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Assessment of foliar application of nutrients on yield and quality of guava (*Psidium guajava*)

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ABSTRACT

Present study was carried out during rainy (*kharif*) seasons of 2020–2022 at CCS Haryana Agricultural University, Hisar, Haryana to assess the effect of foliar application of nutrients on the yield and quality aspects of rainy season guava (*Psidium guajava* L.). Experiment was conducted in a randomized block design (RBD) comprised of 4 different foliar applications of zinc sulphate, viz. $ZnSO_4$ @0% (Control); $ZnSO_4$ @0.3%; $ZnSO_4$ @0.6%; $ZnSO_4$ @0.9%; and 4 foliar applications of potassium sulphate, viz. K_2SO_4 @0% (Control); K_2SO_4 @1.0%; K_2SO_4 @1.5%; and K_2SO_4 @2.0, and replicated thrice. However, foliar application of $ZnSO_4$ @0.9% was found to be the best treatment in improving the fruit yield (46.2 kg/plant), fruit weight (135.2 g), fruit length (6.10 cm) and fruit breadth (5.64 cm) of rainy season guava (cv. L-49). Similarly, $ZnSO_4$ @0.6% was found best for increasing the TSS (total soluble solids) (10.6 B) and ascorbic acid content (187.4 mg/100 g pulp). On the other hand, K_2SO_4 @2.0% increased the fruit yield (45.4 kg/plant), fruit weight (135.2 g) and ascorbic acid content (190.3 mg/100 g pulp) of guava fruit. The maximum N, P, K and Zn content for nutrient analysis in leaf was noted under foliar application of $ZnSO_4$ @0.9% and K_2SO_4 @2.0%. The maximum N and Zn content in fruit was observed due to application of $ZnSO_4$ @0.9% and maximum P and K content was observed with treatment $ZnSO_4$ @0.6%. Similarly, K_2SO_4 @2.0% increased the N, P, K and Zn content of guava fruit.

Keywords: Foliar application, L-49, Treatment, TSS, Yield

Guava (*Psidium guajava* L.) is a tropical fruit crop belonging to the family Myrtaceae. It has about 150 species (Hayes 1970). The major countries where guava is produced are Australia, Venezuela, India, Cuba, USA, Brazil and New Zealand (Negi and Ranjan 2007). It is an important fruit crop of the world and is also known as "Apple of Tropics" (Nakasone and Paull 1998). It is a good source of vitamin A, B, C, iron and phosphorus (Sourabh *et al*. 2020). The leaves of guava are rich in flavonoids, particular in quercetin (Joseph *et al*. 2011). Different products made from guava are jam, jelly, toffee, pulp, juice and some dehydrated products (Suman *et al*. 2016). Fruiting in guava fruit comes during spring, rainy and winter season but the fruits coming during rainy season are deteriorated by the attack of fruit fly (Sharma *et al*. 2022). Potassium has a very drastic role in several physiological and different biochemical processes. Zinc has an important role in the metabolism of starch, affecting the photosynthesis and act as a cofactor of enzymes. Keeping this in view, the present experiment was planned to study the effect of foliar application of nutrients on yield and quality of rainy season guava with the objective to improve the quality of rainy season guava.

MATERIALS AND METHODS

Present study was carried out during rainy (*kharif*) seasons of 2020–2022 at CCS Haryana Agricultural University, Hisar, Haryana on 9-year-old guava trees. L-49 variety was selected as an experimental material to examine the response of foliar application of zinc sulphate and potassium sulphate on yield and quality of rainy season guava. The time of application was first and last week of May and June. The experiment comprised of 4 foliar applications of zinc sulphate i.e. $ZnSO_4$ @0% (Control); $ZnSO_4$ @0.3%; $ZnSO_4$ @0.6%; $ZnSO_4$ @0.9%; and 4 foliar applications of potassium sulphate i.e. K_2SO_4 @0% (Control); K_2SO_4 @1.0%; K_2SO_4 @1.5%; and K_2SO_4 @2.0% with three replications under randomized block design (RBD) using SPSS statistics software. After foliar application, the fruits were analyzed for fruit yield (kg/plant), fruit weight (g), fruit length and breadth (cm), TSS (°Brix), acidity (%), ascorbic acid (mg/100 g pulp) and nutrient analysis (leaf and fruit analysis for N, P, K, Zn content).

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Plant fruit yield (kg/ha): To calculate total fruit yield, the total fruits per tree were multiplied with the average fruit weight.

Fruit weight: Total of 5 fruits (randomly selected) from the tagged branch were taken and then weighed on electric balance. To calculate the fruit weight, total fruit weight was divided by the total fruits taken.

Fruit length and breadth (cm): The observations on size of fruits in terms of fruit length (cm) and breadth (cm) were measured using Vernier Caliper, at the time of fruit harvesting.

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

Acidity (%): The acidity was calculated by following the method provided in A.O.A.C. (1990).

Ascorbic acid (mg/100 g pulp): The ascorbic acid content of guava was calculated by using the standard procedure suggested by A.O.A.C. (1990).

Soil analysis

Collection of soil samples: Soil samples were gathered both at the beginning and conclusion of the experiment from the region beneath the tree canopy in all four directions and were combined.

Processing of soil samples: The soil samples were naturally dried in the shade for a period of 3–4 days. Subsequently, they were ground using mortar and pestle, sieved from a 2 mm sieve to remove coarse fragments. The discarded coarse fragments were excluded and remaining fine earth samples were employed for analysis.

Available nitrogen (kg/ha): The Subbiah and Asija (1956) alkaline permanganate method was employed to determine available nitrogen in soil samples. In an 800 ml Kjeldahl flask, 2 g of soil combined with 20 ml of water and 0.32% $KMnO_4$ solution. In a separate conical flask, 5 ml of N/50 H_2SO_4 with 2 to 3 drops of the methyl red indicator prepared, further end of tube delivering was immersed into this flask. After that tap water circulated through condenser. Following this, 100 ml of 2.5% NaOH solution introduced into flask and corked which activated the heater. After distillation, flask having distillate was removed and heater turned off. Excess H_2SO_4 was titrated for N/100 NaOH and volume recorded. A concurrent blank solution was also runned. After cooling, the Kjeldahl flask was carefully emptied of its contents.

Available phosphorus (kg/ha): To measure available phosphorus Olsen's approach (Olsen *et al*. 1954) was applied. A 100 ml wide mouth bottle was filled with 2 g of soil. It was mixed with 20 ml of the 0.5M $NaHCO_3$ and a small pinch of the Darco G-60. After 30 min of shaking using a mechanical shaker, suspension was filtered through Whatman no. 1 filter paper. A 25 ml volumetric flask was filled with 5 ml of ammonium molybdate solution after 5 ml of filterate had been put to it. To make roughly 20 ml, distilled water was added and used to wash down the sides. Next, 1 ml of recently diluted $SnCl_2$ solution added to it, and distilled water was used to bring the volume up to the desired level. After the contents combined, spectrophotometer's red filter was used to detect blue colour's intensity at 660 nm in wavelength.

Available potassium (kg/ha): It was calculated by neutral normal NH_4OAC solution using flame photometer (Hanway and Heidal 1952). A 5 g of soil taken in a 100 ml of the conical flask and about 25 ml of neutral normal NH_4OAC solution added to it. Further, conical flask was shaken for around 5–6 min. After that, it was filtered via Whatman no. 1 (filter paper).

Leaf analysis

In August, leaf specimens were gathered from the center of various branches except fruiting. Each tree contributed around 40–50 leaves, which were grinded using grinder and the resulting powder collected was stored in the pristine polythene bags.

Digestion: A 0.2 g plant sample was placed in a 50 ml conical flask. A diacid mixture (H_2SO_4 and $HClO_4$ in a 9:1 ratio for N, P, K and HNO_3, and $HClO_4$ in a 4:1 ratio for Zn, Fe) totaling 10 ml was added, and the mixture was left overnight. Subsequently, mixture was gently heated (on a very hot plate), continuously heated till it formed a clear colourless solution of approximately 3–4 ml with all fumes dissipating. After cooling, it was shifted to a volumetric flask of 50 ml. After that, the solution was then filtered using the filter paper (Whatman number 1).

Nitrogen (%): To determine total nitrogen utilized, Lindner's Colorimetric or Nessler's method (1944) was used. 0.2 ml of digested plant material was combined with 5 ml of distilled water in a 25 ml of volumetric flask. To this mixture, approximately 1 ml of 10% NaOH was added to neutralize acidity. Following this, 1 ml of 10% sodium silicate was introduced, and the volume was adjusted to about 20 ml. Subsequently, 2 ml of Nessler's reagent was added, resulting in an orange-coloured complex. The volume was brought to the mark, and the colour intensity was measured on a spectrophotometer using a blue filter at a wavelength of 440 nm. Nitrogen content was then calculated.

Phosphorus (%): For determination of total phosphorus in plant samples, method given by Koenig and Johnson (1942) i.e. Vanado-molybdophosphoric yellow colour method was employed. 2 ml aliquot was combined with 2–3 drops of 2,4-dinitrophenol indicator in a 25 ml of volumetric flask. Subsequently, ammonia solution was added until a yellow colour appeared, followed by the addition of 6 N HCl until it returned to a colourless state. 5 ml of vanadomolybdate solution was introduced and volume adjusted. After thorough mixing, yellow colour intensity was measured on a spectrophotometer using a blue filter at a wavelength of 440 nm and the phosphorus content was determined.

Potassium (%): The Flame photometer was employed to ascertain the potassium concentration in the acid digest of plant samples. 5 ml digested plant material was taken and volume adjusted with distilled water in a 25 ml of the volumetric flask.

Zinc (mg/kg): The determination of zinc (Zn) in the acid digest of plant samples involved analyzing a diluted solution of the digested plant sample using an Atomic Absorption Spectrophotometer (AAS).

RESULTS AND DISCUSSION

Foliar application of $ZnSO_4$ significantly improved the yield and quality parameters of rainy season guava cv. L-49. Results (Table 1) showed that the maximum fruit yield was recorded by foliar application of the $ZnSO_4$ @0.9% (46.2 kg/plant) and minimum was recorded under control (41.9 kg/plant). Increase in yield was owing to increase in per cent of fruit set, no. of fruits, weight of fruits and decrease in the fruit drop of guava. The maximum fruit weight was observed in foliar application of $ZnSO_4$ @0.9% (135.2 g) and minimum was recorded under control (125.6 g). Fruit weight increased due to sugar accumulation and increase in pulp percentage of fruits treated with zinc. The maximum fruit length was recorded under foliar application of $ZnSO_4$ @0.9% (6.10 cm) and minimum was recorded under control (5.45 cm). Similarly, maximum fruit breadth was recorded by foliar application of $ZnSO_4$ @0.9% (5.64 cm) and minimum was recorded under control (5.14 cm). The highest TSS was recorded under $ZnSO_4$ @0.6% (10.6°Brix) and minimum was recorded under control (9.8°Brix). The minimum acidity was found under foliar application of $ZnSO_4$ @0.9% (0.35%). The maximum ascorbic acid was found under foliar application of $ZnSO_4$ @0.6% (187.4 mg/100 g pulp) and minimum was noted under control (180.6 mg/100 g pulp). This is because zinc plays a critical role by converting the complex PSCs to simple sugars and in the fast transfer of photosynthesizing products and minerals to the developing fruit from other areas of the plant, resulting in the rise in TSS, as well as an increase in the presence of ascorbic acid (Hamzah *et al*. 2022).

Likewise, K_2SO_4 was effective in increasing the yield and quality. Maximum yield (45.4 kg/plant) was found by the application of K_2SO_4 @2.0% and minimum yield was obtained in control (42.6 kg/plant) (Table 1). The maximum fruit weight was observed in foliar application of 2.0% K_2SO_4 (131.8 g) and least was noted under the control (128.5 g). Fruit weight increased because of building up of sugar and improving transport of sugars to tissues of guava fruit. The minimum acidity (0.38%) was recorded under foliar application of 1.5% potassium sulphate. This could be caused by a higher sugar content, better transport of sugars into the fruit tissues, or a neutralisation of organic acids resulting from high potassium levels in the tissue (Tisdale and Nelson 1966). On the other hand, maximum ascorbic acid was found under foliar application of 2.0% K_2SO_4 (190.3 mg/100 g pulp) and minimum was noted under control (177.1 mg/100 g pulp). The higher synthesis of some metabolites and certain intermediates contributed to increased levels of ascorbic acid in guava fruit juice with foliar sprays of different nutrients. Similar results were found by Jat and Kacha (2014), Manivannan *et al.* (2015), Suman *et al.* (2016), Patel *et al*. (2023) and Shanker *et al*. (2023) in guava; Pandey and Kumar (2023) in ber; Mohit *et al*. (2023) and Tiwari *et al.* (2023) in aonla.

Maximum nitrogen (1.72%), phosphorus (0.34%), potassium (1.83%) and zinc (49.60 mg/kg) content in guava leaf were observed by the foliar application of $ZnSO_4$ @0.9% and minimum was recorded under control (Table 2). It may be owing to that zinc content increased by application of the zinc sulphate. Similarly leaf nutrient content was highly influenced by the foliar application of potassium sulphate. The maximum leaf nitrogen (1.76%), phosphorus (0.29%), potassium (1.88%) and zinc (50.67 mg/kg) content were observed by the foliar application of K_2SO_4 @2.0% and minimum were found in control (Table 2). Nitrogen, phosphorus and potassium concentration was increased in leaves due to

Table 1 Effect of foliar application of the zinc sulphate and potassium sulphate on the yield and quality parameters (pooled data of three years) of rainy season guava

Zinc sulphate (%)	Fruit yield (kg/plant)	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	TSS (°Brix)	Acidity (%)	Ascorbic acid (mg/100 g)
Control	41.9	125.6	5.45	5.14	9.8	0.43	180.6
0.3	44.0	128.3	5.57	5.26	10.5	0.41	184.0
0.6	45.7	133.2	5.95	5.60	10.6	0.39	187.4
0.9	46.2	135.2	6.10	5.64	10.5	0.35	187.0
CD (*P*=0.05)	1.78	2.3	0.30	0.09	0.2	0.02	2.66
Potassium sulphate (%)							
Control	42.6	128.5	5.73	5.34	10.2	0.43	177.1
1.0	44.5	130.3	5.75	5.41	10.3	0.39	184.3
1.5	45.2	131.7	5.78	5.44	10.4	0.38	186.5
2.0	45.4	131.8	5.82	5.45	10.4	0.39	190.3
CD (*P*=0.05)	1.78	2.3	NS	NS	NS	0.02	2.66

TSS, Total soluble solids.

Table 2 Effect of foliar sprays of zinc sulphate and potassium sulphate on nutrient contents in leaf of rainy season guava (pooled data of 3 years)

Zinc sulphate (%)	Nitrogen content (%)	Phosphorus content (%)	Potassium content (%)	Zinc content (mg/kg)
Control	1.60	0.19	1.75	39.89
0.3	1.63	0.22	1.80	43.19
0.6	1.66	0.30	1.80	48.61
0.9	1.72	0.34	1.83	49.60
CD (*P*=0.05)	0.05	0.04	0.05	2.03
Potassium sulphate (%)				
Control	1.58	0.22	1.69	38.00
1.0	1.62	0.25	1.75	43.69
1.5	1.67	0.28	1.85	48.93
2.0	1.76	0.29	1.88	50.67
CD (*P*=0.05)	0.05	0.04	0.05	2.03

Table 3 Effect of foliar sprays of the zinc sulphate and potassium sulphate on nutrient status of rainy season guava (Pooled data of 3 years)

Zinc sulphate (%)	Nitrogen content (%)	Phosphorus content (%)	Potassium content (%)	Zinc content (mg/kg)
Control	3.21	0.22	0.62	7.54
0.3	3.28	0.25	0.74	7.98
0.6	3.37	0.32	0.81	8.00
0.9	3.47	0.31	0.76	8.10
CD (*P*=0.05)	0.08	0.03	0.05	0.15
Potassium sulphate (%)				
Control	3.25	0.22	0.64	7.05
1.0	3.30	0.26	0.69	7.66
1.5	3.35	0.29	0.78	8.50
2.0	3.41	0.33	0.84	9.01
CD (*P*=0.05)	0.08	0.03	0.05	0.15

an increased concentration of potassium sulphate. Similar results were reported by Amiri *et al.* (2008) in apple; Darshan *et al*. (2023) and Gupta *et al*. (2023) in guava.

In guava fruits, maximum nitrogen (3.47%) and zinc (8.10 mg/kg) content were observed by foliar application of $ZnSO_4$ @0.9%. However, maximum phosphorus (0.32%) and potassium (0.81%) content in guava fruit were observed by foliar spray of $ZnSO_4$ @0.6% and minimum was recorded under control (Table 3). Zinc is easily transportable to soil surface and has been able to be efficiently harvested and transported from these areas into higher ground parts may account for the highest concentration of zinc (Sangeetha *et al*. 2022). Foliar spray K_2SO_4 @2.0% recorded maximum nitrogen (3.41%), phosphorus (0.33%), potassium (0.84%) and zinc (9.01 mg/kg) content in fruit and minimum were recorded in control (Table 3). Foliar application of K_2SO_4 improves nitrogen use efficiency, enhancing nitrogen uptake and better utilization by plants. Similar findings were reported by Kavitha *et al.* (2002) in papaya and Gupta *et al*. (2023) in guava.

Macronutrients like potassium and micronutrients like zinc has a very drastic role in growth, development and yield improvement. Above results concludes that maximum yield (46.2 kg/plant) was noted by foliar spray of $ZnSO_4$ @0.9% which was at par with $ZnSO_4$ @0.6%. Quality parameters of fruits i.e. maximum TSS (10.6°Brix) and ascorbic acid (187.4 mg/100 g) were found by foliar spray of $ZnSO_4$ @0.6%. Foliar application of the K_2SO_4 significantly improved the yield, fruit size and ascorbic acid content in rainy season guava cv. L-49. So, there is need to disseminate this response of foliar spray of zinc sulphate and potassium sulphate on the yield and quality of rainy season guava among the farmers with effective extension methods like front line demonstration and others etc. as it will help in increasing the yield of guava fruit and fetching a better price for it.

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