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Impact of organic manures and inorganic fertilizers on growth, yield, nutrient uptake and soil nutrient status in guava

Y.V. Trivedi, N.L. Patel*, T.R. Ahlawat, S.S. Gaikwad and P.P. Bhalerao
Department of Fruit Science, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari 396 450

ABSTRACT

A two-year field trial was conducted from 2005 to 2007 at Regional Horticultural Research Station, NAU, Navsari to assess the response of guava varieties to the application of organic manures, inorganic fertilizers and biofertilizers. The trial was conducted in a randomized block design with factorial concept and three replications. Results revealed significant differences amongst various growth attributes, fruit yield, leaf nutrient uptake and soil nutrient availability due to varieties, organic manures and biofertilizers. Of the two varieties, Sardar recorded greater plant height, plant spread and nitrogen uptake than Allahabad Safeda. Whereas, Allahabad Safeda registered higher TSS and available N, P_2O_5 and K_2O contents in the soil. Amongst the various organic amendments, application of castor cake resulted in the maximum plant height and available N. The maximum East-West plant spread and the highest potassium uptake was noted under biocompost treatment. The maximum available P_2O_5 and K_2O were also observed with biocompost application. Incorporation of vermicompost resulted in the maximum nitrogen uptake and that of FYM resulted in the maximum phosphorus uptake and organic carbon content in the soil. Addition of biofertilizers recorded higher fruit yield and available P_2O_5 content in the soil.

Key words: Guava, growth, organic manures, fruit yield, nutrient uptake.

INTRODUCTION

Guava (*Psidiuim guavaja* L.) is one of the most common fruit in India. It has assumed significance owing to its hardy nature and prolific bearing even under marginal lands. Its cultivation requires little care and minimal inputs. It also scores over other fruit crops when it comes to productivity, adaptability and vitamin C content. Guava has a well established market in over sixty countries through out the tropics and subtropics including some of the Mediterranean areas. Indiscriminate use of chemical fertilizers aimed at the yield maximization has given rise to several problems associated with soil health, crop management and the environment. There is a growing realization for the necessity of an alternative agriculture method which can function in an eco-friendly method in sustaining and increasing crop productivity. During the last few years, organic farming has emerged as an alternative form of production which not only promises healthy food but also addresses the environmental and sustainability concerns without loosing out on productivity. Organic amendments are an effective means for improving soil aggregation, structure and fertility, increasing microbial diversity and populations, improving the moisture-holding capacity of soils, increasing the soil cation exchange capacity (CEC) and consequently crop yields (Zink and Allen, 21). Keeping in view the importance of organic amendments, the present study was undertaken to study the influence of organic amendments on growth, yield and nutrient uptake of guava. The effect of these amendments on soil nutrients availability was also assessed.

MATERIALS AND METHODS

The present investigation was carried out at the Regional Horticultural Research Station, Navsari Agricultural University, Navsari, India from 2005 to 2007. Thirty trees each of 'Allahabad Safeda' and 'Sardar' were selected from an orchard planted at a distance of 6 m × 6 m in 1994. The experiment comprised of three factors, *viz*., variety [Allahabad Safeda (V_1) and Sardar (V_2)], manure [recommended dose of fertilizers (M_1), FYM (M_2), castor cake (M_3) biocompost (M_4) and vermicompost (M_5)] and biofertilizer [no biofertilizers (B_1) and biofertilizers (B_2)]. These treatments were replicated thrice in a randomized block design with factorial concept. The entire quantity of organic manure was applied on dry weight basis. The chemical composition of different organic manures is given in Table 1. The recommended dose of fertilizers (40 kg FYM and 500-250-250 g NPK/tree) was applied as per the recommendation made by Navsari Agricultural University after the pruning of guava trees. *Azotobacter* and phosphate solublizing bacteria were applied at the rate of 100

*Corresponding author's E-mail: nlpatel_1559@yahoo.co.in

Table 1. Chemical composition of organic manures.

Manure	N	P_2O_5	K_2O	S	Cu	Fe	Mn	Zn
			2005					
		(%)				(mg/kg)		
FYM	1.24	0.32	0.84	0.67	55.00	7803	510.70	256.70
Castor cake	4.24	1.73	1.30	0.48	30.00	1022	44.00	54.00
Biocompost	1.00	3.45	2.08	0.89	54.10	3425	327.70	134.30
Vermicompost	1.00	0.94	1.42	0.48	12.00	1050	96.00	12.70
			2006					
FYM	0.80	0.28	0.76	0.61	51.00	7856	514.00	250.00
Castor cake	4.14	1.69	1.36	0.52	34.00	1036	41.02	56.36
Biocompost	1.00	3.51	2.00	0.92	58.36	3568	336.87	139.58
Vermicompost	1.00	0.86	1.40	0.41	12.69	1121	98.65	13.47

g/tree in the 1st week of June. Other recommended agricultural practices and plant protection measures were adopted as and when required.

Soil samples were collected from a depth of 0-30 cm and about 1.5 m distance from trunk. Available N and K_2O were analyzed as per Jackson (8). Available P_2O_5 and S were estimated by following the method as described by Olsen (12), and Williams and Steinberg (20). The powdered material of leaves was preserved and used for estimating total N, P and K contents. Nitrogen was estimated by the modified Kjeldahl digestion method, phosphorus by Vanado molybdate phosphoric acid method and potassium by the flame photometer method (Jackson, 8) respectively. In addition to the above observations were also recorded on plant height, plant spread, fruit yield and TSS.

RESULTS AND DISCUSSION

Results revealed significant differences amongst various growth attributes and fruit yield in guava due to varieties, organic manures and biofertilizers (Table 2). The two varieties differed significantly for plant height, plant spread and TSS. Variety Sardar recorded greater plant height (4.75 m) and plant spread [East-West (6.01 m) and North-South (5.98 m)] than Allahabad Safeda. This may be due to the fact that trees of Sardar variety are more vigorous in growth and exhibit heavy branching. These results are in line with the findings of Anon (2) in guava. Higher TSS (12.42%) was observed in Allahabad Safeda as compared to Sardar. This is in accordance with an earlier report by Teotia *et al.* (16). However, there was no significant difference between Allahabad Safeda and Sardar for fruit yield.

Organic amendments also exerted a significant effect on plant height and plant spread (East-West). Treatment M_3 (castor cake) noted significantly the maximum plant height (4.75 m), which was at par with M_2 (FYM) and M_4 (bio-compost) treatments. Whereas, the maximum East-West spread (5.72 m) was registered with the application of bio-compost (M_4), which was at par with FYM (M_2), castor cake (M_3) and vermicompost (M_2) treatments. These observations corroborate the findings of Chaudhary *et al*. (5) in guava. Castor cake has higher nitrogen content as compared to other organic manures and it releases this nitrogen gradually, thereby providing slow and steady nourishment to the plants. Incorporation of biocompost and vermicompost could have led to better mobilization of bound nutrients and improvement in the physical condition of the soil facilitating deeper penetration of the roots and higher nutrients extraction from the soil. This in turn might have enabled the plant to put up better growth leading to greater plant height.

FYM being a bulky organic material, releases soil compaction and improves soil aeration in addition to the supply of essential plant nutrients and organic matter, thereby increasing the soil's biological activities. FYM also provided room for better microbial establishment along with the accumulation of excess humus content (Hayworth *et al*., 7). Phenolic compounds liberated during the decomposition of organic matter also have favourable effects on plant growth. A similar increase in plant growth with the application of organic manures was noticed by in sapota (Anon., 1).

There was no significant effect of organic amendments on North-South plant spread, fruit yield and TSS (%). However, the maximum yield (8769.10 kg/ha) was recorded with the application of vermicompost (M_5) followed by the FYM (M_2). This might be due to the fact that application of vermicompost improved the physical, chemical

Table 2. Growth and yield of guava cultivars as influenced by organic and inorganic manuring treatments.

Treatment	Plant height (m)	Plant spread (m)		Yield (kg/ha)	TSS (%)
		East-West	North-South		
Variety					
V_1	4.27	5.00	5.25	6204.30	12.42
V_2	4.75	6.01	5.98	9556.76	11.69
CD (*P* = 0.05)	0.174	0.222	0.248	NS	0.350
Manure					
M_1	4.32	5.04	5.37	7070.95	10.77
M_2	4.52	5.45	5.93	8147.68	13.07
M_3	4.75	5.62	5.54	7599.54	11.68
M_4	4.53	5.72	5.72	7815.39	12.77
M_5	4.42	5.69	5.52	8769.110	11.96
CD (*P* = 0.05)	0.270	0.341	NS	NS	NS
Biofertilizer					
B_1	4.47	5.51	5.58	7593.01	12.07
B_2	4.55	5.50	5.65	8168.05	12.01
CD (*P* = 0.05)	NS	NS	NS	364.550	NS
CV %	10.64	10.98	12.07	12.77	8.02

and biological properties of the soil. It is also a rich source of macro and micronutrients in plant available form such as nitrates, phosphate and exchangeable calcium and soluble potassium thereby facilitating their easy and quick uptake (Orozco *et al.*, 13). The results are in close conformity with those reported by Ushakumari *et al*. (18) in banana.

Significant differences were observed between the two biofertilizer treatments with regard to fruit yield. Application of biofertilizers (B_2) recorded higher fruit yield (8,168.05 kg/ha) than nil application (B_1). The possible reasons for increased fruit yield may be attributed to better inorganic utilization in the presence of *Azotobacter,* enhanced biological nitrogen fixation, better development of root system and possibly higher synthesis of plant growth hormones (Mishustin and Naumova, 11; Pandey and Kumar, 14). According to Broadbent *et al.* (4) phosphate solubilizing microbes often provide protection against non parasitic pathogens, produce biologically active substances like auxins and gibberellins and transform unavailable minerals and organic compounds into forms available to the plant.

Total uptake of nitrogen, phosphorus and potash by guava leaves as influenced by genotype, organic amendments and biofertilizers is given in Table 3. Variety Sardar recorded greater nitrogen uptake (1.99%) than Allahabad Safeda. However, there was no significant effect of varieties on the phosphorus and potassium contents of the leaves.

Nutrient uptake was also significantly influenced by the application of organic amendments. Maximum nitrogen content (1.97%) was observed in treatment M_5 (vermicompost), which was at par with the treatments M_2 (FYM) and M_3 (castor cake). Application of FYM (M_2) recorded the maximum phosphorus uptake (0.21%) and it was at par with the biocompost treatment (M_4). The highest potassium uptake (1.50%) was also noted under M_4 (bio-compost) treatment and it was at par with castor cake (M_3) and vermicompost (M_5) applications. Application of organic manures increased the N, P and K content in the guava leaves as compared to RDF. Addition of organic manures might have led to better mineralization, availability and utilization of the available micronutrients by the plants.These results are in agreement with those reported by Patel (15) in banana. Nutrient uptake was not affected significantly by the application of biofertilizer.

Varieties had a significant effect on available N, P_2O_5 and K_2O content in the soil (Table 4). Higher availability of N, P_2O_5 and K_2O was reported under the variety Allahabad Safeda as compared to Sardar guava. However, organic carbon content did not differ significantly with the varieties. The treatment M_3 (castor cake) resulted in the maximum available N

Table 3. Effect to inorganic and organic fertilizers on leaf nutrient status of guava cultivars.

Treatment	Leaf nutrient status (%)		
	N	P	K
Variety			
V_1	1.76	0.19	1.42
V_2	1.99	0.20	1.40
CD (*P* = 0.05)	0.076	NS	NS
Manure			
M_1	1.75	0.18	1.31
M_2	1.93	0.21	1.36
M_3	1.89	0.19	1.44
M_4	1.84	0.20	1.50
M_5	1.97	0.19	1.44
CD (*P* = 0.05)	0.121	0.015	0.059
Biofertilizer			
B_1	1.89	0.20	1.41
B_2	1.86	0.19	1.41
CD (*P* = 0.05)	NS	NS	NS
CV %	11.16	13.68	7.51

content (233.92 kg/ha). The above treatment was at par with the application of the FYM (M_2). Higher nutrient availability under castor cake could be attributed to the direct addition and slow release of N, P and K from the manure. When FYM is added to the soil, complex nitrogenous compounds slowly break down and thereby provide a steady supply of N throughout the growth period of the crop which might have attributed to more N availability and its subsequent uptake (Chavan *et al.*, 6). Further beneficial effect of FYM on improving soil physical properties in terms of better root penetration might have also helped in increasing biomass and uptake as observed by Kaminwar and Rajagopal (11). The maximum available P_2O_5 (59.13 kg/ha) and K_2O (382.79 kg/ha) were recorded with the addition of biocompost (M_4), which was at par with the application of vermicompost (M_5) for available K_2O in the soil. Application of organic matter leads to the formation of coating on esquioxides whereby, P fixation of the soil is reduced. Similar results were reported by Bharadwaj and Omanwar (3).

Higher availability of K_2O in the soils might be due to the beneficial effect of organic manures on the reduction of K fixation. The added organic matter interacted with K-clay to release K from the non-exchangeable fraction to the available pool. The higher availability of macronutrients in vermicompost and castor cake treatments might be attributed to its inherent capacity to add good amount of organic carbon content to the soil which hastens the process of mineralization of organically bound macro-nutrients present in the native soil. Application of FYM (M_2) noted the maximum organic carbon (0.50%) content in the soil and was statistically at par with biocompost (M_4) and vermicompost (M_5) treatments. This corroborates an earlier findings by Kanwar and Parihar (10) stating that application of FYM increased the organic carbon content of the soil. These results clearly indicate that the application of organic amendments had a positive effect on the availability of all the macro-nutrients and organic carbon as compared to RDF. This is in accordance with the findings of Vasanthi and Kumaraswamy (19) in sapota.

It was observed that available P_2O_5 content in the soil was significantly affected by the application of bio-fertilizers (Table 4). Treatment B_2 (biofertilizers) registered higher available P_2O_5 (52.49 kg/ha) as compared to B_1 (no bio-fertilizers). This might be due to the production of organic acids by phosphate solublizing bacteria. The organic and inorganic acids convert tri-calciurn phosphates into di and monobasic phosphates resulting in enhanced availability to the plant. These results are in line with those reported by Tomar *et al.* (17). The effect of bio-fertilizers on available N, K_2O and organic carbon content in the soil was non-significant.

Table 4. Effect of inorganic and organic fertilizers on soil nutrients available in a guava cultivars.

Treatment	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)	Organic Carbon (%)
Variety				
V_1	223.38	53.30	378.93	0.50
V_2	221.78	49.42	368.37	0.50
CD (P = 0.05)	5.579	0.977	9.055	NS
Manure				
M_1	210.48	42.04	366.17	0.49
M_2	228.96	47.72	367.54	0.51
M_3	233.92	51.93	361.83	0.49
M_4	219.67	59.13	382.79	0.50
M_5	219.87	56.00	377.42	0.50
CD (P = 0.05)	8.821	1.550	14.318	0.013
Biofertilizer				
B_1	221.26	50.24	370.72	0.50
B_2	223.90	52.49	371.58	0.50
CD (P = 0.05)	NS	0.975	NS	NS
CV %	6.89	5.18	5.54	4.58

NB: All the interactions were found non-significant with respect to available N, P_2O_5, K_2O and organic carbon content in the soil.

Table 5. Interaction effect of V × B × M on yield (kg/ha) of guava.

Variety	V_1		V_2	
Manure	B_1	B_2	B_1	B_2
M_1	4941.20	6921.30	8185.18	8236.11
M_2	5365.74	5060.18	10312.96	11851.85
M_3	5893.52	4736.11	10305.55	9462.96
M_4	6293.98	6462.96	9083.33	9421.30
M_5	7381.94	8986.11	8166.67	10541.67
CD (P = 0.05)		1130.48		

Result revealed that the highest fruit yield, *i.e.*, 11851.85 kg/ha was obtained with the application of biofertilizers and FYM to variety Sardar (Table 2). It is evident from the result that application of organic amendments in guava favoured vegetative growth, encouraged nutrient uptake and enhanced soil nutrient availability. Whereas, biofertilizers proved most effective in increasing fruit yield. The highest fruit yield was obtained by the application of bio-fertilizers and FYM to variety Sardar.

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