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Effect of Organic Treatments on Growth Parameters of Guava (*Psidium guajava* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during the year 2020-21, at Deen Dayal Upadhyay Centre of Excellence for Organic Farming, CCS Haryana Agricultural University, Hisar. Different combinations of organic and microbial sources of nutrients (Poultry Manure, Vermicompost, FYM, Jeevamrit, Azotobacter and PSB) replicated thrice in Randomized Block Design. The maximum plant height (172.67 cm), plant spread (241.71 cm), stem girth (167.33 mm) and leaf area (62.47 cm^2) were recorded at last stage of growth with FYM + Poultry manure + *Azotobacter* + PSB application followed by plant height (170.24 cm), plant spread (237.32 cm), stem girth (165.46 mm) and leaf area (61.29 cm^2) in FYM + Poultry manure + PSB and minimum under control. Therefore, on the basic of results FYM + Poultry manure + *Azotobacter* + PSB found best for plant growth parameters.

Keywords: Azotobacter; biofertilizers; FYM; poultry manure; PSB; vermicompost.

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1. INTRODUCTION

Guava (*Psidium guajava* L.) is a member of Myrtaceae family and it is one of the most important fruits of tropical and subtropical parts of the world due to its hardy nature. Guava is indigenous to Tropical America. Guava is considered as an apple of tropics, because of it richness in minerals like Ca, P and Fe, and vitamins especially vitamin C. The dietary fibres are one of the most important constituents of its seed [1]. It can be grown in a wide range of soil types from heavy clay to very light sandy soil and performs well in a wide range of pH *i.e*. 4.5-8.2. Guava has been adopted in India so well that it appears to be Indian fruit.

Guava productivity has begun to decline because of the overuse of pesticides, chemical fertilizers and insecticides in the field. As a result there is a need to develop a sustainable system, which is economically viable and ecologically sound. Agricultural practices used in the ancient times are the solution to the problem. Organic farming is one of the many practices that the gaining popularity around the world.

Guava is consumed fresh along with skin and pulp, so, there is the feasibility of organic farming in its cultivation. Organic farming using organic sources like farmyard manure, crop residue, oil cakes, and animal's excreta is slowly regaining its importance.

In this experiment, the emphasis was made to study the effect of organic treatments on growth parameters of Thai guava variety VNR Bihi. This variety is developed by VNR nursery, a private research organization in the horticulture sector. VNR Bihi is India's biggest guava. It is unique in all aspects like big size attractive fruit, average fruit size vary from 300 g to 1.2 kg per fruit, appealing fruit color, less seed area, very thick pericarp and an early fruiting. Therefore the aim of present experiment is to study the effect of organic source of nutrients on growth parameters of guava.

2. MATERIALS AND METHODS

The field experiment was conducted during the year 2020-21 at Deen Dayal Upadhyay Centre of Excellence for Organic Farming, CCS Haryana Agricultural University, Hisar. The Experimental site is located at 215.2 m above sea level with coordinates of 29º13′ N latitude and 75º70′ E longitudes. The climate of experimental site is semi-arid with mean annual rainfall and mean annual temperature of 443 mm and 24.8˚C, respectively. Most of the rainfall is received between July to September month. The guava variety used was VNR Bihi and the age of plant was two years. The experiment was laid out in a Randomized Block Design with fourteen treatments and three replications *viz*., T_1: FYM (100% replacement of nitrogen through FYM), T_2: Vermicompost (100% replacement of nitrogen through Vermicompost), T_3: FYM + Poultry manure (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure), T_4: FYM + *Azotobacter* (150 ml/plant), T_5: FYM + PSB (150 ml/plant), T_6: FYM + *Azotobacter* (75 ml/plant) + PSB (75 ml/plant), T_7: Vermicompost + *Azotobacter* (150 ml/plant), T_8: Vermicompost + PSB (150 ml/plant), T_9: Vermicompost + *Azotobacter* (75 ml/plant) + PSB (75 ml/plant), T_{10}: FYM + Poultry manure + *Azotobacter* (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure), T_{11}: FYM + Poultry manure + PSB (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure), T_{12}: FYM + Poultry manure + *Azotobacter* + PSB (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure), T_{13}: 50% FYM + Jeevamrit (4 litre per plant in 21 days interval), T_{14}: Control (no application).

Full dose of organic manures and biofertilizers were incorporated under the periphery of trees that is 30 cm away from the trunk and were mixed with soil 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 1.

Growth parameters like, plant height (cm), plant spread (cm), stem girth (mm) and leaf area (cm^2) were recorded by using standard methods. Leaf area (cm^2) was recorded by randomly collecting twenty five fully developed leaves from all directions of the tree periphery, measured with the help of the help of Biogen Scientific Leaf Area Meter.

Table 1. Chemical composition of organic manures

Organic manure	Nitrogen%	Phosphorus%	Potassium%
Farmyard Manure	0.5	0.2	0.5
Vermicompost	1.8	0.7	1.5
Poultry Manure	2.8	2	2.2

3. RESULTS AND DISCUSSION

3.1 Plant Height

As depicted in Table 2, in March and April, plant height was not influenced by different organic sources of nutrients, whereas, maximum plant height in May (137 cm), June (143 cm), July (149.67 cm), August (157.66 cm), September (161.67 cm), October (166.67 cm), November (168.67 cm), and December (172.67 cm) resulted with the application of 80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure + *Azotobacter* + Phosphate Solubilizing Bacteria. This might be due to the fact that poultry manure contains the maximum amount of nitrogen as compared to other organic sources. Nitrogen is essential for protein synthesis and proteins are important for protoplasm formation thus affecting the cell division and cell elongation and result in more vegetative growth of the plant [2]. Similar findings were also reported by Devadas and Kuriakose [3] in pineapple; Zothansiami and Mandal [4] in giant Cavendish banana; Sahu and Sahu [5] in pomegranate [6].

3.2 Plant Spread

Plant spread of guava was recorded at monthly intervals from March to December (Table 3). In March and April plant spread was not affected by different organic sources of nutrients, whereas, it was significantly affected from May to December. Maximum plant spread in May (157.13 cm), June (167.55 cm), July (186.77 cm), August (205.21 cm), September (218.27 cm), October (226.22 cm), November (233.22 cm), and December (241.71 cm) resulted with the application of 80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure + *Azotobacter* + Phosphate Solubilizing Bacteria. According to Yadav et al. (2013), this may be due to the high amount of nutrients and minerals present in poultry manure as compared to other organic sources. The high amount of nitrogen, phosphorus, and potassium in plants leads to the increased formation of plant metabolites that might have helped to form plant tissues [7]. The above findings are in accordance with the finding of Yadav et al. [8]; Naik and Babu [9] and Kumar et al. [2] in guava.

3.3 Stem Girth (mm)

The experimental data indicated that treatments were not statistically significant during March, while, significant from April to December (Table 4). Maximum stem girth in April (131.33 mm), May (136.84 mm), June (143.84 mm), July (149.83 mm), August (153.84 mm), September (158.33 mm), October (161.33 mm), November (165.34 mm), and December (167.33 mm) was found with the application of 80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure + *Azotobacter* + Phosphate Solubilizing Bacteria. This might be due to the fact that, as compared to other organic sources, poultry manure contains higher amount of nitrogen. Nitrogen plays an important role in increasing the vegetative characters and hence stem girth increased maximum with treatment consisted of poultry manure. Also, nitrogen is constituent of the protein, which plays an important role in protoplasm formation thus influencing the cell elongation and cell division and hence, more vegetative growth of plant occurs (Kumar et al*.,* 2019). Similar results were also reported by Zothansiami and Mandal [4] and Kumar et al. [2] in banana and Poonia et al. [10] in mango.

3.4 Leaf Area (cm^2)

The results showed that treatments were not statistically significant during March, April, May and June while, significant from July to December (Table 5). The maximum leaf area in July (54.13 cm^2), August (56.13 cm^2), September (57.99 cm^2), October (60.10 cm^2), November (61.38 cm^2), and December (62.47 cm^2) was found with the application of 80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure + *Azotobacter* + Phosphate Solubilizing Bacteria. According to Yadav et al*.* [8], poultry manure contains nutrients and minerals, which are higher than any other organic manure. The high amount of nutrients in plants leads to the increased formation of plant metabolites that could have

Table 2. Effect of organic source of nutrients on plant height (cm) in guava *cv*. VNR bihi

Treatments	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
T_1 (FYM)	119.00	122.79	127.71	132.42	138.02	144.67	147.17	150.78	151.73	154.03
T_2 (Vermicompost)	121.33	125.29	130.96	135.76	141.46	148.21	151.01	154.76	155.76	158.16
T_3 (FYM + Poultry manure)	123.67	128.38	134.77	140.45	146.88	154.38	157.99	162.49	164.28	168.03
T_4 (FYM + *Azotobacter*)	120.00	123.85	129.26	134.12	139.94	146.77	149.83	153.67	154.79	157.28
T_5 (FYM + PSB)	120.33	124.33	129.89	134.96	141.15	148.29	151.44	155.51	156.79	159.36
T_6 (FYM + *Azotobacter* + PSB)	121.00	125.19	131.19	136.45	142.75	149.96	153.17	157.35	158.77	162.01
T_7 (Vermicompost + *Azotobacter*)	122.33	126.59	132.00	137.31	143.63	150.90	154.22	158.42	159.91	163.22
T_8 (Vermicompost + PSB)	121.67	126.00	132.19	137.68	144.09	151.47	154.96	159.28	160.94	164.48
T_9 (Vermicompost + *Azotobacter* + PSB)	122.33	126.98	133.20	138.79	145.21	152.72	156.31	160.71	162.42	166.11
T_{10} (FYM + Poultry manure + *Azotobacter*)	123.33	128.13	134.57	140.28	146.74	154.34	158.04	162.74	164.63	168.42
T_{11} (FYM + Poultry manure + PSB)	124.00	128.90	135.57	141.40	147.91	155.71	159.61	164.41	166.40	170.24
T_{12} (FYM + Poultry manure + *Azotobacter* + PSB)	125.00	130.00	137.00	143.00	149.67	157.66	161.67	166.67	168.67	172.67
T_{13} (50% FYM + Jeevamrit)	119.50	122.81	127.81	132.22	137.63	144.04	146.14	149.70	150.56	152.75
T_{14} (Control)	118.33	121.42	126.30	130.65	135.98	142.35	144.21	146.75	147.52	149.57
C.D. at 5%	NS	NS	4.66	5.31	5.57	6.11	6.70	7.30	7.70	8.10

T_1= FYM (100% replacement of nitrogen through FYM), T_2 = Vermicompost (100% replacement of nitrogen through Vermicompost), T_3= FYM + Poultry manure (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure, T_4= FYM + Azotobacter (150 ml/plant) T_5= FYM + PSB (150 ml/plant), T_6= FYM + Azotobacter + PSB (75 ml + 75 ml/plant), T_7= Vermicompost + Azotobacter (150ml/plant), T_8= Vermicompost + PSB (150 ml/plant), T_9= Vermicompost + Azotobacter + PSB (75 ml + 75 ml/plant), T_{10}= FYM + Poultry manure + Azotobacter (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure), T_{11}= FYM + Poultry manure + PSB (80% replacement of nitrogen through FYM+20% replacement of nitrogen through poultry manure + PSB, T_{12}= FYM + Poultry manure + Azotobacter + PSB (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure), T_{13}= 50% FYM +Jeevamrit (4 litre Per plant in 21 days interval), T_{14}= Control (no application)

Table 3. Effect of organic source of nutrients on plant spread (cm) in guava *cv*. VNR bihi

Treatments	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
T_1 (FYM)	119.42	126.42	138.42	145.57	159.57	173.64	182.54	187.15	192.08	197.63
T_2 (Vermicompost)	120.36	128.03	141.03	148.26	162.34	176.84	185.84	190.75	195.76	201.66
T_3 (FYM + Poultry manure)	123.18	133.88	150.25	158.68	176.43	194.23	206.23	213.22	219.94	227.15
T_4 (FYM + *Azotobacter*)	120.20	127.92	141.19	149.02	164.27	179.02	188.09	193.09	198.47	204.64
T_5 (FYM + PSB)	120.01	129.64	143.01	151.38	166.55	181.24	190.42	196.22	201.37	207.62
T_6 (FYM + *Azotobacter* + PSB)	119.51	129.44	142.86	151.32	166.89	182.04	191.54	197.49	203.10	209.50
T_7 (Vermicompost + *Azotobacter*)	121.71	131.84	146.15	155.22	172.19	189.28	199.44	205.89	211.79	218.44
T_8 (Vermicompost + PSB)	122.00	132.24	146.67	155.85	173.02	190.22	200.62	207.28	213.65	220.48
T_9 (Vermicompost + *Azotobacter* + PSB)	122.67	133.20	148.36	157.83	175.00	192.24	203.50	210.23	216.91	224.01
T_{10} (FYM + Poultry manure + *Azotobacter*)	123.50	135.54	152.06	161.73	179.83	197.84	210.34	217.74	224.60	232.40
T_{11} (FYM + Poultry manure + PSB)	123.73	137.92	154.69	165.12	183.47	201.87	214.77	222.62	229.17	237.32
T_{12} (FYM + Poultry manure + *Azotobacter* + PSB)	123.90	140.22	157.13	167.55	186.77	205.21	218.27	226.22	233.22	241.71
T_{13} (50% FYM + Jeevamrit)	119.32	125.97	136.53	142.53	155.86	169.11	177.67	181.66	185.66	191.00
T_{14} (Control)	119.00	124.02	133.58	139.14	152.05	164.47	172.43	176.23	180.18	184.41
C.D. at 5%	NS	NS	5.21	6.61	7.86	8.03	7.45	7.41	7.61	9.06

T_1= FYM (100% replacement of nitrogen through FYM), T_2 = Vermicompost (100% replacement of nitrogen through Vermicompost), T_3= FYM + Poultry manure (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure, T_4= FYM + Azotobacter (150 ml/plant) T_5= FYM + PSB (150 ml/plant), T_6= FYM + Azotobacter + PSB (75 ml + 75 ml/plant), T_7= Vermicompost + Azotobacter (150ml/plant), T_8= Vermicompost + PSB (150 ml/plant), T_9= Vermicompost + Azotobacter + PSB (75 ml + 75 ml/plant), T_{10}= FYM + Poultry manure + Azotobacter (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure), T_{11}= FYM + Poultry manure + PSB (80% replacement of nitrogen through FYM+20% replacement of nitrogen through poultry manure + PSB, T_{12}= FYM + Poultry manure + Azotobacter + PSB (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure), T_{13}= 50% FYM +Jeevamrit (4 litre Per plant in 21 days interval), T_{14}= Control (no application)

Table 4. Effect of organic source of nutrients on stem girth (mm) in guava *cv.* VNR bihi

Treatments	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
T_1 (FYM)	121.33	125.21	129.06	134.06	138.94	141.35	144.44	146.32	148.54	149.54
T_2 (Vermicompost)	121.85	125.81	129.77	134.94	139.90	142.50	145.70	147.66	149.96	151.05
T_3 (FYM + Poultry manure)	124.03	129.58	134.65	141.08	146.75	150.36	154.39	157.05	160.69	162.44
T_4 (FYM + *Azotobacter*)	122.33	126.40	130.45	135.83	140.87	143.66	147.00	149.06	151.47	152.66
T_5 (FYM + PSB)	122.67	126.93	131.06	136.49	141.65	144.53	147.98	150.12	152.64	153.92
T_6 (FYM + *Azotobacter* + PSB)	123.00	127.58	131.79	137.35	142.58	145.54	149.09	151.36	154.04	155.36
T_7 (Vermicompost + *Azotobacter*)	123.00	127.96	132.51	138.33	143.72	146.76	150.47	152.86	155.90	157.39
T_8 (Vermicompost + PSB)	123.21	128.30	133.12	139.11	144.59	147.78	151.64	154.05	157.23	158.75
T_9 (Vermicompost + *Azotobacter* + PSB)	123.67	128.88	133.84	139.92	145.44	148.75	152.73	155.26	158.57	160.23
T_{10} (FYM + Poultry manure + *Azotobacter*)	124.33	130.02	135.16	141.77	147.56	151.32	155.47	158.18	161.94	163.75
T_{11} (FYM + Poultry manure + PSB)	125.00	130.83	136.04	142.83	148.69	152.52	156.91	159.69	163.50	165.46
T_{12} (FYM + Poultry manure + *Azotobacter*+ PSB)	125.34	131.33	136.84	143.84	149.83	153.84	158.33	161.33	165.34	167.33
T_{13} (50% FYM + Jeevamrit)	120.00	123.56	127.11	131.70	136.45	138.65	141.56	143.12	145.12	146.02
T_{14} (Control)	119.73	122.39	125.68	129.88	134.49	136.49	139.00	140.41	142.23	143.11
C.D. at 5%	NS	2.90	3.70	3.72	4.67	4.88	5.19	5.44	5.68	5.83

T_1= FYM (100% replacement of nitrogen through FYM), T_2 = Vermicompost (100% replacement of nitrogen through Vermicompost), T_3= FYM + Poultry manure (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure, T_4= FYM + Azotobacter (150 ml/plant) T_5= FYM + PSB (150 ml/plant), T_6= FYM + Azotobacter + PSB (75 ml + 75 ml/plant), T_7= Vermicompost + Azotobacter (150ml/plant), T_8= Vermicompost + PSB (150 ml/plant), T_9= Vermicompost + Azotobacter + PSB (75 ml + 75 ml/plant), T_{10}= FYM + Poultry manure + Azotobacter (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure), T_{11}= FYM + Poultry manure + PSB (80% replacement of nitrogen through FYM+20% replacement of nitrogen through poultry manure + PSB, T_{12}= FYM + Poultry manure + Azotobacter + PSB (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure), T_{13}= 50% FYM +Jeevamrit (4 litre Per plant in 21 days interval), T_{14}= Control (no application)

Table 5. Effect of organic source of nutrients on leaf area (cm^2) in guava *cv*. VNR bihi

Treatments	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
T_1 (FYM)	42.97	44.45	46.01	47.09	48.20	49.44	50.67	51.98	52.69	53.35
T_2 (Vermicompost)	43.08	44.61	46.22	47.41	48.60	49.91	51.53	52.58	53.34	54.03
T_3 (FYM + Poultry manure)	44.52	46.52	48.61	50.37	52.02	53.83	55.54	57.49	58.60	59.53
T_4 (FYM + *Azotobacter*)	43.21	44.87	46.55	47.86	49.07	50.48	51.83	53.31	54.10	54.81
T_5 (FYM + PSB)	43.42	45.10	46.89	48.61	49.56	51.04	52.46	54.04	54.89	55.63
T_6 (FYM + *Azotobacter* + PSB)	43.56	45.32	47.20	48.68	50.03	51.54	53.02	54.64	55.53	56.32
T_7 (Vermicompost + *Azotobacter*)	43.96	45.79	47.80	49.36	50.77	52.35	53.86	55.56	56.53	57.34
T_8 (Vermicompost + PSB)	44.01	45.85	47.94	49.55	51.03	52.72	54.31	56.09	57.11	57.94
T_9 (Vermicompost + *Azotobacter* + PSB)	44.13	46.03	48.16	49.84	51.43	53.19	54.84	56.70	57.78	58.64
T_{10} (FYM + Poultry manure + *Azotobacter*)	44.89	46.92	49.18	50.99	52.61	54.57	56.36	58.37	59.52	61.14
T_{11} (FYM + Poultry manure + PSB)	45.06	47.17	49.56	51.45	53.26	55.19	57.33	59.05	60.26	61.29
T_{12} (FYM + Poultry manure + *Azotobacter* + PSB)	45.57	47.75	50.30	52.25	54.13	56.13	57.99	60.10	61.38	62.47
T_{13} (50% FYM + Jeevamrit)	42.49	43.92	45.43	46.44	47.53	48.74	49.96	51.21	51.90	52.51
T_{14} (Control)	42.08	43.40	44.88	45.87	46.92	47.77	49.29	50.50	51.11	51.69
C.D. at 5%	NS	NS	NS	NS	2.01	2.83	3.12	2.96	2.80	2.91

T_1= FYM (100% replacement of nitrogen through FYM), T_2 = Vermicompost (100% replacement of nitrogen through Vermicompost), T_3= FYM + Poultry manure (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure, T_4= FYM + Azotobacter (150 ml/plant) T_5= FYM + PSB (150 ml/plant), T_6= FYM + Azotobacter + PSB (75 ml + 75 ml/plant), T_7= Vermicompost + Azotobacter (150ml/plant), T_8= Vermicompost + PSB (150 ml/plant), T_9= Vermicompost + Azotobacter + PSB (75 ml + 75 ml/plant), T_{10}= FYM + Poultry manure + Azotobacter (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure), T_{11}= FYM + Poultry manure + PSB (80% replacement of nitrogen through FYM+20% replacement of nitrogen through poultry manure + PSB, T_{12}= FYM + Poultry manure + Azotobacter + PSB (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure), T_{13}= 50% FYM +Jeevamrit (4 litre Per plant in 21 days interval), T_{14}= Control (no application)

helped to form plant tissues [7]. This observation is in accordance with those obtained by Moustafa [11] in Washington navel orange; Osman and El-Rhman [12] in fig and Kamatyanatti et al. [13] in plum.

4. CONCLUSION

Among various treatment studied, the treatment T_{12} - FYM + Poultry manure + *Azotobacter* + PSB (80% replacement of nitrogen through FYM + 20% replacement of nitrogen through poultry manure) had reported maximum plant height, plant spread, stem girth, and leaf area of guava cv. VNR Bihi. Followed by treatment T_{11} -FYM + Poultry manure + PSB (80% replacement of nitrogen through FYM+20% replacement of nitrogen through poultry manure).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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