principle that the nutrients are quickly absorbed by leaves and transported to different parts of the plant to ~~fulfil~~ ~~fulfill~~ the functional requirement of nutrition. This method is highly helpful for the correction of element deficiencies to restore disrupted nutrient supply, ~~and~~ overcome stress factors limiting their availability and it plays an important role in improving fruit set, productivity and quality of fruits and recovery of nutritional and physiological disorders in fruit trees.

Zinc is ~~the-an~~ important ~~constitute~~ ~~constituent~~ of several enzyme systems which regulate various metabolic ~~reaction~~ ~~reactions~~ associated with water ~~relation~~ ~~relations~~ in the plant. Zinc is essential for auxin and protein synthesis, seed production and proper maturity. It also increases fruit size as well as yield. Zinc is essential for improving the vegetative growth of guava trees obtained in terms of terminal shoots, shoot diameter and number of leaves per shoot (Price *et al.*, 1972). Boron is a constituent of cell membrane and essential for cell division. It acts as a regulator of ~~potassium~~ ~~/~~ ~~ealeium~~ ~~potassium/calcium~~ ratio in the plant and helps in nitrogen absorption and translocation of sugar in plant. Boron increases nitrogen availability to ~~plant~~ ~~plants~~. It is involved in the synthesis of cell wall components. It has a central role in pollen viability and good fruit set. It increases the elongation growth of primary and lateral roots (O' Kelley, 1957).

Iron plays ~~a~~ critical role in metabolic processes such as DNA synthesis, respiration, and photosynthesis. It serves as a component of many vital enzymes such as cytochromes of the electron transport chain, and it is thus required for a wide range of biological functions. In plants, iron is involved in the synthesis of chlorophyll, and it is essential for the maintenance of chloroplast structure and function (Rout and Sahoo, 2015).

Manganese plays an essential role in respiration and N metabolism in plants. Also act as an activator for the enzymes, nitrite reductase and hydroxylamine reductase. Manganese is directly or

indirectly involved in chloroplast formation and probably in their multiplication and also involved in various oxidation-reduction reactions in photosynthesis (Nijjar, 1990).

Material and methods

The present investigation was carried out at Horticulture Research Farm, Department of Horticulture, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya-Vihar, Rae Bareli Road, Lucknow 226 025 (U.P.), India during ~~the~~ 2019-20. The Horticulture Research Farm, Department of Applied Plant Science Horticulture, Babasaheb Bhimrao Ambedkar University, Vidya- Vihar, Rae Bareli Road, Lucknow is situated at an elevation of 111 ~~meter-meters~~ above mean sea level in the subtropical tracts of Central U.P. at 260-560 North latitude. The experiment is laid out in randomized block design with a factorial concept containing 8 treatment combinations (T₀, T₁, T₂, T₃, T₄, T₅, T₆, T₇) in which T₀: Control (Water Spray). T₁: Zinc Sulphate 0.5%, T₂: Manganese Sulphate 0.5%, T₃: Iron Sulphate 0.4% T₄: Zinc Sulphate + Manganese Sulphate 0.5% + 0.5%, T₅: Zinc Sulphate + Iron Sulphate 0.5% + 0.4%, T₆: Manganese Sulphate + Iron Sulphate 0.5% + 0.4%, T₇: Zinc Sulphate + Manganese Sulphate + Iron Sulphate 0.5% + 0.5% + 0.4%. Application of treatment was given in two doses 1st spray at Fruit Set and 2nd Spray 15 days after Fruit Set.

Table:1. Treatment details

S. No.	Treatment notation	Treatment content
1.	T ₀	Control (Water Spray)
2.	T ₁	Zinc Sulphate (0.5 %)
3.	T ₂	Manganese Sulphate (0.5 %)
4.	T ₃	Iron Sulphate (0.4%)
5.	T ₄	Zinc Sulphate + Manganese Sulphate (0.5 % +0.5 %)
6.	T ₅	Zinc Sulphate + Iron Sulphate (0.5 % +0.4%)
7.	T ₆	Manganese Sulphate + Iron Sulphate (0.5 % +0.4%)
8.	T ₇	Zinc Sulphate + Manganese Sulphate + Iron Sulphate (0.5 % + 0.5 % +0.4%)

Plant parameters recorded during ~~the course of~~ experiment are Physico-chemical ~~characteristic of fruits i.e~~ characteristics., fruit size (cm), fruit weight (gm), volume of fruit (cm³), specific gravity and chemical parameters are Total soluble solids (TSS ⁰Brix), acidity (%), ascorbic acid

(Vitamin 'C') (mg/100gm pulp), reducing sugars (%), non-reducing sugar (%) and total sugar (%) are recorded. The data mended during the experimentation were statistically ~~analysed~~analyzed by randomized block design as suggested by Panse *et al.* (1995).

Results and Discussion

Fruit characteristics (physical) of guava

The result revealed ~~that the~~ application of micronutrients on Physico-chemical parameters and yield of guava. The parameters viz. Fruit length, Fruit breadth, Fruit weight, Fruit volume, Fruit set, Fruit drop, Total soluble solids (TSS), total sugar, ascorbic acid content, number of fruits per plant, yield and yield efficiency.

Fruit length and breadth the data reveal that different micronutrients application exhibited a significant influence on fruit length and breadth during ~~the course of the~~ study. Maximum fruit length (64.33 mm) was recorded in T₇. Whereas, the minimum fruit length (54.73 mm) was observed under treatment T₂. Maximum fruit breadth (68.03 mm) was recorded in T₇. Minimum fruit breadth (61.12 mm) was, however, observed in T₀ (control).

The data on fruit weight as influenced by different micronutrients application reveals that different micronutrients application had a significant effect on fruit weight which ranged from 116.93 g – 165.37 g. Maximum fruit weight (165.37 g) was recorded in T₇. The minimum fruit weight (116.93 g) was, however, observed in T₀ (control).

Different micronutrients ~~effected~~affected fruit volume considerably whose value varied from 121.67 cc to 182.67 cc. ~~Highest~~The highest fruit volume (168.33 cc) was in T₇ and ~~the~~ minimum (121.67 cc) in T₀ (control). As indicated above, the application of different micronutrients alone or in combination has a significant effect on fruit size (length and breadth), weight and volume. The possible reason for this effect might be ~~due to the fact that~~because mineral nutrients appear to have an indirect role in hastening the process of cell division and cell elongation due to which the size of ~~the~~ fruit might have improved. The increase in fruit weight may also be due to the rapid increase in the size of cells or it is also ~~due the fact that~~because foliar application of boron increased the fruit weight eventually by maintaining a lighter level of auxins in various parts of the fruits which helped in increasing the fruit growth (Kaur, 2017). The findings are similar to those reported by Bagali *et al.*, (1993), Pal *et al.*, (2008), Kumawat *et al.*, (2012) in guava and Meena *et al.*, (2014) in aonla who recorded maximum fruit size and weight with the foliar application of micronutrients.

The fruit set was not much influenced by micronutrients application during ~~the the course of~~ study (Table 2). However, the maximum fruit set (61.32 %) was recorded in T₇ and ~~the~~ minimum (60.03%) in T₁. As is evidenced from the data in Table 3, the micronutrients alone or in combinations had no significant effect on ~~the~~ fruit set. The possible reason for ~~non-significant~~non-significant effect on ~~the~~

fruit set in the present study might be because of the foliar application of micronutrients started after the fruit set.

It is evident from the data presented in Table 2 that those different treatments of micronutrient application exhibited a marked influence on the extent of fruit drop during the the course of study. Minimum fruit drop (42.08 %) was recorded in T₇. Maximum fruit drop (58.60 %) was recorded in T₀ (control).

The data in Table 2 indicate that the foliar application of different micronutrients alone or in combination resulted in a significant effect on fruit drop. The minimum fruitdrop was observed in trees sprayed with zinc sulphate @ 0.5% + manganese sulphate @ 0.5% + iron sulphate @ 0.4% (T₇). The results are in conformityconform with those of Hada *et al.* (2014); Bagali *et al.* (1993); Balakrishnan (2000) who found a reduction in fruit drop in guava with foliar application of micronutrients. The reduction in fruit drop might be due to the fact thatbecause the foliar application of micronutrients affected metabolic activities of the tree, improved the source-sinksrelationship and favourably influenced the metabolic status resulting in better control of drop and enhancing the fruits retentionthe retention of the fruits (Katiyar *et al.*, 2008). Wright (1956) also suggested that the primitive effect of growth substances attributed in to greater retention of fruit and reduction in fruit drop. There is a correlation between fruit drop and endogenous hormonal status, and the existence of a high level of internal auxin is useful for preventing fruit drop. Since a high level of endogenous hormones might help in building up endogenous hormonehormones atthe appropriate level that might be potent enough to reduce the fruit drop. Application-The application of zinc could have promoted the auxin synthesis in the plant system which might have delayed the formation of the abscission layer during the early stages of fruit development (Nason and McElroy, 1963).

Treatments	Fruit length (mm)	Fruit breadth (mm)	Fruit weight (g)	Fruit volume(cc)	Fruit set(%)	Fruit drop(%)
T ₁	59.46	64.86	136.43	140.00	60.03	45.66
T ₂	54.73	63.22	123.33	127.33	60.08	48.84
T ₃	55.98	63.29	120.70	126.33	60.89	49.16
T ₄	62.65	66.63	155.07	158.00	61.01	43.62
T ₅	59.14	65.08	140.10	145.67	60.66	44.29
T ₆	55.12	63.45	125.53	130.67	60.33	48.52
T ₇	64.33	68.03	165.37	168.33	61.32	42.08
T ₀	55.16	61.12	116.93	121.67	61.34	58.60
CD _{0.05}	4.87	2.49	2.41	4.88	NS	1.91

Table 2. Effect of micronutrients on fruit characteristics (physical) of guava

Chemical parameters of fruits

The result revealed ~~that the~~ application of micronutrients ~~on to~~ chemical parameters of guava. Data ~~pertaining to about~~ the effect of micronutrients application on total soluble solids in fruits are given in Table 3. It is evident from the data that the application of micronutrients exerted a significant influence on ~~the~~ total soluble solid contents of fruits. Maximum total soluble solids (10.63° B) were recorded in ~~the~~ fruits of the plants treated ~~with~~. The minimum total soluble solids (8.45° B) ~~was were~~, however, found in T₀ (control). The increase in TSS has also been recorded by Yadav *et al.* (2018), Awasthi and Lal (2009), and Singh *et al.* (2004) in guava. ~~Increase~~ An increase in total soluble solids might be ~~due to the fact that because~~ boron helped in trans-membrane sugar transport. Micronutrients play important role in vital plant metabolic functions such as chlorophyll synthesis, various enzymatic ~~reaction reactions~~, respiration and photosynthesis. Given that the main product of photosynthesis is sugar, so increasing the photosynthesis, ~~lead leads~~ to an increase in the sugar compounds and ~~cause~~ causes more soluble solids in fruit juice (Ram and Bose, 2000).

The scrutiny of data given in Table 3 ~~indicate indicates~~ that ~~the~~ application of different micronutrients and their combinations exerted a significant effect on total sugars during ~~the~~ the course of present study. ~~Highest~~ The highest total sugars (7.51%) were induced in fruits under T₇. While, ~~the~~ lowest total sugars (5.74%) ~~was were~~ recorded with T₀ (control).

Statistical analysis of data ~~in relation to about the~~ ascorbic acid content of guava provides substantiation that different micronutrients application individually or in combinations pronouncedly increased the ascorbic acid content as per Table 3. Maximum ascorbic acid content (161.77 mg/100 g pulp) was recorded with T₇. Whereas, minimum ascorbic acid content (140.04 mg/100 g pulp) was found in T₀ (control).

~~Above~~ The above observations of the present study indicate that the total sugars, reducing sugars, non-reducing sugars and ascorbic acid content were significantly affected by micronutrients applications alone or in combination (Table 3). These results ~~are in~~ conformity conform with the results achieved by Kumar *et al.*, (2015) and Jat and Kacha (2014). According to them, micronutrients application increased the quality parameters of guava fruit. The increase in the sugars content might be due to the more rapid translocation of sugars from leaves to developing fruits. Boron facilitated sugar transport within the plant. It was also reported that borate reacted with sugar to form a sugar-borate complex. Boron acted as a switcher in the degradation of glucose either by glycolysis or by pentose sugar ~~path way~~ pathway (Singh and Kaur 2016). The improvement in ~~the~~ quality of fruit might be due to the catalytic action of micronutrients particularly at higher concentrations. The foliar application of micronutrients quickly increased the uptake of macronutrients in the tissues and organs and improves fruit

quality. The boron also plays an important role in activating the synthesis of ascorbic acid (Baranwal *et al.*, 2017). The present results on ascorbic acid ~~is in conformity~~conform with the results achieved by Jeyabaskaran and Pandey (2008).

Table 3. Effect of micronutrients on TSS and titratable acidity of guava

Treatments	TSS (° B)	Total sugar (%)	Ascorbic acid (mg/100 g pulp)
T ₁	10.63	7.12	164.24
T ₂	9.66	6.69	147.66
T ₃	9.50	6.76	146.79
T ₄	10.26	7.05	159.49
T ₅	9.90	6.66	156.40
T ₆	9.75	6.53	152.79
T ₇	10.56	7.51	161.77
T ₀	8.45	5.74	140.04
CD _{0.05}	0.40	0.35	6.46

YIELD PARAMETERS:

Data ~~pertaining to~~about the effect of different micronutrients and their combinations on ~~several number of~~ fruits per plant in guava is summarized in Table 4. The data indicated that the number of fruits per plant in guava increased significantly with the foliar application of micronutrients. The maximum number of fruits per plant (45.33) was recorded under treatment T₇. The minimum number of fruits per plant (37.00) was recorded under treatment T₀ (control).

It is clear from the data given in Table 4 that the application of micronutrients exerted a significant effect on fruit yield per plant during ~~the course of~~ study. Maximum fruit yield (7.50 kg/ tree) was observed under T₇. While the minimum fruit yield (4.33 kg/ tree) was recorded in treatment T₀ (control), which was significantly lower than all other treatments.

The application of micronutrients exerted a significant influence on yield efficiency (kg/cm² TCSA) during ~~the course of~~ study. The data in the Table 3 showed that the highest yield efficiency of 0.35 kg/cm² TCSA was recorded in T₇ and the lowest yield efficiency of 0.16 kg/cm² TCSA was recorded in T₅. As far as the effect of micronutrients on guava yield and yield efficiency is concerned, the increase in fruit yield with the application of micronutrients may be attributed to increased fruit size, fruit weight, and minimum fruit drop resulting from the effects of micronutrients on cell division, cell elongation and translocation of photosynthetic and metabolites from leaves and other parts of plants to the developing fruits. The highest fruit yield which was obtained by foliar spray of micronutrients may be attributed to better uptake and mobilization of nutrients to the sink which caused better fruit development. These findings are also supported by earlier reports ~~of by~~ Bagali *et al.* (1993), Rajkumar *et al.* (2014), Jat and Kacha (2014), and Gaur *et al.* (2014a) who also found that foliar application of micronutrients increases the yield of guava.

Table 4: Effect of micronutrients on number of fruits per plant, yield, and yield efficiency of guava

Treatments	Number of fruits/plants	Yield (kg/tree)	Yield efficiency (kg/cm ² TCSA)
T ₁	42.67	5.82	0.23
T ₂	40.67	4.91	0.20
T ₃	44.33	6.87	0.27
T ₄	43.33	6.07	0.24

T ₅	41.33	5.19	0.16
T ₆	46.00	7.35	0.34
T ₇	45.33	7.50	0.35
T ₀ (control)	37.00	4.33	0.25
CD (5%)	1.91	0.31	0.02

1. CD has been calculated based on percentage value

Conclusion

On the basis of the results obtained in the present investigation, it is concluded the combined foliar application of zinc sulphate (ZnSO₄) @ 0.5% + manganese (MnSO₄) (0.5%) + iron sulphate (FeSO₄) (0.4%) (T₇). Therefore, combined spray of ZnSO₄ (0.5%) + MnSO₄ (0.5%) + FeSO₄ (0.4%) can be advocated to guava growers for maximum physical, chemical and yield parameters of guava.

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