Agric Res J **58** (5) : 835-839, *October* 2021
DOI No. 10.5958/2395-146X.2021.00119.8

EFFECT OF ORGANIC MANURES AND BIOFERTILIZERS ON GROWTH, FRUIT QUALITY AND LEAF NUTRIENT STATUS OF GUAVA

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ABSTRACT

The study was conducted to investigate the effect of organic manures and biofertilizers on the vegetative growth, fruit quality and leaf nutrient status of guava. The treatments consisted of the application of vermicompost, Azotobacter, Azospirillum, phosphorous solubilising bacteria (PSB) and farmyard manure (FYM) in different doses and combinations along with a control in which only inorganic fertilizers were applied. Combined application of vermicompost (30 kg/ Plant) + Azospirillum @ 250 g/tree + PSB @250 g/tree resulted in maximum plant height, canopy spread, trunk girth, fruit weight, TSS, total sugars and vitamin C while maintaining yield at par with inorganic fertilizers treatment. Maximum leaf P and K content was recorded in treatment consisting of vermicompost (30 kg/ plant) + Azospirillum @ 150 g/tree + PSB @150 g/tree but maximum leaf N content was recorded under FYM (30 kg/ plant) + Azospirillum @ 250 g/tree + PSB @250 g/tree. Use of biofertilizers with organic manures was found to be a good approach for production of quality guava fruits without compromising the yield.

Keywords: Guava, Biofertilizers, Vermicompost

Guava (*Psidium guajava* L.) is an important fruit crop grown in both tropical and the subtropical regions of the world. It is often known as “apple of the tropics” due to its high nutritive properties particularly the vitamin C content. In India, it is the fourth most important fruit crop after mango, banana and citrus in terms of area and fifth in terms of production. India enjoys a prestigious position in world guava production with an annual production of 4054 thousand metric tonnes from an area of 268 thousand hectare (NHB, 2019). Guava outruns majority of other fruit crops in terms of productivity, adaptability, tolerance to wide range of soil and climatic conditions. It bears fruits twice a year i.e. during rainy season and winter season in northern India and thus becomes a popular choice among fruit growers for assured income around the year. Guava trees remove large amount of nutrients from soil which necessitate the application of balanced amount of fertilizers for maintaining the productivity of guava trees. Role of nitrogen in production of fruit crops is well known. There is no surprise that consumption of NPK fertilizers in India has increased from 60 lakh tonnes to 260 lakh tonnes from 1981 to 2018. However, continuous use of heavy doses of chemical fertilizers and pesticides has led to the deterioration of soil fertility and soil health. The occurrence of multi-nutrient deficiencies and decrease in productive capacity of soil have been widely reported (Chhonkar, 2008). Additionally, the high cost of inorganic fertilizers along with wastage of nutrients caused through leaching, volatilization and denitrification cause severe economic loss to growers. Consequently, the use of organic manures and biofertilizers which are safe for humans and environment is gaining the attention of researchers. Biofertilizers, carrier based microbial inoculates containing living microorganisms, are known to increase productivity either by fixing atmospheric nitrogen or solubilising phosphorous or producing growth promoting substances in the rhizosphere.

Biofertilizers improve physical, chemical, and biological properties of soil which are indicators of an enhanced soil health and thus lead to sustainability of crop production (Ramesh *et al.,* 2010). Biofertilizers are cheaper than inorganic fertilizers, eco-friendly and sustainable as their manufacturing do not require exhaustible energy sources. Under established conventional farming system, organic matter faces a diminishing trend and needs strategy to increase its level in the soil which will facilitate to restore the optimal microbial population in soil. Studies by Kukal *et al.* (2009) in a rice-wheat system, for a period of 32 years showed that farmyard manure application at 20 t ha^{-1} resulted in 17% increase in organic carbon content compared with NPK fertilizers. It is therefore, advantageous that an approach for organic nutrient supply should be developed by using a judicious mixture of biofertilizers and organic sources. *Azotobacter, Azospirillum, Glomus fasciculatum, Glomus mosseae*, PSB (phosphorous solubilising bacteria) in combination with organic manures like farmyard manure and vermicompost have

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Date of receipt: 16.07.2020, Date of acceptance: 31.10.2021

been found useful for many horticultural crops (Bora *et al.,* 2016). The presence of substances such as humic acid and plant growth hormones in vermicompost, formed by interactions between microorganisms and earthworms, has also been reported as a potential factor contributing to increased plant growth, microbiological processes and yield. Among the biofertilizers, *Azotobacter* (free living) and *Azospirillum* (Associative symbiotic) are nitrogen fixing bacteria and can fix about 20-40 kg N/ ha under field conditions and thus capable of substituting up to 50 per cent of nitrogen requirement as has been reported in banana by Tiwary *et al.* (1998). Moreover, the awareness of the consumer for the organic production of fruits is increasing day by day.

Keeping these aspects in view, the present study was undertaken to assess the effect of different combinations of biofertilizers (nitrogen fixing and phosphorus solubilising) and organic manures (vermicompost and farmyard manure) on growth, yield and quality of guava *cv.* Allahabad Safeda.

MATERIALS AND METHODS

This experiment was conducted in year 2017-19 at Fruit Research Farm, Department of Fruit Science, Punjab Agricultural University, Ludhiana, Punjab, India on five year old guava trees. The experiment was laid out by randomized block design with nine treatments and three replications. The treatment combinations were as under:

T_1: Vermicompost @ 30 kg/Plant + *Azotobacte*r @ 150 g/tree + phosphorous solubilising bacteria (PSB) @150 g/tree,

T_2: Vermicompost @ 30 kg/Plant + *Azotobacter* @ 250 g/tree + PSB @ 250 g/tree),

T_3: Vermicompost @ 30 kg/Plant + *Azospirillum* @ 150 g/tree + PSB @ 150 g/tree),

T_4: Vermicompost @ 30 kg/Plant + *Azospirillum* @ 250 g/tree + PSB @ 250 g/tree),

T_5: Farm yard manure (FYM) @30 kg/Plant + *Azotobacter* @150 g/tree + PSB @150 g/tree),

T_6: FYM @ 30 kg/Plant + *Azotobacter* @ 250 g/tree + PSB @ 250 g/tree),

T_7: FYM @ 30 kg/Plant + *Azospirillum* @ 150 g/tree + PSB @ 150 g/tree),

T_8: FYM @ 30 kg/Plant + *Azospirillum* @ 250 g/tree + PSB @ 250 g/tree),

T_9: Recommended dose of inorganic fertilizers (urea 450 g, single super phosphate 1750 g and muriate of potash 800 g per tree)

Full doses of FYM, vermicompost and biofertilizers were applied as per various treatments in first week of July in the tree basin. The biofertilizers were applied uniformly under tree canopy mixed thoroughly with FYM or vermicompost as per treatment. Chemical fertilizers in recommended dose (urea 450 g, single super phosphate 1750 g and muriate of potash 800 g per tree) were applied only in control treatment (T_9) in two split doses. Half of the fertilizers were applied in June and half was applied in September by broadcasting in the tree basin. Fertilizers were applied after regulating the rainy season crop for obtaining winter season crop of guava, using 600 ppm NAA applied at full bloom stage in the second week of May. Growth parameters of the plant were determined twice i.e. before and after application of treatment. Tree height and spread was measured and trunk girth of guava plant was measured by using measuring tape at the ground level. At harvest, sample of ten fruits at mature green stage was taken and their weight was recorded using digital balance. Yield was calculated by multiplying the number of fruits harvested from the tree with average weight of a fruit. Fruit quality parameters, namely total soluble solids, acidity and total sugars were determined as per standard procedures given in AOAC (2005). The ascorbic acid was estimated by using 2, 6-dichlorphenol-indophenol dye method as described by Ranganna (2000) and expressed in percentage. For leaf nutrient analysis, third pair of recently matured leaves was collected in December (at harvest). The samples were decontaminated and dried powder of leaf was used for analyzing total nitrogen (by microkjeldhal method), phosphorus (by vanado-molybdo-phosphoric yellow colour method) and potassium (by flame photometer method). The data was subjected to analysis of variance using CPCS1 statistical programme. The treatment effects were tested at 5 per cent level of significance.

RESULTS AND DISCUSSION

It is clear from the data (Table 1) that vegetative growth of guava was significantly influenced with the application of organic manures and biofertilizers. During the experimentation, significant higher increase in tree height (4.25 %) and spread (3.85 %) was recorded with incorporation of vermicompost (30 kg/ plant) + *Azospirillum* @250 g/plant + PSB @250 g/ plant (T_4) followed by the treatment of FYM (30 kg/ plant) + *Azospirillum* @250 g/tree + PSB @250 g/tree (T_8) where 3.86 per cent increase in tree height and 3.40 per cent increase in tree spread was recorded. But when compared with recommended dose of fertilizers (T_9) the differences were non-significant. However, the minimum growth was recorded under FYM (30 kg/plant) + *Azotobacter* @150 g/tree + PSB @150 g/tree (T_5) treatment. The fact that tree applied with vermicompost , *Azospirillum* @ 250 g/tree + PSB @ 250 g/tree produced maximum tree height, spread and girth could be attributed due to valuable effect of microbes present

Table 1. Effect of organic manures and biofertilizers on growth parameters of guava

Treatment	Tree height (m)			Stem girth (cm)			Tree spread(m)		
	Initial	After harvest	Percentage increase	Initial	After harvest	Percentage increase	Initial	After harvest	Percentage increase
T_1	4.23	4.31	1.89	24.55	30.20	23.01	5.25	5.42	3.24
T_2	3.92	4.05	3.31	29.47	38.17	29.52	5.04	5.20	3.17
T_3	4.07	4.17	2.45	27.67	35.24	27.36	5.18	5.34	3.09
T_4	4.23	4.41	4.25	26.25	40.30	53.52	4.93	5.12	3.85
T_5	4.20	4.25	1.19	29.63	35.83	20.92	4.10	4.24	3.41
T_6	4.53	4.63	2.20	33.87	42.33	24.98	4.35	4.51	3.68
T_7	3.97	4.06	2.26	32.25	40.83	26.60	5.20	5.35	2.88
T_8	3.37	3.50	3.86	25.4	35.00	37.80	5.29	5.47	3.40
T_9	4.13	4.27	3.38	25.4	34.17	34.53	5.43	5.61	3.31
CD at 5%	0.52	0.57		1.82	1.92		0.27	0.28	

in the rhizosphere leading to higher mobilization of solute to the roots and thus the improvement in tree growth behaviour. Nitrogen fixing biofertilizers mainly *Azospirillum* and *Azotobacter* produce growth-promoting hormone like IAA which is absorbed by the roots which could be one of the reasons for increase in vegetative growth (Marathe and Bharambe, 2007).

The data on leaf nutrient status presented in Table 2 reveals that after fruit harvest, maximum leaf nitrogen (2.68%) was recorded with the treatment comprising of FYM (30 kg/plant) + *Azospirillum* @250 g/plant + PSB @250 g/plant (T_8) followed by the treatment of vermicompost (30 Kg/plant) + *Azospirillum* @250 g/plant + PSB @250 g/plant (T_4) having nitrogen content 2.52 per cent. While, minimum nitrogen content (2.14 %) was recorded under FYM (30 kg/plant) + *Azospirillum* @150 g/tree + PSB @150 g/tree (T_7) treatment. This is an indication of the fact that *Azospirillum* and vermicompost increased the vegetative growth by virtue of their nutrient releasing properties. The increase in leaf N content due to *Azospirillum* can be attributed to its nitrogen fixing properties as well its role in better absorption of water and nutrients. The maximum leaf P (0.24 %) was recorded in treatment containing vermicompost (30 kg/ Plant) + *Azospirillum* @ 150 g/tree + PSB @150 g/tree (T_3) which was statistically at par with T_1, T_2, T_6 and T_7 treatments. The P content in leaf improved by application of different combinations of organic manure and biofertilizers is probably due to the fact that phosphorus solubilising microbes applied through the treatments solubilised the fixed P and made it easily available to the plant. The highest amount of potassium in leaf (0.87 %) after fruit harvest was found under the treatment of vermicompost (30 kg/plant) + *Azospirillum* @150 g/plant + PSB @150 g/plant (T_3) which was statistically at par with T_2, T_4, T_6, T_7 and T_8 treatments. While minimum potassium content of 0.53 per cent was recorded under control (T_9). It should be noted that microorganisms are the main agents of nutrient mineralization, being that about 90 per cent of nutrients are mineralized by microorganisms, making them available in the soil solution and, consequently,

Table 2. Effect of organic manures and biofertilizers on leaf nitrogen, phosphorus and potassium content of guava

Treatment	Nitrogen (%)	Phosphorus (%)	Potassium (%)
T_1	2.18	0.21	0.60
T_2	2.28	0.21	0.73
T_3	2.15	0.24	0.87
T_4	2.52	0.18	0.73
T_5	2.05	0.18	0.60
T_6	2.29	0.21	0.73
T_7	2.14	0.23	0.73
T_8	2.68	0.18	0.73
T_9	2.22	0.16	0.53
CD@5%	0.10	0.04	0.17

Table 3. Effect of organic manures and biofertilizers on physical parameters of guava fruit and yield per tree

Treatments	Average Fruit weight (g)	Length of fruit (cm)	Breadth of Fruit (cm)	Average fruit yield (kg plant^{-1})
T_1	156.33	6.27	7.03	27.78
T_2	177.67	7.73	6.53	51.68
T_3	200.00	7.77	7.93	51.19
T_4	212.33	8.20	7.77	66.72
T_5	137.33	7.08	6.07	34.56
T_6	202.00	8.13	6.93	35.19
T_7	192.67	7.83	7.17	47.99
T_8	207.33	7.93	7.23	61.65
T_9	209.33	8.33	7.83	67.87
CD@ 5%	13.2	1.15	1.23	5.48

in plants. Pathak and Ram (2005) also reported similar effect of organic sources of nutrients on leaf nutrient content in guava.

Physical parameters of guava fruits

Perusal of data presented in Table 3 with respect to physical parameters shows that there was significant variation due to various combinations of biofertilizers and manures. Data revealed that the maximum fruit weight (212.33 g), fruit breadth (7.93 cm) was obtained in the treatment Vermicompost @ 30 kg/Plant + *Azospirillum* @ 250 g/tree + PSB @ 250 g/tree (T_4). This was closely followed by treatment T_9 in which trees received full dose of inorganic fertilizers and average fruit weight was recorded to be 209.33 g. Also the fruit length (8.33 cm) was the highest in this treatment. The minimum fruit length of 6.27 cm was recorded in vermicompost (30 kg/plant) + *Azotobacter* @150 g/tree + PSB @150 g/tree (T_1) treatment. The increase in fruit weight was attributed to the corresponding increase in length and diameter. The beneficial effect of vermicompost and biofertilizers on fruit size of guava could be attributed to the fact that vermicompost after proper decomposition and mineralization supplied available nutrients directly to the trees along with solubilizing effect of biofertilizers (PSB) on fixed forms of nutrients in soil. These organic sources of nutrients are also known to accelerate mobility of photosynthates from source to sink owing to release or synthesis of growth hormones which probably promoted increase in fruit size. Devi *et al.* (2012) also concluded that the addition of biofertilizers along with organic manures was more effective than use of organic manures alone in enhancing fruit growth parameters.

Combination of biofertilizers along with vermicompost was effective in maintaining the guava productivity when compared with inorganic fertilizers and a slightly higher dose of biofertilizers, that is, 250 g per tree as compared to 150 g per tree was more effective when applied with organic manure. Data presented in Table 3 revealed that maximum fruit yield (67.87 kg per plant) was obtained with the application

Table 4. Effect of organic manures and biofertilizers on biochemical composition of guava

Treatment	TSS (%)	Titratable acidity (%)	Reducing sugars (%)	Non-reducing sugars (%)	Ascorbic acid (mg/ 100 gm)
T_1	7.43	0.41	4.43	2.55	143.75
T_2	7.70	0.50	4.97	2.65	151.25
T_3	8.07	0.49	4.70	2.60	150.33
T_4	8.27	0.47	5.46	2.70	157.42
T_5	7.13	0.52	4.80	2.50	132.08
T_6	7.70	0.37	4.57	2.60	145.42
T_7	7.47	0.41	4.57	2.63	153.08
T_8	7.83	0.37	3.73	2.79	139.58
T_9	7.50	0.31	4.63	2.90	129.17
CD@ 5%	0.37	0.12	0.33	0.10	12.94

of inorganic fertilizers however, it was statistically at par with that obtained with Vermicompost @ 30 kg/ Plant + *Azospirillum* @ 250 g/tree + PSB @ 250 g/tree (T_4). Among the combinations, the yield improvement was especially marked when *Azosprillium* was one of the components. The enhanced growth and yield of the plants in response to dual inoculum containing *Azospirillum* and PSB that might be due to more availability of P made available by PSB coupled with better nitrogen fixation by *Azospirillum* in the rhizosphere. These findings are in line with Dey *et al*. (2005) who reported an increase in the physical characteristics of guava with the application of biofertilizers and organic manure alone.

Combination of organic manures and different levels of biofertilizers significantly influenced the chemical composition of fruits (Table 4). Data showed that the highest total soluble solids TSS (8.27 %), reducing and non-reducing sugars (5.46 and 2.47 %) and ascorbic acid (157.42 mg/100g) were recorded in the treatment vermicompost @ 30 kg/plant + *Azospirillum* @ 250 g/tree + PSB @ 250 g/tree (T_4). Minimum total soluble solid content of 7.13 per cent was recorded in fruits produced by the treatment of FYM (30 kg/ plant) + *Azotobacter* @150 g/plant + PSB @150 g/ plant (T_5). Thus, out of *Azospirillum* and *Azotobacter*, *Azospirillum* could be considered to be superior to its counterpart in the improvement of guava fruit quality since with the application of *Azospirillum* spp. best results were obtained in TSS values. The increased fruit quality may be explained from the fact that these microbial fertilizers increased the nutrient availability and enhanced the capability of plants to better solute uptake from rhizosphere as evident from data on leaf nutrient status. The organic manures and biofertilizers also act source of micronutrients which play important role in reproductive phase of plant. Additionally plant promoting substances, vitamins and amino acid content produced by microorganism of biofertilizers might have possibly been a reason of the improvement in quality of the fruit (Sharma *et al.*, 2009). Thus the guava fertilized with biofertilizers produced better quality fruits than plants receiving inorganic fertilizers only.

Present studies suggest that the biofertilizers can be used to obtain quality guava fruits without compromising the yield. Since combination of nitrogen fixing bacteria and PSB with organic manures significantly increased the growth, quality and leaf nutrient content of guava. Thus the use of *Azospirillum* and PSB along with vermicompost was found as a good approach for production of quality guava fruits.

Authors' contribution

Conceptualization and designing of the research work (GK, NKA); Execution of field/lab experiments and data collection, (MR,GK); Analysis of data and interpretation (GK, KK); Preparation of manuscript (KK,GK).

LITERATURE CITED

AOAC 2005. *Official methods of analysis of AOAC International*. (18th ed) AOAC MD, USA.

Bora L, Tripathi A, Bajeli J, Chaubey A K and Chander S 2016. A Review on Microbial Association: Its Potential and Future Prospects in Fruit Crops. *Plant Archives* **16**: 1-11.

Chhonkar P K 2008. Organic farming and its relevance in India. In *Organic Agriculture,* Tarafdar J C, Tripathi K P and Mahesh Kumar (eds.). Scientific Publishers, Jodhpur, India, pp. 5-33.

Devi H L, Mitra S K and Poi S C 2012. Effect of different organic and biofertilizer sources on guava (*Psidium guajava* L.) *cv*. Sardar. *Acta Hort* **959**: 201-08.

Dey P, Rai M, Nath V, Das B and Reddy N N 2005. Effect of biofertilizer on physico-chemical characteristics of guava fruit. *Indian J Agric Sci* **75**: 95-96.

Kukal S S, Rehanna R and Benbi D K 2009. Soil organic carbon sequestration in relation to organic and inorganic fertilization in rice-wheat and maize-wheat systems. *Soil Tillage Res* **102**: 87-92.

Marathe R A and Bharambe P R 2007. Micrological population in rizosphere as affected by organic, inorganic and biofertilizer and their influence on soil and leaf nutrient status of sweet orange. *PKV Res J* **29**: 20-23.

NHB 2019. *Indian Horticulture Database*. National Horticulture Board, Ministry Of Agriculture Government of India. *www.nhb.gov.in*

Pathak R K and Ram R A 2005. Integration of organic farming practices for sustainable production of guava. **In**: First International Guava Symposium, 5-8 Dec, 2005, CISH, Lucknow, India, pp.144-45.

Ramesh P, Parwar N R, Singh A B, Ramana S, Yadav S K, Shrivastava R and Rao A S 2010. Status of organic farming in India. *Current Sci* **98**: 1190-94.

Ranganna S 2000. *Handbook of analysis and quality control for fruit and vegetable products.* 652p. (6th ed.). Tata McGraw-Hill Publishing Co. Ltd, New Delhi.

Sharma A, Kher R, Wali V K and Bakshi P 2009. Effect of biofertilizers and organic manures on physico-chemical characteristics and soil nutrient composition of guava (*Psidium guajava* L.) *cv.* Sardar. *Sher-e-Kashmir Univ Agric Sci and Tech J Res* **8**: 150-56.

Tiwary D K, Hasan M A and Chattopadhyay P K 1998. Effect of bio-fertilizers on soil nutrient status and microbial population in banana (Musa AAA) subgroup Cavendish *cv*. Giant Governor plantation. *Environ Ecol* **17**: 338-41.