J. Hortic. Sci.
Vol. 18(2) : 345-350, 2023

https://doi.org/10.24154/jhs.v18i2.1860

Original Research Paper

Yield sustainability through micronutrient management in guava

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ABSTRACT

A field study conducted with soil and foliar application of $ZnSO_4$ and borax at different phenological stages of guava cv. Shewta in sandy loam soil, revealed that highest sustainable yield index (0.80) was recorded with two sprays of 0.4% $ZnSO_4$ + 0.2% borax during fruit growth at one month interval, followed by 0.63 with three sprays of 0.4% $ZnSO_4$ + 0.2% borax before flowering, fruit set and during fruit growth. Highest TSS (13.13°Brix), acidity (0.652%) and ascorbic acid (262.21 mg/100 g) was recorded in two sprays of 0.4% $ZnSO_4$ + 0.2% borax at fruit growth in one month interval. Significant differences in Zn and B content in guava fruit pulp was recorded. It was noted that Guava fruit pulp had Zn content of 13.7 mg kg^{-1} in control tree fruits while 14.6 to 16.5 mg kg^{-1} in treated trees. Moreover, guava fruit pulp enriched with B (14.3 to 17.3 mg kg^{-1}) in treated tree fruits as compared to 12.4 mg kg^{-1} in control trees. Micronutrient contents in leaf tissues showed significant difference in Zn and B concentration, whereas, Fe, Mn and Cu contents were statistically non-significant. The index suggested for attaining the sustainability and to economize the nutrient application, technology package consisting of two sprays of 0.4% $ZnSO_4$ and 0.2% borax during fruit growth at one month interval should be adopted at growers' field.

Keywords: Fruit pulp, guava, micronutrient, sustainability index, yield

INTRODUCTION

Horticulture ecosystem not only provides the nutritional security but also equally important for providing ecosystem services. Fruit crops like guava provides ample amount of minerals and other nutrients for human health. However, its productivity, sustainability and nutrient content will depend on a number of edaphic, management and tree factors. In fact, the fruit productivity is a dependent factor and soil-tree-climate interactions act as independent factors. The guava productivity is also affected under different types of soil, management and resource conservation practices. Morales-Sillero et al. (2009) described the soil-tree response in olive productivity, while, Barne et al. (2011) observed positive effect of integrated nutrient management on guava yield and quality component by using NPK+Azotobacter+ PSB+FYM, and various crop regulation methods gives positive impacts on the guava sustainability (Das et al., 2007). However, Patel et al. (2013) reported significant difference in quality attributes during fruit growth and maturity. In fact, the precise sustainability depends on the crucial factor of varietal response to the resource management. Adak et al. (2019a) recommended the need of developing soil nutrient index for precise nutrient management in orchards. The ecological significance is also acts as precursor for supporting the robust life cycling of trees considering micronutrient distribution pattern based on vast area (Adak et al., 2019c). Kumar et al. (2017) recommended green manuring and precision farming in mango, and soil & tree health management in guava for enhancing the sustainable yield index (Adak et al., 2020). The present investigation was, thus, laid out with the objective of assessing the sustainable yield index in guava along with nutrient dynamics in fruit pulp under the influence of micronutrient spray at different critical developmental stages of guava.

MATERIALS AND METHODS

Field experiment with soil and foliar application of micronutrients on guava cv. Shewta (10-11 years old) was conducted on sandy loam soils at experimental farm of ICAR-Central Institute of Sub-tropical Horticulture, Rehmankhera, Lucknow during 2015 to

2017. Maintenance of crop field was carried out as per standard cultural practices. Third pairs of leaves as an index leaf during March were collected for assessing the leaf micronutrient status. Initial soil DTPA extractable Fe, Mn, Zn and Cu were estimated and found to be 3.56, 1.52, 0.18 and 0.24 mg kg^{-1}, respectively, while, leaf samples had 94, 51, 8.0 and 8.0 mg kg^{-1} of Fe, Mn, Zn and Cu, respectively. Leaf 'B' content was 22.4 mg kg^{-1}. Six treatments viz., T_1: 3 sprays of 0.4% $ZnSO_4$ + 0.2% borax before flowering, after fruit set and during fruit growth, T_2 : 2 sprays of 0.4% $ZnSO_4$ + 0.2% borax after fruit set and during fruit growth, T_3: 2 sprays of 0.4% $ZnSO_4$ + 0.2% borax during fruit growth at 1 month interval, T_4 : 2 sprays of 0.4% $ZnSO_4$ + 0.2% borax before flowering and during fruit growth, T_5 : soil application of 200 g $ZnSO_4$ + 50 g borax/tree just before flowering and T_6: control, were imposed every year as soil application in September-October and spraying at critical stage wise i.e. flowering, fruit set and development, in randomized block design with four replications. Fruit yield and fruit quality attributes *viz.*, acidity (%), TSS (°Brix), ascorbic acid (mg/100 g) and micronutrient content (Fe, Mn, Zn and Cu) recorded and analyzed during 2015-16 and 2016-17. Atomic absorption spectrophotometer (model 'Chemito'AA203D) was used to estimate the micronutrient contents. Quality attributes was estimated as per the standard procedures (Ranganna, 2001). Sustainable yield index (SYI) was calculated based on Singh et al. (1990) and also to identify the best treatment so that farmers get best option for enhancing yield in sandy loam soils of guava growing region.

$$SYI = (Y - \sigma_{n-1})/Y_m$$

Where, Y: average annual fruit yield and Y_m: maximum yield recorded in a given set of treatments from all years; σ_{n-1}: standard deviation.

Statistical significance of data and standard error of mean for yield and quality attributes, micronutrient concentration of guava fruit pulp and leaves was carried out using OPSTAT (Sheoran et al., 1998).

RESULTS AND DISCUSSION

Significant positive effect of soil and foliar applications of micronutrients at different phenological stages on guava fruit yield and fruit quality (Table 1) inferred improvement in fruit yield from 16.3 to 39.12 kg $tree^{-1}$ (control) and 26.28 to 73.57 kg $tree^{-1}$ (T_3), respectively during 2015-16 and 2016-17. The treatments and seasonal effects may be responsible for such yield enhancement. The role of Zn and B nutrition on TSS, acidity and ascorbic acid was also evidenced. In control fruit trees, lowest content of TSS (11.53, 11.78), acidity (0.548, 0.564), and ascorbic acid (239.81, 247.02) was recorded. Higher fruit quality attributes was observed in T_1 to T_3 treated guava trees where Zn and B was applied at different critical phenological stages. The SYI (sustainable yield index) in guava varied from 0.22 to 0.28. The highest SYI (0.80) was recorded in the treatment T_3 (Table 2). The index concluded that for maintaining the stability in guava yield, T_3 treatment should be practiced at farmers' field. Further the CV data also showed the yield variability across the treatments within the guava orchards. Standard deviations and associated univariate statistics of yield data practically suggested for wide spread variability.

In order to assess the effect of nutrient enrichment treatments on fruit pulp and leaf tissues of guava trees, statistical significance was observed in Zn and B concentrations (Table 3). Greater Zn concentrations (16.10 to 16.75 and 13.25 to 16.50 mg kg^{-1}) in fruit pulp of guava trees were recorded across T_1 to T_3 treatments, whereas, lower contents (13.00 to 14.43 mg kg^{-1}) under control plot (T_6) was recorded. Similarly, lowest B concentration (11.40 to 13.43 mg kg^{-1}) in fruit pulp of control plots and higher contents (15.38 to 16.45 and 15.95 to 18.15 mg kg^{-1}) in T_1 to T_3 treatments was recorded. The analysis inferred greater Zn and B content in guava fruit pulp.

Non-significant difference in foliar micronutrient concentration was evidenced in case of Fe, Mn and Cu (Table 4). The B content varied between 23.30 to 25.70 mg kg^{-1} in leaf tissues of T_6 treatment, while, 43.63 to 47.68 and 34.15 to 42.28 mg kg^{-1} in T_1 to T_3 treatments. Likewise, Zn concentration of 19.23 to 25.43 and 53.90 to 59.28 and 32.60 to 52.65 mg kg^{-1} was recorded in T_6 and T_1 to T_3 treated plots. Interestingly, T_4 and T_5 treatments showed lower yield, SYI, nutrient concentrations as compared to T_1, T_2 and T_3 treatments but greater than control plot (T_6). Greater nutrient build up (Zn and B) in the T_3 treatment was obtained because of two sprays during fruit growth times at one month interval. This may have facilitates nutrient penetration in the fruits. The economic calculations based on prices of $ZnSO_4$ and

Table 1 : Effect of phenological stage wise application of micronutrients on fruit yield and quality of guava

Treatment	Fruit yield (kg/tree)			TSS (°Brix)			Acidity (%)			Ascorbic acid (mg/100 g)		
	2015-16	2016-17	Mean	2015-16	2016-17	Mean	2015-16	2016-17	Mean	2015-16	2016-17	Mean
T_1- Three sprays of 0.4% $ZnSO_4$+0.2 % borax before flowering, fruit set and during fruit growth	26.03	59.86	42.95	12.70	11.85	12.28	0.632	0.579	0.61	252.28	252.28	252.28
T_2- Two sprays of 0.4% $ZnSO_4$+0.2 % borax after fruit set and during fruit growth	24.82	62.04	43.43	12.83	12.10	12.47	0.628	0.615	0.62	252.87	256.37	254.62
T_3- Two sprays of 0.4% $ZnSO_4$+0.2 % borax during fruit growth at one month interval	26.28	73.57	49.93	13.13	12.40	12.77	0.616	0.652	0.63	259.88	262.21	261.05
T_4- Two sprays of 0.4% $ZnSO_4$+0.2 % borax before flowering and during fruit growth	20.58	49.39	34.98	12.63	12.13	12.38	0.648	0.584	0.62	244.85	254.04	249.45
T_5- Basal application of 200 g $ZnSO_4$+50 g borax/ tree just before flowering	19.28	46.26	32.77	12.73	11.95	12.34	0.632	0.584	0.61	247.44	252.87	250.16
T_6- Control	16.30	39.12	27.71	11.53	11.78	11.66	0.548	0.564	0.56	239.81	247.02	243.42
CD (P=0.05)	6.17	15.31		0.46	0.274		NS	0.037		12.37	3.85	
SEm±	2.00	5.00		0.15	0.09		0.03	0.01		4.10	1.30	

Table 2 : Sustainable yield index and other statistical parameters of yield of guava

Treatment	SYI		sd		Skewness		Kurtosis		CV (%)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
T_1- Three sprays of 0.4% $ZnSO_4$+0.2 % borax before flowering, fruit set and during fruit growth	0.28	0.63	5.7	13.2	0.32	0.32	-2.67	-2.67	22.1	22.1
T_2- Two sprays of 0.4% $ZnSO_4$+0.2 % borax after fruit set and during fruit growth	0.25	0.62	6.5	16.3	0.62	0.62	1.27	1.27	26.3	26.3
T_3- Two sprays of 0.4% $ZnSO_4$+0.2 % borax during fruit growth at one month interval	0.28	0.80	5.4	15.1	-0.28	-0.28	-3.82	-3.82	20.5	20.5
T_4- Two sprays of 0.4% $ZnSO_4$+0.2 % borax before flowering and during fruit growth	0.23	0.55	3.8	9.1	-0.05	-0.05	-2.06	-2.06	18.4	18.4
T_5- Basal application of 200g $ZnSO_4$+50 g borax/ tree just before flowering	0.23	0.54	2.7	6.5	-1.12	-1.12	1.98	1.98	14.1	14.1
T_6- Control	0.22	0.52	0.5	1.1	0.47	0.47	-3.23	-3.23	2.8	2.8

Table 3 : Effect of phenological stage wise application of Zn and B on micronutrient content of guava fruits

Treatment	Micronutrient concentration (mg kg^{-1}) in fruit pulp									
	Fe		Mn		Zn		Cu		B	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
T_1- Three sprays of 0.4% $ZnSO_4$ + 0.2 % borax before flowering, fruit set and during fruit growth	117.4	117.50	8.25	7.50	16.75	13.25	6.43	6.25	15.53	17.40
T_2- Two sprays of 0.4% $ZnSO_4$ + 0.2 % borax after fruit set and during fruit growth	114.9	112.50	7.78	7.25	16.10	15.25	6.25	6.75	15.38	15.95
T_3- Two sprays of 0.4% $ZnSO_4$ + 0.2 % borax during fruit growth at one month interval	119.8	120.00	7.68	8.25	16.50	16.50	6.38	7.75	16.45	18.15
T_4- Two sprays of 0.4% $ZnSO_4$ + 0.2 % borax before flowering and during fruit growth	115.4	117.25	7.65	7.00	15.70	14.50	6.08	6.50	14.88	13.73
T_5- Basal application of 200g $ZnSO_4$ + 50 g borax/ tree just before flowering	113.3	115.75	7.40	6.50	15.38	13.75	5.95	6.00	17.23	13.13
T_6- Control	115.3	108.25	8.18	6.50	14.43	13.00	5.83	5.00	11.40	13.43
CD (P=0.05)	NS	5.6	NS	1.0	1.26	1.75	NS	1.4	2.86	2.41
SEm±	1.24	1.84	0.23	0.33	0.41	0.57	0.32	0.46	0.94	0.79

Table 4 : Effect of phenological stage wise application of Zn and B on micronutrient content of guava leaves

Treatment	Micronutrient concentration in leaves (mg kg^{-1})									
	Fe		Mn		Zn		Cu		B	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
T_1- Three sprays of 0.4% $ZnSO_4$ + 0.2 % borax before flowering, fruit set and during fruit growth	247.3	358.8	124.4	209.5	53.90	32.60	6.38	11.00	44.93	37.83
T_2- Two sprays of 0.4% $ZnSO_4$ + 0.2 % borax after fruit set and during fruit growth	248.0	368.3	120.0	189.3	54.83	36.93	6.95	11.50	47.68	34.15
T_3- Two sprays of 0.4% $ZnSO_4$ + 0.2 % borax during fruit growth at one month interval	253.8	363.0	124.1	189.0	59.28	52.65	6.93	13.00	43.63	42.28
T_4- Two sprays of 0.4% $ZnSO_4$ + 0.2 % borax before flowering and during fruit growth	267.8	354.8	123.0	178.0	53.55	31.10	7.83	12.50	40.85	29.68
T_5- Basal application of 200g $ZnSO_4$ + 50 g borax/tree just before flowering	256.8	366.3	125.8	172.5	26.75	27.10	6.98	12.25	36.43	26.28
T_6- Control	261.8	340.0	120.7	170.5	19.23	25.43	6.05	13.00	23.30	25.70
CD (P=0.05)	NS	NS	NS	NS	6.57	16.35	NS	NS	9.6	11.2
SEm±	7.5	21.2	4.1	14.4	2.2	5.4	0.49	0.9	3.2	3.7

borax, laboures for treatments application along with guava selling process @ Rs. 20/- per kg of fruit was analyzed. In control plot, net profit of Rs. 524.2 per tree, while, in other spraying treatments (T_1 to T_4) was Rs. 649.3 to Rs. 948.3 and soil application (T_5) recorded Rs. 649.3 per tree. Therefore, in order to economize the micronutrient application and stage, T_3 treatment should be the best option for guava growers.

Assessment of yield sustainability in any agroecosystem is topmost priority as resources are getting scarce under the influence of climate change (Vittal et al., 2002). Wanjari et al. (2004) recommended the usefulness of SYI as an indicator for assessing the sustainability across systems. Actually, Neilsen et al. (2014) opined that tree performances is dependent on orchard floor management, and precise orchard managements were good enough for providing the ecosystem services (Montanaro et al., 2017) also. Adak et al. (2019b) reported the importance of adoption of advanced soil and water conservation practices in fruit orchards in order to sustain the soil and tree. The positive response of any nutrient doses and its split spray in single or in combination had significant positive effect (Ares et al., 2003). In the present field study, spraying of Zn and B during fruit growth and development was found to be beneficial for fruit growth and overall yield performance. Significant difference in pulp and leaf micronutrient content was the resultant for these types of nutrition application. Adak et al. (2018) also observed the variable content of B and K in major mango germplasm.

CONCLUSION

Robust guava cultivation needs resource allocation for the betterment of yields and quality fruit. Application of $ZnSO_4$ and borax before flowering, after fruit set and fruit growth stages enhanced the yield from 39.12 kg tree^{-1} (control) to 73.57 kg tree^{-1}. Likewise, improvement in TSS, acidity and ascorbic acid content was also observed. SYI suggested that for maintaining highest index, 2 sprays of 0.4% $ZnSO_4$ + 0.2% borax during fruit growth at monthly interval should be practiced. Farmers of Uttar Pradesh and other region should practice precise application of Zn and B for ensuring higher sustainability.

ACKNOWLEDGEMENT

Authors sincerely acknowledged the financial assistance provided by ICAR under networking project on 'Micronutrient management in horticultural crops for enhancing yield and quality'. The Director, ICAR-CISH, Lucknow is also acknowledged for his cooperation during the field study, and assistance received from Dr. Vinod Kumar Singh and Ram Kumar during laboratory and field experimentation is also acknowledged.

REFERENCES

Adak, T., Kumar, K., Shukla, S. K., & Pandey, G. (2020). Improving sustainable yield index in guava (*Psidium guajava*) through organic and inorganic inputs. *Indian Journal of Agricultural Sciences, 90*(7), 1267-1270.

Adak, T., Pandey, G., Singh, V. K., & Rajan, S. (2019a). Assessing soil nutrient index in mango orchards of Maal area, Lucknow, U.P. *Journal of Soil and Water Conservation, 18*(3), 263-267. https://doi.org/10.5958/2455-7145.2019.00037.7

Adak, T., Pandey, G., Rajan, S. (2019b). Advanced knowledge on soil and water conservation measures in fruit orchards. *Journal of Agricultural Physics, 19*(1), 35-45. http://www.agrophysics.in

Adak, T., Kumar, K., & Singh, V. K. (2019c). Assessment of soil micronutrients from a mango based agroecology of Malihabad, Uttar Pradesh, India. *Tropical Plant Research*, *6*(2), 176-182. https://doi.org/10.22271/tpr.2019.v6.i2.026

Adak, T., Rajan, S., Singh, V. K., Pandey, G., & Kumar, K. (2018). Boron and potassium content of major mango (*Mangifera indica* L.) germplasms. *Journal of Agricultural Physics*, *18*(1), 135-140. http://www.agrophysics.in

Ares, A., Falcao, N., Yuyama, K., Yost, R. S., & Clement, C.R. (2003). Response to fertilization and nutrient deficiency diagnostics in peach palm in Central Amazonia. *Nutrient Cycling in Agroecosystems, 66*(3), 221-232. https://doi.org/10.1023/A:1024458823052

Barne, V. G., Bharad, S. G., Dod, V. N., & Baviskar, M. N. (2011). Effect of integrated nutrient management on yield and quality of Guava. *The Asian Journal of Horticulture, 6*(2), 546-548.

Das, B., Nath, V., Jana, B. R., Kumar, S., & Dey, P. (2007). Evaluation of different methods of crop regulation in guava grown under rainfed plateau conditions of Eastern India. *Indian Journal of Horticulture*, *64*(3), 294-299.

Kumar, K., Adak, T., & Singh, V. K. (2017). Green manuring and nutrient management impacting soil properties and sustainability of mango orchard. *Journal of Soil and Water Conservation, 16*(1), 72-78. https://doi.org/10.5958/2455-7145.2017.00013.3

Montanaro, G., Xiloyannis, C., Nuzzo, V., & Dichio, B. (2017). Orchard management, soil organic carbon and ecosystem services in Mediterranean fruit tree crops. *Scientia Horticulturae*, *217*, 92-101. https://doi.org/10.1016/j.scienta.2017.01.012

Morales-Sillero., A., Fernández., J. E., Ordovás., J., Suárez., M. P., Pérez., J. A., Liñán., J., López., E. P., Girón. I., & Troncoso, A. (2009). Plant-soil interactions in a fertigated 'Manzanilla de Sevilla' olive orchard. *Plant and Soil*, *319*(1-2), 147-162. https://doi.org/10.1007/s11104-008-9857-0

Neilsen, G., Forge, T., Angers, D., Neilsen, D., & Hogue, E. (2014) Suitable orchard floor management strategies in organic apple orchards that augment soil organic matter and maintain tree performance. *Plant and Soil, 378*, 325–335. https://doi.org/10.1007/s11104-014-2034-8

Patel, R. K., Maiti, C. S., Deka, B. C., Deshmukh, N. A., & Nath, A. (2013). Changes in sugars, pectin and antioxidants of guava (*Psidium guajava*) fruits during fruit growth and maturity. *Indian Journal of Agricultural Sciences, 83*(10), 1017-1021.

Ranganna, R. (2001). Handbook of analysis and quality control for fruit and vegetable products, 2nd edition, Tata Mcgraw Hill, pp. 860-861.

Singh, R. P., Das, S. K., Bhaskar Rao, U. M., & Narayana Reddy, M. (1990). Towards Sustainable Dryland Agricultural Practices. CRIDA, Hyderabad, India.

Sheoran, O. P., Tonk, D. S., Kaushik, L. S., Hasija, R.C., & Pannu, R.S. (1998). Statistical Software Package for Agricultural Research Workers. *Recent Advances in Information Theory, Statistics & Computer Applications by D.S. Hooda & R.C. Hasija Department of Mathematics Statistics, CCS HAU, Hisar* (pp. 139-143).

Wanjari, R. H., Singh, M. V., & Ghosh, P. K. (2004). Sustainable yield index: An approach to evaluate the sustainability of long-term intensive cropping systems in India. *Journal of Sustainable Agriculture*, *24*(4), 39-56. https://doi.org/10.1300/J064v24n04_05

Vittal, K. P. R., Maruthi Sankar, G. R., Singh H. P., & Samra, J. S. (2002). Sustainability of Practices of dryland agriculture: Methodology and assessment. All India Coordinated Research Project for Dryland Agriculture, Central Research Institute for Dryland Agriculture, Indian Council of Agricultural Research, Hyderabad - 500059, p. 100.

(Received : 06.02.2023; Revised : 17.12.2023; Accepted : 24.12.2023)