Impact of organic fertilizers on guava (*Psidium guajava* L.) yield

ABSTRACT

The study was conducted at horticulture farm, Aroma College, Haridwar during summer season of 2022-23 to evaluate the performance of different organic source of nutrients on growth of Thai guava cv. VNR bihi. Therefore, biofertilizers were applied as per various treatments under the tree canopy. This experiment was designed in Randomized Block Design with three replicates. The highest fruit length (10.08 cm), Fruit breadth (12.90 cm), Average fruit weight (616.30 g), Number of fruits per plant (35), Yield (21.60 kg/plant), Number of seeds per fruit (287.00) to were found in T_{12} (Farmyard Manure + Poultry manure + Azotobacter + Phosphate Solubilizing Bacteria) From March to December every month followed by T_{11} (FYM + Poultry manure + PSB).The lowest of all these parameters were found in control T_{14} (8.77 cm, 9.97 cm, 524.02 g, 25. Number of fruits/plant, 13.28 kg/plant, 225.25 Number of seeds/ fruit) was recorded.

Keywords - Guava, Farmyard Manure, Phosphate Solubilizing Bacteria.

INTRODUCTION

The Myrtaceae family fruit guava (*Psidium guajava* L.) is one of the most important fruits in tropical and subtropical India. Guavas are native to Tropical America. The guava tree is distinguished by its smooth bark. They contain globose berries that range in colour from greenish-brown to brown, along with an inferior ovary, scaly, angular juvenile stems, and an abundance of stamens. The meat has several seeds embedded in it that can be red, pink, yellow, or white. The genus "*Psidium*" contains about 150 species, of which about 20 produced edible fruits. Grown up to 1500 meters above sea level, guavas are grown. It may thrive in a wide range of soil types, from extremely light sandy soil to deep clay soil. Because of its high vitamin C concentration (75–260 mg/100 g pulp) and plenty of minerals, guavas are referred to as the "*apple of the tropics*". Dietary fiber is one of the most important parts of the seed (Anonymous, 2009). Vitamin C fortifies our defenses against common illnesses and pathogens. Guavas contain appropriate levels of thiamine (0.03-0.07 mg/100 g pulp) and riboflavin (0.02-0.04 mg/100 g pulp). Together with minerals including phosphorus (22.5–40.0 mg/100 g pulp), calcium (10.0–30.0 mg/100 g pulp), and iron (20–25 mg/100 g pulp), guava 9 pulp also contains carbs, pectin (0.5–1.8%), and sugars. It also contains polyphenols, omega-3 and omega-6 fatty acids, and a class of potent antioxidants called carotenoids, which are derivatives of unsaturated fatty acids. Because guavas are consumed raw together with their pulp and skin, growing them organically is an option. The majority of Indian farmers are organic, but since the start of the green revolution a few years ago, artificial fertilizers and insecticides have been used much more frequently. This had negative effects on human health as well as the environment. Organic farming is slowly making a comeback. It uses organic resources including oil cakes, farmyard manure, leftover agricultural products, and animal feces. Synthetic agrochemicals are not used in organic farming. Keeping it in view, the present experiment was conducted with the following objectives: To study the effect of organic source of nutrients on yield and quality of guava.

MATERIALS AND METHOD

The experiment was conducted during summer season of 2022-23 at experimental site of Horticulture Farm, Distt Haridwar, and Uttarakhand by applying difference composition of following Farmyard Manure, poultry manure and others (1.) Farmyard Manure (100% replacement of nitrogen through FYM) (2.) Vermicompost (100% replacement of nitrogen through Vermicompost (3.) FYM + Poultry manure (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure) (4.) FYM + Azotobacter (150 ml/plant) (5.) FYM + PSB (150 ml/plant) (6.) FYM + Azotobacter + PSB (75 ml + 75 ml/plant) (7.) Vermicompost + Azotobacter (150 ml/plant) (8.) Vermicompost + PSB (150 ml/plant) (9.) Vermicompost + Azotobacter + PSB (75 ml + 75 ml/ plant) (10.) FYM + Poultry manure + Azotobacter (80% replacement of nitrogen through FYM +20% replacement of nitrogen through poultry manure) (11.) FYM + Poultry manure + PSB (80% replacement of nitrogen through FYM + 20%replacement of nitrogen through poultry manure) (12.) FYM + Poultry manure + Azotobacter + PSB (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure) (13.) 50% FYM + organic fertilizer Jeevamrit (4 litre per plant in 21 days interval) (14.) Control (no application). Full dose of organic manures and biofertilizers were incorporated in first week of March. Jeevamrit is applied in the field at 21 days interval. During March, after applying water through drip irrigation, the biofertilizers were applied as per various treatments under the tree canopy.

Variety : Thai guava cv. VNR bihi

Replications : 3

Number of plants per replication : 1

Age of plants : Two years old

Experimental Design : Randomized Block Design

Full dose of organic manures and biofertilizers were incorporated in first week of March. Jeevamrit is applied in the field at 21 days interval. During March, after applying water through drip irrigation, the biofertilizers were applied as per various treatments under the tree canopy. The chemical composition of different organic manures used for the experiment is given in Table.

List 1 : The chemical composition (N.P.K.) of different organic manures used for the experiment

Organic manure	**Nitrogen %**	**Phosphorus %**	**Potassium%**
Farmyard Manure	0.5	0.5	0.5
Vermicompost	1.8	0.7	1.5
Poultry Manure	2.8	2	2.2

Yield parameters

1.Fruit length (cm): Ten fruits were collected from each replication of all treatments during harvesting time and fruit length was calculated using vernier calliper in centimeters and average length was calculated.

2.Fruit breadth (cm): Ten fruits were collected from each replication of all treatments during harvesting time in rainy and winter season both and fruit breadth was calculated in centimeters using vernier calliper at the widest point and average breadth wascalculated.

3.Average fruit weight (g): From each replication of all treatments, ten fruits were taken during harvesting time in rainy and winter season and weighed on electronic balance and then mean weight was calculated.

4.Number of fruits per plant: Number of fruits for each replication of all treatments was calculated by simply counting their numbers before harvesting of guava fruit in rainy and winter season.

5.Yield (kg/plant): Number of fruits per plant and average fruit weight were calculated for each replication in rainy and winter season, then total yield (kg/plant) was calculated by simply multiplying number of fruits with average fruit weight (kg).

6.Number of seeds per fruit: In rainy and winter season both, the seeds of the selected fruits were extracted physically by macerating the pulp. The seeds were washed thoroughly and the numberof seeds per fruit was recorded treatment wise.

Results & Discussion :

1.Fruit length (cm): According to the data presented in Table 1 in the summer season, FYM + poultry manure + *Azotobacter* + PSB resulted in maximum fruit length of 9.00 cm, which was at par with FYM + poultry manure + PSB (8.83 cm), FYM + poultry manure + *Azotobacter* (8.77 cm), FYM + poultry manure (8.70 cm), and vermicompost + *Azotobacter* + Phosphate Solubilizing Bacteria (8.60 cm), whereas, control resulted in minimum fruit length of 7.73 cm. Similarly, the winter season, (Table .1) FYM + poultry manure + *Azotobacter* + PSB resulted in maximum fruit length of 10.08 cm which was at par with FYM + poultry manure + PSB (9.90 cm), FYM + poultry manure + *Azotobacter* (9.85 cm), whereas, the minimum fruit length (8.77 cm) was observed in control. Results revealed that in rainy season, the highest fruit length (9.00cm) was recorded with 80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure + *Azotobacter* + PSB which was at par with FYM + poultry manure + PSB (8.83 cm), FYM + poultry manure + *Azotobacter* (8.77 cm), FYM + poultry manure (8.70 *cm),* vermicompost + *Azotobacter* + Phosphate Solubilizing Bacteria (8.60 cm), whereas, control had resulted in minimum fruit length of 7.73 cm. Similarly, in the winter season, 80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure + *Azotobacter* +PSB had resulted in maximum fruit length of 10.08 cm which was at par with FYM + poultry manure + PSB (9.90 *cm),* FYM + poultry manure + *Azotobacter* (9.85 cm), whereas, the minimum fruit length (8.77 cm) was recorded in control. The present findings are in agreement with the findings that all the essential plant nutrients that are used by plants for growth and development are present in the poultry manure (Amanullah *et al.* 2010). More uptake of nutrients leads to better filling of fruits. As a result, fruit length increases. Microbial inoculants also play a significant role in increasing fruit size by releasing phytohormones especially gibberellins- and also, the efficient partitioning of photosynthesis towards the sink by *Azotobacter* inoculation increased the fruit size and weight (Rana and Chandel, 2003). The above results are in conformity with the verdicts of Hassan *et al.* (2015) in olive; Moustafa (2002) in Washington Navel orange; Dadashpour and Jouki (2012) in strawberry; Panelo and Diza (2017) in banana; Osman and El-Rhman (2010) in fig. Hegazi *et al.* (2007) observed that among different organic sources of nutrients, poultry manure was the most efficient in improving fruit physical properties of olive trees.

2. Fruit breadth (cm): According to the data in Table -1, the application of FYM + poultry manure + Azotobacter + PSB resulted in maximum fruit breadth of 9.56 cm during the rainy season, which was at par with FYM + poultry manure + PSB (9.17 cm), FYM + poultry manure + Azotobacter (9.00 cm), FYM + poultry manure (8.93 cm) and vermicompost + Azotobacter + PSB (8.90 cm), whereas, control had resulted in minimum fruit breadth of 8.13 cm. Similarly, in the winter season, (Table 1) the application of FYM + poultry manure + Azotobacter + Phosphate Solubilizing Bacteria had resulted in maximum fruit breadth of 12.90 cm, which was at par with FYM + poultry manure + PSB (12.73 cm), FYM + poultry manure + Azotobacter (12.43 cm) and FYM + poultry manure (12.43 cm), whereas, minimum fruit breadth was observed in control (9.97 cm). Fruit breadth differed significantly among all the treatments during both the rainy and winter season. Concerning the fruit breadth, data showed that fruit breadth was obtained more in the winter season as compared to rainy season fruits. In rainy season, maximum fruit breadth (9.56 cm) was recorded in 80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure + *Azotobacter* +PSB, which was at par with FYM + poultry manure + PSB (9.17 cm), FYM + poultry manure + *Azotobacter* (9.00 cm), FYM + poultry manure (8.93 cm) and vermicompost + *Azotobacter* + PSB (8.90 cm), whereas, control resulted in minimum fruit breadth of 8.13 cm. In winter season, 80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure + *Azotobacter* + PSB had resulted in maximum fruit breadth of 12.90 cm, which was at par with FYM + poultry manure + Phosphate Solubilizing Bacteria (12.73 cm), FYM +poultry manure + *Azotobacter* (12.43 cm) and FYM + poultry manure (12.43 cm), whereas, minimum fruit breadth was recorded in control (9.97 cm). According to Hegazi *et al.* (2007), poultry manure was the most efficient manure as compared to other organic sources, in influencing fruit physical properties of olive trees. As a result, it takes of more nutrients, which enhances carbohydrate synthesis and cell enlargement, hence fruit breadth increases. Dadashpour and Jouki, (2012) reported that marked improvement in fruit size is due to balance of nutrient availability to the plant and secretion of growth-promoting hormones by the biofertilizers. According to Sidahmed and Kliewer (1980) growth regulators also play a significant role in the mobilization of carbohydrates to the developing fruit and help in increasing berry size. This can be supported with findings by Hassan *et al.* (2015) in olive; Moustafa (2002) in Washington Navel orange; Dadashpour and Jouki (2012) in strawberry; Panelo and Diza (2017) in banana and Osman and El-Rhman (2010) in fig.

3. **Average fruit weight (g):** The average fruit weight from different sources of organic nutrients ranged from 460.83-531.43 g (Table 1) in the rainy season. The highest average fruit weight of 531.43 g was noticed with FYM + poultry manure + *Azotobacter* + PSB which was at par with FYM + poultry manure + PSB (524.32 g), FYM + poultry manure + *Azotobacter* (513.96 g), FYM + poultry manure (511.41g) and vermicompost + Azotobacter + PSB (510.40 g), while, control showed lowest average fruit weight of 460.83g. Similarly, in the winter season (Table 1), it ranged from 524.02-616.30 g. The highest fruit weight of 616.30 g was noticed with FYM + poultry manure + *Azotobacter* + PSB which was at par with FYM + poultry manure + (613.47 g), FYM + poultry manure + *Azotobacter* (596.05 g), FYM + poultry manure (589.33 g) and vermicompost + 52 *Azotobacter* + (580.38 g), while, control showed lowest average fruit weight of 524.02 g. Different organic treatments had a significant effect on average fruit weight. It was recorded that the average fruit weight in winter season was higher than in the rainy season. The maximum average fruit weight (531.43 g) in rainy season was recorded in 80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure + *Azotobacter* + PSB which was at par with FYM + poultry manure + PSB (524.32 g), FYM + poultry manure + *Azotobacter* (513.96 g), FYM + poultry manure (511.41g) and vermicompost + *Azotobacter* + PSB (510.40 g), while, control showed minimum average fruit weight (460.83 g). In the winter season, the highest fruit weight (616.30 g) was noticed with 80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure + *Azotobacter* + PSB, which was at par with FYM + poultry manure + PSB (613.47 g), FYM + poultry manure + *Azotobacter* (596.05 g), FYM + poultry manure (589.33 g) and vermicompost + *Azotobacter* + PSB (580.38 g), while, control showed lowest average fruit weight (524.02 g). This might be due to the poultry manure contains more nutrients and minerals than the other selected organic sources for this study. More up take of these nutrients by the plant enhances the carbohydrate synthesis and hence fruit weight increases. Microbial inoculants play role in the mobilization of carbohydrates to the developing fruit. As a result, fruit size and weight increase. These results are in accordance with the results of Hassan *et al.* (2015) and Hegazi *et al.* (2007) in olives; Zothansiami and Mandal (2021); Panelo and Diza (2017) in banana and Dadashpour and Jouki (2012) in strawberry.

4.**Number of fruits per plant** : significant effects with respect to the number of fruits per plant due to the different organic sources of nutrients are presented in Table .2 In rainy season, the maximum number of fruits per plant (54) was recorded in FYM + poultry manure + *Azotobacter* + PSB , which was at par with FYM + poultry manure PSB (52), FYM + poultry manure + *Azotobacter* (51) and FYM + poultry manure (49), while minimum number of fruits per plant (39) was observed in control. In winter season, the maximum number of fruits per plant (35) was recorded in FYM + poultry manure + *Azotobacter* + PSB , which was at par with FYM + poultry manure + *Azotobacter* (34.67), FYM + poultry manure + PSB (34), and FYM + poultry manure (33) and number of fruits per plant were minimum (25) in control. It was observed that organic treatments significantly affected the number of fruits per plant. The number of fruits per plant was more in rainy season compared to winter season. The maximum number of fruits per plant in summer season (54) was recorded in 80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure + *Azotobacter* + PSB which was at par with FYM + poultry manure + PSB (52), FYM + poultry manure + *Azotobacter* (51) and FYM + poultry manure (49), while minimum number of fruits per plant (39) was observed incontrol and in winter season, the maximum number of fruits per plant (35) was recorded in FYM + poultry manure + *Azotobacter* + PSB, which was at par with FYM + poultry manure + *Azotobacter* (34.67), FYM + poultry manure + PSB (34) and FYM + poultry manure (33) and number of fruits per plant were minimum (25.33) in control. The production of more number of fruits might be due to improvement in physical, biological and chemical properties of soil. As a result, plants receive the required nutrition for the conversion of flowers to fruits. This enhances the fruit set and ultimately increase the number of fruits per tree.

These results are in harmony with the report of Moustafa (2002) in orange and Osman and El-Rhman (2010) in fig.

5.Yield (kg/plant): The observations recorded on the effect of the application of organic manures and biofertilizers on fruit yield (kg/ha) are presented in Table .2. During the experimentation in rainy season, the maximum fruit yield (29.41 kg/ha) was obtained under FYM + poultry manure + *Azotobacter* + PSB . The fruit yield of this treatment was significantly at par with FYM + poultry manure + PSB (27.11 kg/ha), FYM + poultry manure + *Azotobacter* (26.04 kg/ha), FYM + poultry manure (24.90 kg/ha) and vermicompost + *Azotobacter* + PSB (24.00 kg/ha). However, minimum fruit yield (17.98 kg/ha) was recorded under control. In the winter season , maximum fruit yield (21.60 kg/ha) was obtained with the application of FYM + poultry manure + *Azotobacter* + PSB . The fruit yield of this treatment was statistically at par with treatment of FYM + poultry manure + PSB (20.87 kg/ha), FYM + poultry manure + *Azotobacter* (20.68 kg/ha) and FYM + poultry manure (19.45 kg/ha). However minimum fruit yield (13.28 kg/ha) was recorded in control condition. The yield during both seasons varied significantly among the treatments. The yield was more in rainy season as compared to winter season. The maximum yield in rainy season (29.41 kg/plant) was recorded in 80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure + *Azotobacter* + PSB, which was statistically at par with FYM + poultry manure + PSB (27.11 kg/ha), FYM + poultry manure + *Azotobacter* (26.04 kg/ha), FYM + poultry manure (24.90 kg/ha) and vermicompost + *Azotobacter* + PSB (24.00 kg/ha). However, minimum fruit yield (17.98 kg/ha) was recorded in control condition . While in the winter season, highest fruit yield (21.60 kg/ha) was noticed with the application of FYM + poultry manure + *Azotobacter* + PSB . The fruit yield of this treatment was statistically at par with treatment of FYM + poultry manure + PSB (20.87 kg/ha), FYM + poultry manure + *Azotobacter* (20.68 kg/ha) and FYM + poultry manure (19.45 kg/ha). However lowest fruit yield (13.28 kg/ha) was recorded under control. The maximum yield is due to the interaction between organic manures and biofertilizers, which helped in improving soil nutrient availability and hence more uptake of nutrients by the plant. This enhanced the vegetative growth of the plant. As a result, a higher quantum of carbohydrates was produced for the development of fruits, thereby increasing size, number, and weight of fruits which leads towards getting higher fruit yield. These results agreed with those obtained by Moustafa (2002) in orange; Zothansiami and Mandal (2021) in banana; Kurer *et al*. (2017) in pomegranate; Osman and Abd El-Rhman (2010) in fig; Yadav *et al*. (2013) in guava; Hassan *et al*. (2015) in olives and Dadashpour andJouki (2012) in strawberry.

6. Number of seeds per fruit: Significant effects with respect to the number of seeds per fruit were observed with different treatments and are presented in Table .2. The maximum number of seeds per fruit (276) was recorded in FYM + poultry manure + *Azotobacter* + PSB , which was statistically at par with treatment of FYM + poultry manure + PSB (272) and it was minimum (207) in control during the rainy season. In the winter season, the maximum number of seeds per fruit (287) was recorded in treatment FYM + poultry manure + *Azotobacter* + PSB ,which was statistically at par with treatment of FYM + poultry manure + PSB (282) and minimum number of seeds per fruit (225) were recorded in control. Data showed that the number of seeds per fruit was significantly influenced by various treatments. The maximum number of seeds per fruit (276.67) in rainy season was recorded with 80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure + *Azotobacter* + PSB, which was statistically at par with treatment of FYM + poultry manure + PSB (272) and it was minimum (207) in control. While the maximum number of seeds per fruit (287) in the winter season, was recorded in treatment FYM + poultry manure + *Azotobacter* + PSB was statistically at par with treatment of FYM + poultry manure + PSB (282) and minimum number of seeds per fruit (225) were recorded in control. All the treatments proved significantly superior over control with respect to the number of seeds per fruit. This might be due to the fact that seed character is associated with fruit growth and development. According to Keulemans *et al.* (1996), new seeds synthesize auxin, which enhance cell growth. So, there are positive linear correlations between seed number and fruit size.

Table .1: Effect of organic source of nutrients on fruit length, fruit breadth and average fruit weight in guava *cv*. VNR bihi

Treatments	Fruit length (cm)		Fruit breadth (cm)		Avg. fruit weight (g)	
	Summer	Winter	Summer	Winter	Summer	Winter
T_1 (FYM)	8.04	8.93	8.23	10.70	485.43	528.28
T_2(Vermicompost)	8.10	9.03	8.27	11.00	478.00	543.00
T_3 (FYM + Poultry manure)	8.70	9.83	8.93	12.43	511.41	589.33
T_4 (FYM + *Azotobacter*)	8.20	9.13	8.40	11.03	482.03	551.47
T_5 (FYM + PSB)	8.25	9.27	8.57	11.17	485.72	561.66
T_6 (FYM + *Azotobacter* + PSB)	8.31	9.47	8.60	11.63	489.34	564.36
T7 (Vermicompost + *Azotobacter*)	8.40	9.57	8.70	11.90	493.66	572.21
T8 (Vermicompost + PSB)	8.57	9.63	8.77	11.97	500.04	577.43
T9 (Vermicompost + *Azotobacter* + PSB)	8.60	9.70	8.90	12.13	510.40	580.38
T10 (FYM + Poultry manure + *Azotobacter*)	8.77	9.85	9.00	12.43	513.96	596.05
T11 (FYM + Poultry manure + PSB)	8.83	9.90	9.17	12.73	524.32	613.47
T12 (FYM + Poultry manure + *Azotobacter* + PSB)	9.00	10.08	9.56	12.90	531.43	616.30
T13 (50% FYM + Jeevamrit)	7.80	8.84	8.17	10.10	465.39	537.37
T14 (Control)	7.73	8.77	8.13	9.97	460.83	524.02
C.D. at 5%	0.42	0.23	0.69	0.66	30.55	37.34

Table .2 : Effect of organic source of nutrients on number of fruits per plant, yield and number of seeds per fruit in guava *cv*. VNR bihi

Treatments	No. of fruits per plant		Yield (kg/plant)		No. of seeds per fruit	
	Summer	Winter	Summer	Winter	Summer	Winter
T1 (FYM)	40.67	26.00	19.77	13.72	221.54	231.06
T2 (Vermicompost)	42.33	27.03	20.20	14.69	225.49	231.30
T3 (FYM + Poultry manure)	48.67	33.00	24.90	19.45	263.50	255.43
T4 (FYM + *Azotobacter*)	42.67	27.33	20.52	15.04	235.01	235.23
T5 (FYM + PSB)	44.67	28.33	21.66	15.81	236.32	241.68
T6 (FYM + *Azotobacter* + PSB)	45.00	30.00	22.01	16.93	237.80	244.50
T7 (Vermicompost + *Azotobacter*)	45.67	31.00	22.55	17.74	240.40	244.98
T8 (Vermicompost + PSB)	46.67	31.67	23.34	18.27	249.35	248.43
T9 (Vermicompost + *Azotobacter* + PSB)	47.00	32.33	24.00	18.77	257.71	251.37
T10 (FYM + Poultry manure + *Azotobacter*)	50.67	34.67	26.04	20.68	267.29	259.09
T11 (FYM + Poultry manure + PSB)	51.67	34.00	27.11	20.87	272.29	282.36
T12 (FYM + Poultry manure + *Azotobacter* + PSB)	54.33	35.00	29.41	21.60	276.67	287.00
T13 (50% FYM + Jeevamrit)	41.00	26.67	19.07	14.32	220.61	230.26
T14 (Control)	39.00	25.33	17.98	13.28	207.45	225.25
C.D. at 5%	6.04	2.45	5.97	2.70	7.58	6.99

CONCLUSION

Maximum fruit length and breadth highest number of fruit per plant and average fruit weight and fruit yield and the number of sees in guava (*Psidium guajava L.*) is recorded under the treatment of FYM + poultry manure + *Azotobacter* + PSB compared to the control which showed the minimum for all the tested parameters of the plant in both summer and winter season. The effect of application of organic manures and biofertilizers on yield is significant in both season compared to thee control treatment without adding any nutrient.

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