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Effect of Soil Application of Zinc Sulphate on Growth, Yield and Quality of Guava cv. L-49

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field study was carried out to determine the effect of soil application of zinc sulphate on growth, yield and quality of guava cv. L-49 during rainy and winter season. Different soil applications were applied i.e. T_1 : $ZnSO_4$ @ 0 g/plant (Control), T_2 : $ZnSO_4$ @ 50 g/plant, T_3 : $ZnSO_4$ @ 75 g/plant, T_4 : $ZnSO_4$ @ 100 g/plant, T_5 : $ZnSO_4$ @ 125 g/plant and T_6 : $ZnSO_4$ @ 150 g/plant with three replications under randomized block design. The results of the study revealed significant increase in growth, yield and quality of guava fruit. However, application of $ZnSO_4$ @ 125 g/plant proved to be the best treatment in increasing the yield, fruit length & fruit breadth, fruit weight, TSS, Ascorbic acid and decreased acidity during rainy and winter seasons. For nutrient analysis, maximum N and Zn content in leaf and fruit was recorded under application of $ZnSO_4$ @ 125 g/plant and maximum K content in guava fruit was observed due to application of $ZnSO_4$ @ 100 g/plant. Thus, it can be concluded that effect of soil application of zinc sulphate increases the growth, yield and quality of guava fruits.

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1. INTRODUCTION

Guava (*Psidium guajava* L.), "Apple of the Tropics" and "Poor Man's Apple" is an important fruit crop of country, not because of large area and production, but due to its wider edapho-climatic adaptability, various biotic and abiotic stresses hardiness, precocious and prolific bearing habit, quality fruit with high nutritive value and medicinal attribute. It is classified under genus Psidium covering about 150 species [1] but only *Psidium guajava* L. has been commercially exploited. It was introduced in India in the 17th century by Portuguese and became a commercial crop. "It is very popular fruit crop and widely grown in tropical and sub-tropical regions up to 1500 m above mean sea-level. It is being cultivated throughout the American tropics, Asia, Africa and Pacific Islands. It is a more income generating crop without much care and input as it is sturdy in nature, prolific in bearing even on marginal lands. It is considered as a multipurpose tree due to its utility as a fruit, fuel, fodder, timber and it is highly remunerative crop. Although guava is native to Central America but now it is cultivated and naturalized throughout the tropics and due to increasing demand; it is also grown in some subtropical regions. Guava is a rich source of sugars, ascorbic acid and pectin. The content of ascorbic acid (Vitamin- C) ranges from 75-260 mg/100 g pulp which varies with cultivar, season, location and stage of maturity. Guava fruits are good source of vitamin A (about 250 IU/100g) and contain appreciable quantities of thiamine, niacin and riboflavin" [2]. "Micronutrients are required by the plants in small quantities and thus, can be applied more safely and easily through foliar application. Application of micronutrients through foliar fertilization has advantage of lower application rates, uniformity in distribution of fertilizer materials and quick response to applied nutrients" [3]. Among these micronutrients, zinc is most important. Although soil application of zinc is potentially very efficacious but it is very unpopular. Zinc plays an important role in starch metabolism, acts as a cofactor for many enzymes and affects photosynthesis, nucleic acid metabolism and protein biosynthesis. Zinc deficiency can inhibit the growth of fruit trees by impeding photosynthesis, carbon metabolism and respiration, which reduces the yield and quality of fruit. Keeping in view, this experiment has been planned to study the "Effect of soil application of zinc sulphate on growth, yield and quality of guava cv. L-49" with the objective to study the requirement of zinc sulphate in guava.

2. MATERIALS AND METHODS

The present investigation was conducted at Experimental orchard of Department of Horticulture, CCS Haryana Agricultural University, Hisar on 9 year old guava trees during the year 2018-22 for the rainy and winter season guava fruits. L-49 variety was selected as an experimental material to examine the effect of soil application of zinc sulphate on growth, yield and quality of guava. The time of application was first fortnight of July. The experiment comprised of total 6 soil applications i.e. T_1 : $ZnSO_4$ @ 0 g/plant (Control), T_2 : $ZnSO_4$ @ 50 g/plant, T_3 : $ZnSO_4$ @ 75 g/plant, T_4 : $ZnSO_4$ @ 100 g/plant, T_5 : $ZnSO_4$ @ 125 g/plant and T_6 : $ZnSO_4$ @ 150 g/plant with three replications under randomized block design. After soil application, the fruits were analyzed for plant height (m), yield (kg/plant), fruit weight (g), fruit length (cm), fruit breadth (cm), TSS (°Brix), acidity (%), ascorbic acid (mg/100 g pulp) and nutrient analysis (soil analysis before starting of the experiment and leaf & fruit analysis for N, P, K, Zn content).

Plant height (m) : The initial and final heights of the trees were measured with the help of measuring pole, upto maximum point of height. Odd type shoots were ignored. The increase in plant height was calculated by the following formula:

$$\text{Plant height (m)} = \frac{\text{Final height} - \text{initial height}}{\text{Initial height}} \times 100$$

Yield (kg/plant): To calculate total fruit yield, the total number of fruits per tree was multiplied with average fruit weight and the value was expressed in kilograms (kg/tree).

Fruit weight: Five randomly selected fruits from the tagged branch of the tree were picked and weighed on top pan electric balance. To calculate the average fruit weight the total fruit weight was divided by total number of fruits taken and expressed in grams (g).

Fruit length and breadth (cm): The observations on size of fruits in terms of their length (cm) and diameter (cm) were taken with the help of Vernier Caliper, at the time of fruit harvesting. Then the average length and diameter were calculated and expressed in centimeter (cm).

TSS (ºBrix): The total soluble solids (TSS) was measured by hand refractometer.

Acidity (%): Acidity was estimated by using the method given in A.O.A.C. [4].

Ascorbic acid (mg/100g pulp): The ascorbic acid content was estimated by following the standard method suggested by A.O.A.C, [4].

2.1 Soil Analysis

Collection of soil samples: Soil samples were collected at the start as well as at the end of experiment from the area under tree canopy in all four directions and were mixed. Trowel was used for this purpose and kept in clean polythene bags.

Processing of soil samples: Soil samples were air dried in shade for three to four days. These were grinded using wooden mortar and pestle and passed through 2mm sieve to separate out the coarse fragments. Coarse fragments were discarded and fine earth samples were used for analysis.

Available nitrogen (kg/ha): The alkaline permanganate method proposed by Subbiah and Asija (1956) was used for the determination of available nitrogen in soil sample.

Available phosphorus (kg/ha): For the determination of available phosphorus, Olsen's method (Olsen *et al.*, 1954) was used.

Available potassium (kg/ha): Available Potassium was determined by neutral normal NH_4OAC solution using flame photometer (Hanway and Heidal, 1952).

2.2 Leaf Analysis

Leaf samples were collected during August month from middle of non-fruiting branches. Forty to fifty leaves were taken from each tree. These were grinded using grinder and the powder formed was stored in clean polythene bags. These powdered leaf samples were used for digestion.

Digestion: 0.2 g plant sample was taken in 50 ml conical flask. 10 ml of diacid mixture (H_2SO_4 and $HClO_4$ in ratio of 9:1 for N,P,K & HNO_3 and $HClO_4$ in ratio of 4:1 for Zn, Fe) was added to it and kept overnight. After this, it was kept on hot plate and heated gently at first. Then, it was heated vigorously till it became a clear colourless solution of about 3-4 ml and all the fumes ceased out. It was cooled down and transferred to 50 ml volumetric flask and volume was made to the mark using distilled water. It was then filtered using Whatman no. 1 filter paper and used for analysis.

Nitrogen (%): Colorimetric or Nessler's method proposed by Lindner in 1944 [5] was used for the determination of total nitrogen.

Phosphorus (%): Vanado-molybdophosphoric yellow color method proposed by Koenig and Johnson [6] was used for the determination of total phosphorus in plant sample.

Potassium (%): Flame photometer was used for the determination of Potassium in the acid digest of plant samples.

Zinc (mg/kg): Atomic Absorption Spectrophotometer (AAS) was used for the determination of Zn in the acid digest of plant samples.

3. RESULTS AND DISCUSSION

The initial soil nutrient status was calculated before the start of the experiment (Table 1).

Table 1. Initial soil nutrients status

Properties	Values
Available N (Kg/ha)	125.00
Available P (Kg/ha)	20.00
Available K (Kg/ha)	380.0

Soil application of zinc was found effective in influencing the growth and yield of guava fruit. The plant height was not affected by the soil application of zinc sulphate. During rainy season, the maximum yield (45.3 kg/plant) of guava fruit was recorded in T_5 i.e. $ZnSO_4$ @ 125 g/plant and during winter season the maximum yield (19.3 kg/plant) of guava fruit was recorded in T_4 i.e. $ZnSO_4$ @ 100 g/plant which was statistically at par with $ZnSO_4$ @ 100 & 150 g/plant and minimum yield was recorded under control. The total combined yield (64.6 kg/plant) of both rainy and winter seasons was recorded maximum under T_5 i.e. $ZnSO_4$ @ 125 g/plant (Table 2). Increase in yield may be due to increase in fruit set per cent, number of fruits, weight of fruits and decrease in fruit drop. Similar findings were reported by Nijjar and Brar [7] in Kinnow, Khera et al. [8] in citrus and Meena et al. [9], Yadav et al. [10], Jat and Kacha [11] & Suman et al. [12] in guava.

The maximum fruit length during rainy season (5.15 cm) and winter season (6.03 cm) was recorded in T_5 i.e. $ZnSO_4$ @ 125 g/plant and minimum was recorded under control. The maximum fruit breadth during rainy season (4.63 cm) and winter season (5.49 cm) was recorded under T_5 i.e. $ZnSO_4$ @ 125 g/plant and minimum was recorded under control. On the other hand, the maximum fruit weight during rainy season (96.7 g) and winter season (124.7 g) was recorded under T_5 i.e. $ZnSO_4$ @ 125 g/plant which was statistically at par with $ZnSO_4$ @ 100 & 150 g/plant and minimum fruit weight was recorded under control (Table 3). The enlargement in fruit size is caused by drawing of photosynthates to the fruit as a consequence of intensification of the sink. An increase in fruit weight was due to accumulation of sugars and high pulp percentage in zinc treated fruits. Similar observations were recorded by Meena et al. [9], Pal et al. [13], Yadav et al. [10], Goswami et al. [14], Trivedi et al. [15], Jat and Kacha [11], Parmar et al. [3], Arshad and Ali [16] in guava and Sharma et al. [17] in ber.

However, the maximum TSS during rainy season (10.3°Brix) and winter season (11.2°Brix) was also recorded under T_5 i.e. $ZnSO_4$ @ 125 g/plant and the minimum TSS was noted in control. The acidity during rainy and winter season was found non-significant. Similarly, the highest ascorbic acid content during rainy season (175.0 mg/100g pulp) was found under T_3 i.e. $ZnSO_4$ @ 75 g/plant and during winter season, the maximum ascorbic acid content (197.7 mg/100g pulp) was noted under T_5 i.e. $ZnSO_4$ @ 125 g/plant and minimum ascorbic acid content was found under control (Table 4). As zinc is credited with definite role in the hydrolysis of complex polysaccharides into simple sugars, synthesis of metabolites and rapid translocation of photosynthetic products and minerals from other parts of the plant to the developing fruits ultimately leading to the increase in TSS and the higher ascorbic acid content may be attributed to adequate supply of hexose sugars via photosynthetic activity which increases on application of micronutrients. Similar results were observed by Devi et al. [18] in sweet orange, Meena et al. [9], Yadav et al. [10], Jat and Kacha [11] in guava and Sharma et al. [17] in ber.

Table 2. Growth and yield of guava as influenced by soil application of zinc sulphate

$ZnSO_4$ (g/plant)	Plant height (m)	Yield (kg/plant)		
		Rainy	Winter	Total
Control	5.81	35.3	14.0	49.3
50	6.05	40.0	17.3	57.3
75	6.11	41.7	17.7	59.4
100	6.03	44.0	19.7	63.7
125	6.17	45.3	19.3	64.6
150	6.01	44.7	19.0	63.7
CD (p=0.05)	NS	1.7	1.1	2.2

Table 3. Fruit length, fruit breadth and fruit weight of guava as influenced by soil application of zinc Sulphate

$ZnSO_4$ (g/plant)	Fruit length (cm)		Fruit breadth(cm)		Fruit weight (g)	
	Rainy	Winter	Rainy	Winter	Rainy	Winter
Control	4.79	5.70	4.21	4.73	85.1	107.0
50	5.03	5.70	4.45	4.89	91.7	117.7
75	5.10	5.83	4.50	5.29	93.0	121.0
100	5.11	5.90	4.61	5.43	95.0	122.0
125	5.15	6.03	4.63	5.49	96.7	124.7
150	5.11	6.00	4.61	5.31	95.1	123.3
CD (p=0.05)	0.07	0.14	0.07	0.17	1.7	2.1

Table 4. Quality of guava as influenced by soil application of zinc sulphate

$ZnSO_4$ (g/plant)	TSS (°Brix)		Acidity (%)		Ascorbic acid (mg/100g)	
	Rainy	Winter	Rainy	Winter	Rainy	Winter
Control	9.3	9.6	0.47	0.41	151.7	182.7
50	9.9	10.4	0.46	0.42	163.7	189.3
75	10.0	10.7	0.46	0.42	175.0	193.7
100	10.1	11.1	0.44	0.41	167.3	195.0
125	10.3	11.2	0.46	0.40	171.7	197.7
150	10.2	11.1	0.47	0.41	170.7	197.0
CD (p=0.05)	0.2	0.2	NS	NS	2.9	2.5

Table 5. Leaf nutrient content of guava as influenced by soil application of zinc sulphate

$ZnSO_4$ (g/plant)	N (%)	P (%)	K (%)	Zn (mg/kg)
Control	1.21	0.24	0.60	28.77
50	1.4	0.28	0.71	31.33
75	1.41	0.39	0.74	34.00
100	1.45	0.31	0.77	34.77
125	1.50	0.30	0.75	37.33
150	1.49	0.32	0.76	36.00
CD (p=0.05)	0.09	N.S	0.07	1.70

Table 6. Nutrient content of guava fruit as influenced by soil application of zinc sulphate

$ZnSO_4$ (g/plant)	N (%)	P (%)	K (%)	Zn (mg/kg)
Control	3.11	0.27	0.59	7.09
50	3.51	0.31	0.71	7.71
75	3.63	0.30	0.72	8.17
100	3.61	0.33	0.75	8.13
125	3.77	0.32	0.76	8.21
150	3.76	0.29	0.74	8.20
CD (p=0.05)	0.23	N.S	N.S	0.11

The leaf nutrient content of guava was highly influenced by the soil application of zinc sulphate. The maximum N (1.50%) and Zn (37.33 mg/kg) content in leaf was recorded under T_5 i.e. $ZnSO_4$ @ 125 g/plant and minimum was recorded under control. On the other hand, maximum K (0.77%) was recorded under T_4 i.e. $ZnSO_4$ @ 100 g/plant and minimum was noted under control. The P content of leaf was not much affected by the soil application of zinc sulphate (Table 5). Increase in zinc sulphate leads to increasing nitrogen concentration in soil. The zinc content increased might be due to soil application of zinc sulphate. Similar results were obtained by Amiri et al. [19] in apple.

The nutrient content of guava fruit was also influenced by soil application of zinc sulphate. The maximum N (3.77 %) and Zn (8.21 mg/kg) content in guava fruit was recorded under T_5 i.e. $ZnSO_4$ @ 125 g/plant and minimum was recorded in control. The P and K content of guava fruit were found non-significant (Table 6). Increase in zinc sulphate leads to increasing nitrogen concentration in leaf. The maximum zinc concentration may be due to the reason that zinc easily moved down to the soil profile and was efficiently taken up and transported to above ground parts. Similar findings was noted by Nijjar and Brar [7] in Kinnow, Devi et al. [18] in Sathgudi orange, Pawan [20] in apple and Kavitha et al. [21] in papaya [22-25].

4. CONCLUSION

Micronutrients like zinc play an important role in growth, fruit retention and development and cause efficient yield improvement. Results revealed that the maximum yield (64.6 kg/plant), TSS (10.3 & 11.2°Brix**)** and ascorbic acid (171.7 & 197.7 mg/100g pulp) during rainy and winter seasons and N and Zn contents in leaves and fruits of guava cv. L-49 were recorded in 125 g $ZnSO_4$. So, there is need to disseminate this soil application of zinc sulphate on guava among the farmers with effective extension methods like front line demonstration and others etc.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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