



Response of on farm produced organic inputs on soil, plant nutrient status, yield and quality of guava (*Psidium guajava*) cv Allahabad Safeda

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ABSTRACT

A field experiment was conducted during 2008-09 to compare the efficacy of different organic inputs in the production of guava (*Psidium guajava* L.) cv Allahabad Safeda. The highest number of fruits (363/tree) and yield (41.45 kg/tree) was recorded by application of 250 g rhizospheric soil of *Ficus bengalensis* + 5% *Amritpani* + organic mulching followed by 328 fruits/tree and yield of 31.76 kg/tree by biodynamic compost (30 kg/tree). Maximum TSS (11.7 °Brix) in fruits was recorded through application of biodynamic compost fortified with BD-500 (30 kg/tree) and cow pat pit (100 g/tree) followed by 11.3 °Brix with of vermicompost (30 kg/tree) + *Azospirillum* culture (250 g/tree) + PSB (50 g/tree). The treatments did not affect acidity, ascorbic acid and reducing sugars significantly. Microbial analysis of different organic inputs indicated that cow pat pit contained maximum load of *Azotobacter* sp (1.5×10^6 cfu/g) and *Azospirillum* sp (1.3×10^6 cfu/g). Rhizospheric soils of *Ficus bengalensis* contained maximum number (1.5×10^5 cfu/g) of *Azotobacter* and (1.4×10^7 cfu/g) *Azospirillum* as compared to mango (2×10^4 cfu/g and 1.2×10^4 cfu/g, respectively). After two years of experimentation, maximum organic carbon (0.818%) was recorded in the basin soil of treatment biodynamic compost fortified with BD-500 (30 kg/tree) and cow pat pit (100 g/tree). On the other hand, highest build of available P (67.6 ppm) was maximum with application of biodynamic compost @ 30 kg/tree, while available K (384 ppm), Zn (14.12 ppm), Cu (11.20 ppm) and Fe (15.7 ppm) were maximum with application of biodynamic compost fortified with BD-500 (30 kg/tree) and cow pat pit (100 g/tree), compared to initial soil nutrient status. Improvement in leaf nutrient status was also noticed and maximum leaf N (1.68%), P (0.244%), K (1.74%), Ca (1.49%), Zn (33.8 ppm) with application of rhizospheric soil of *Ficus bengalensis* @ 250 g/tree + 5% *Amritpani* + organic mulching, Mg (0.63%); with vermicompost (30 kg/tree) + *Azospirillum* culture (250 g/tree) + PSB (50 g/tree), Cu (78.7 ppm) and Mn (195.1 ppm) were recorded with FYM (30 kg/tree as compared to control (1.21%, 0.212%, 1.23%, 1.33%, 0.21 ppm, 27.5 ppm, 46.4 ppm and 167.6 ppm, respectively).

Key words: *Azospirillum*, BD-500, Biodynamic, Cow pat pit, Guava, Nutrient status, Vermicompost, Yield

Indiscriminate use of agrochemicals in horticultural crops has resulted in various environmental and health hazards along with socio-economic problems (Audus 1970, Kakkar 1981, Gupta 1991 and Joshi *et al.* 1995). The situation is more serious in production of large number of fruits, vegetables and spices. High cost and less availability of required chemical fertilizers and their adverse effect on fruit quality and soil health has prompted to find out alternative source(s) of nutrients.

It is important to mention that horticultural crops are grown for their nutritive/therapeutic/aesthetic value and many of them are consumed as fresh, hence, their organic production is more relevant than most of the field crops. Organic agriculture aims at a sustainable production system

based on natural processes and relies primarily on local, renewable resources. In horticultural crops, there is ample scope of organic farming to obtain superior quality produce to ascertain nutritional security for better human health. On farm produced quality organic inputs from locally available bio-resources form an integral component of organic agriculture. Therefore, keeping these facts in mind, an experiment was planned to study the efficacy of different organic farming practices and on-farm produced inputs on the fruit yield and quality of guava (*Psidium guajava* L.) and orchard soil health.

MATERIALS AND METHODS

A field experiment was laid out, in randomized block design with 3 replications on 12 year old plants of guava cv Allahabad Safeda during 2008-09 at Central Institute for Subtropical Horticulture, Lucknow. Seven treatments, viz biodynamic compost @ 30 kg/tree (T1), biodynamic compost fortified with BD-500 @ 30 kg/tree and cow pat

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pit @ 100 g/tree (T2), rhizospheric soil of *Ficus benghalensis* @ 250 g/tree + 5 per cent *Amritpani* (T3) + organic mulching; FYM @ 30 kg/tree + 5 per cent *Panchagavya* (T4); vermicompost @ 30 kg/tree + *Azospirillum* culture 250 g + PSB 50 g/tree (T5), FYM @ 30 kg/tree (T6) and control (T7) were imposed. Soil and leaf samples were drawn and analysed before the imposition of treatments and at the end of experiment.

Organic carbon was estimated by the chromic acid oxidation method (Walkley and Black 1934). Available phosphorus was extracted by Olsen's method (Olsen *et al.* 1954) and P in the extract was estimated colourimetrically by ascorbic acid blue colour method (Watanabe and Olsen 1965). Available K was estimated by flame photometer in 1N neutral ammonium acetate soil extract. The micronutrients (Fe, Mn, Zn and Cu) were extracted by DTPA method (Lindsay and Norvell 1978) and their content in the extract was estimated by atomic absorption spectrophotometer Chemito Model-203D. Nitrogen in leaf and manure samples was analysed by micro Kjeldahl method (Jackson 1967). For the analysis of P, K, Ca, Mg, Fe, Mn, Zn and Cu, the leaf and manure, samples were digested in tri-acid mixture of nitric acid: sulphuric acid: perchloric acid (10:1:4). Phosphorus and potassium in the extract was analysed colourimetrically by vanadate-molybdate yellow colour method and flame photometrically, respectively, Ca and Mg by versene titration method and micronutrients by atomic absorption spectrophotometer (Jackson 1967).

Experimental soil had 7.5 pH and electrical conductivity ranging from 0.11 to 0.17 dS/m with 0.759% organic carbon, 30.7 ppm P, 235 ppm K, 6.7 ppm Zn, 10.9 ppm Cu, 6.0 ppm Mn and 11.0 ppm Fe (Tandon 1993). Microbial analysis of on farm produced organic inputs with locally available materials, viz biodynamic compost fortified with BD-502-507, BD-500, BD-501, *Amritpani*, *Panchagavya* and rhizospheric soils of different trees was done for *Azotobacter* and *Azospirillum*. Enumeration of beneficial free-living N₂-fixing bacteria *Azotobacter* sp. and *Azospirillum* sp. has been carried out by dilution plate count method using specific media, viz. Jenson's media for *Azotobacter* (Jenson 1954) and N-free malate medium for *Azospirillum* (Okon *et al.* 1977) in different rhizospheric soils, organic inputs. Fruit size, weight and other yield attributes were recorded of winter crop. For quality, total soluble solids were recorded with the help of refractometer calibrated in °Brix and acidity was determined using standard procedures of AOAC (1975). Reducing sugars were determined by N/10 NaOH using phenolphthalein red indicator. Ascorbic acid content in freshly harvested fruit was determined as mg/100 g fruit (Johnson 1948). Experimental data were statistically analysed following the analysis of variance method (Panse and Sukhatme 1978).

RESULTS AND DISCUSSION

The data on fruit yield and its attributes are presented in Table 1. Maximum number of fruits (363/tree) and fruit yield (41.45 kg/tree) was recorded with application of 250

Table 1 Response of different treatments on yield and its attributes of guava cv. Allahabad Safeda

Treatment	Fruit number (/tree)		Average fruit wt (g)		Av. fruit length (cm)		Av. fruit diameter (cm)		Fruit yield (kg/tree)				
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009			
Biodynamic compost (30 kg/tree)	233	291	262	120.13	155.66	137.89	5.40	6.40	6.00	6.24	23.56	37.73	30.64
Biodynamic compost fortified with BD-500 (30 kg/tree) and cow pat pit (100 g/tree)	277	379	328	215.33	195.33	205.33	7.29	7.37	7.60	6.97	31.16	32.37	31.76
Rhizospheric soil of <i>Ficus benghalensis</i> (250 g/tree) + 5% <i>Amritpani</i> + organic mulching	328	398	363	124.68	177.00	150.84	5.48	6.78	5.73	6.92	42.78	40.13	41.45
FYM (30kg/tree) + 5 per cent of <i>Panchagavya</i>	155	283	219	122.75	191.66	157.20	5.85	5.97	5.96	6.03	15.98	20.9	18.44
Vermicompost (30 kg/tree) + <i>Azospirillum</i> culture (250 g/tree) + PSB (50g/tree)	199	319	259	217.73	190.33	204.03	7.68	6.40	7.33	6.66	19.78	32.5	26.14
FYM (30 kg/tree)	246	339	292.5	157.75	150.0	153.087	6.61	6.45	7.20	6.73	25.16	34.2	29.68
Control	212	256	234	122.06	190.0	155.03	5.02	6.61	6.66	6.61	21.30	23.09	22.19
CD (P=0.05)	80.11	0.57		16.03	0.97		0.92	0.57	1.07	0.57	8.59	0.977	

Table 2 Effect of different treatments on quality parameters of guava cv Allahabad Safeda

Treatment	TSS (°Brix)			Acidity (%)			Ascorbic acid (mg/100g fruit)			Reducing sugars (%)		
	2008	2009	Average	2008	2009	Average	2008	2009	Average	2008	2009	Average
Biodynamic compost (30 Kg/tree)	10.25	10.23	10.24	0.15	0.27	0.21	183.70	197.03	190.63	4.25	4.04	4.14
Biodynamic compost fortified with BD-500 (30 kg/tree) and cow pat pit (100 g/tree)	12.01	11.68	11.84	0.15	0.27	0.21	242.10	181.71	211.90	4.10	4.28	4.19
Rhizospheric soil of <i>Ficus benghalensis</i> (250 g/tree)+ 5% <i>Amritpani</i> + organic mulching	11.73	11.06	11.39	0.13	0.30	0.21	193.85	198.69	196.27	4.48	4.47	4.475
FYM (30 kg/tree) + 5% of <i>Panchagavya</i>	11.91	11.25	11.58	0.16	0.24	0.20	213.76	185.67	199.71	3.89	3.55	3.72
Vermicompost (30 kg/tree) + <i>Azospirillum</i> culture (250 g/tree) + PSB (50 g/tree)	11.66	11.33	11.49	0.16	0.27	0.21	207.13	175.49	191.30	4.23	4.03	4.13
FYM (30 kg/tree)	11.08	10.75	10.91	0.17	0.25	0.21	188.83	213.07	200.95	4.03	4.28	4.15
Control	10.83	10.16	10.49	0.16	0.29	0.23	196.56	188.19	192.37	3.41	3.63	3.52
CD (P=0.05)	1.05	0.977		NS	NS		NS	NS		NS	0.41	

g rhizospheric soil of *Ficus benghalensis* + 5% *Amritpani* + organic mulching followed 30 kg biodynamic compost (328 fruits and 31.76 kg yield/tree). Improvement in fruit quality was also observed with different treatments and maximum TSS (11.8 °Brix) was recorded with application of 30 kg biodynamic compost fortified with BD 500 and cow pat pit followed by 11.5 °Brix with application of FYM @ 30 kg/tree + 5% panchagavya. Rhizospheric soil of *Ficus benghalensis* contained good population of nitrogen fixing bacteria, i.e. *Azotobacter* (1.50×10^6 cfu/g) and *Azospirillum* (1.40×10^6 cfu/g), which improved the availability of nutrients in presence of compost to the plants and resulted into yield increase and improvement in fruit quality of guava. Similar results were also reported by Ram and Rajput (1998) and Ram and Pathak (2006) in guava cv Allahabad Safeda. The variations in quality parameters viz; acidity, ascorbic acid and reducing sugars of fruits were non-significant due to application of various treatments (Table 2). The organic inputs produced with locally available organic materials were evaluated for nutrients and some known microbes. Maximum N (2.37%), P (4.91%) and K (6.45%) was analysed in *Amritpani* followed by 2.15% N in vermicompost, 3.85% P in Cow pat pit and 1.23% K in biodynamic compost accordingly (Table 3). Maximum Ca

(4.25%) was analysed in cow pat pit followed by 3.35% in *amritpani*. Most of the on farm produced organic inputs applied as treatments contained good amount of micronutrients. Similar findings were reported by Ram and Singha (2012). The highest number of *Azotobacter* sp (1.5×10^6 cfu/g) and *Azospirillum* (1.4×10^7 cfu/g) was recorded in cow pat pit and lowest (1.0×10^3 cfu/g) in BD-501. Other organic preparations which contained good number of

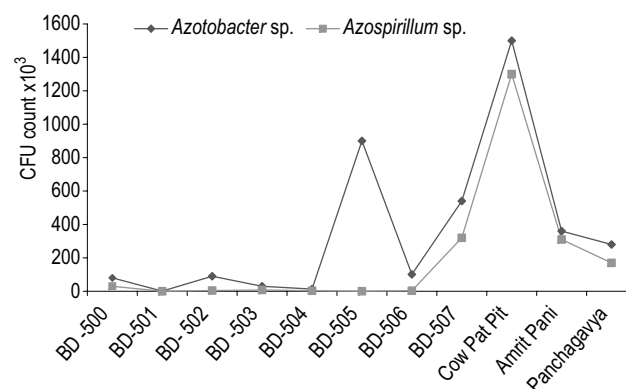
Fig 1 CFU count of *Azotobacter* and *Azospirillum* sp in biodynamic and other organic preparations

Table 3 Nutrient analysis (% on dry weight basis) of different organic preparations (liquid/50ml)

Organic inputs	N (%)	P (%)	K (%)	Ca (%)	Zn (ppm)	Cu (ppm)	Fe (ppm)	Mn (ppm)
Vermi compost	2.15	1.29	0.53	0.72	168	61	3545	252
Biodynamic compost	1.68	0.17	1.23	1.20	96	45	357	3352
FYM	0.70	0.19	0.37	0.24	75	34	222	134
Cow pat pit	2.10	3.85	0.42	4.25	160	62	2595	309
BD 500	1.26	1.32	0.57	0.45	100	55	1945	173
<i>Amritpani</i>	2.37	4.91	6.45	3.35	65	33	1680	109
<i>Panchagavya</i>	0.007	0.01	0.06	trace	2.9	2.4	1.7	25.8

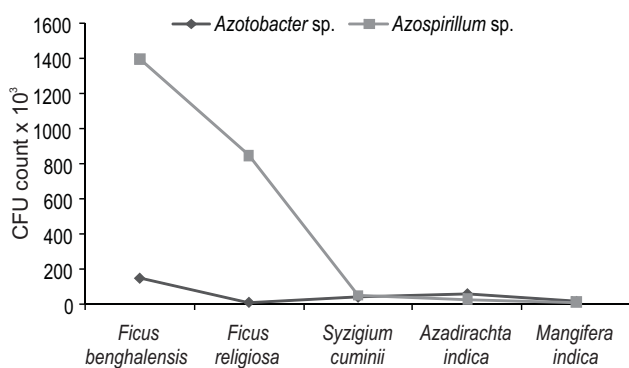


Fig 2 CFU count of Azotobacter and Azospirillum sp. in rhizospheric soil of different tree

Azotobacter sp. were BD-505 (9.0×10^5 cfu/g), BD-507 (5.4×10^5 cfu/g), *Amritpani* (3.6×10^5 cfu/g), *Panchagavya* (2.8×10^5 cfu/g), BD-506 (1.01×10^6 cfu/g), and BD-500 (8×10^4 cfu/g). Similarly, highest number of *Azospirillum* sp. (1.30×10^6 cfu/g) was recorded in cow pat pit (Fig 1). A good number of *Azospirillum* sp. was recorded in BD-507 (3.2×10^3 cfu/g), *Panchagavya* (1.7×10^5 cfu/g) and BD-500 (3.0×10^4 cfu/g).

Microbial analysis of rhizospheric soil of *Ficus benghalensis* contained maximum number of *Azotobacter*

(1.50×10^6 cfu/g) and *Azospirillum* (1.40×10^6 cfu/g) followed by *Ficus religiosa* which contained *Azotobacter* (1.0×10^5 cfu/g) and *Azospirillum* (8.5×10^5 cfu/g). Other rhizospheric soils of *Mangifera indica*, *Syzigium cumini* and *Azadirachta Indica* contained comparatively less number of *Azotobacter* and *Azospirillum* population. Rhizospheric soils of *Ficus benghalensis* and *Ficus religiosa* also contained highest soil organic carbon which attributed presence of maximum aerobic bacteria (Fig 2).

Composite soil samples drawn for initial nutrients analysis showed that experimental field contained 0.798% organic carbon, 30.4 ppm P, 175.55 ppm K, 5.4 ppm Zn, 7.60 ppm Cu, 5.40 ppm Mn and 13.80 ppm Fe. After two year of treatments imposition, maximum OC (0.818%) was recorded with treatment biodynamic compost fortified with BD-500 @ 30 kg/tree and cow pat pit @ 100 g/tree. Maximum improvement in soil nutrient content in term of available P (67.6 ppm) was recorded in treatment biodynamic compost @ 30 kg/tree, while available K (384 ppm), Zn (14.12 ppm), Cu (11.20 ppm) and Fe (15.7 ppm) was maximum in treatment biodynamic compost fortified with BD-500 @ 30 kg/tree and cow pat pit @ 100 g/tree (Table 4). In a study, Reganold *et al.* (2001) have reported the sustainability of organic production system and better soil

Table 4 Improvement in soil nutrients status after two years of treatments application in guava cv Allahabad Safeda

Treatment	OC (%)	P (ppm)	K (ppm)	Zn (ppm)	Cu (ppm)	Mn (ppm)	Fe (ppm)
Biodynamic compost (30 kg/tree)	0.545	67.6	177.75	4.22	6.60	14.30	5.96
Biodynamic compost fortified with BD-500 (30 kg/tree) and cow pat pit (100 g/tree)	0.818	50.1	384.00	14.12	11.20	12.16	15.7
Rhizospheric soil of <i>Ficus benghalensis</i> (250 g/tree) + 5% <i>Amritpani</i> + organic mulching	0.564	36.6	344.25	4.20	4.94	8.92	7.64
FYM (30 kg/tree) + 5% of <i>Panchagavya</i>	0.584	44.9	329.75	3.88	4.34	8.50	6.30
Vermicompost (30 kg/tree) + <i>Azospirillum</i> culture (250 g/tree) + PSB (50 g/tree)	0.623	64.7	333.00	6.00	5.68	12.8	9.68
FYM (30 kg/tree)	0.701	65.6	268.25	5.38	5.44	9.74	7.82
Control	0.545	52.1	318.50	5.60	6.08	10.12	6.22
CD (P= 0.05)	0.121	12.60	12.74	0.43	0.58	1.12	NS

Table 5 Initial plant nutrients level in guava cv Allahabad Safeda

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Zn (ppm)	Cu (ppm)	Mn (ppm)
Biodynamic compost (30 kg/tree)	1.01	0.12	1.68	0.39	0.52	25.5	30.52	11.30
Biodynamic compost fortified with BD 500 (30 kg/tree) and cow pat pit (100 g/tree)	1.59	0.13	1.49	0.33	0.52	23.2	28.30	10.30
Rhizospheric soil of <i>Ficus benghalensis</i> (250 g/tree) + 5% <i>Amritpani</i> + organic mulching	1.87	0.53	1.51	0.16	0.43	30.3	7.42	7.96
FYM (30 kg/tree) + 5% of <i>Panchagavya</i>	1.87	0.17	1.15	0.30	0.44	26.5	3.45	5.58
Vermicompost (30 kg/tree) + <i>Azospirillum</i> culture (250 g/tree) + PSB (50 g/tree)	1.37	0.40	1.11	0.31	0.54	22.3	0.84	6.56
FYM (30 kg/tree)	1.50	0.07	1.57	0.31	0.41	23.5	11.90	8.16
Control	1.37	0.10	1.37	0.38	0.51	20.14	28.38	8.60
CD (P=0.05)	0.21	0.20	NS	NS	NS	1.16	5.20	2.06

Table 6 Plant nutrients level after two years of treatments application in guava cv Allahabad Safeda

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg(%)	Zn (ppm)	Cu (ppm)	Mn (ppm)
Biodynamic compost (30 kg/tree)	1.63	0.208	1.36	0.99	0.27	30.5	51.8	167.3
Biodynamic compost fortified with BD 500 (30 kg/tree) and cow pat pit (100 g/tree)	1.45	0.210	1.46	1.22	0.20	29.3	57.6	185.1
Rhizospheric soil of <i>Ficus benghalensis</i> (250 g/tree) + 5% <i>Amritpani</i> + organic mulching	1.68	0.244	1.74	1.49	0.27	33.8	49.7	150.1
FYM (30 kg/tree) + 5% of <i>Panchagavya</i>	1.65	0.197	1.58	1.47	0.39	31.9	51.0	138.0
Vermicompost (30 kg/tree) + <i>Azospirillum</i> culture (250 g/tree) + PSB (50 g/tree)	1.75	0.216	1.61	1.38	0.37	28.1	60.2	189.8
FYM (30 kg/tree)	1.58	0.156	1.54	1.28	0.63	28.0	78.7	195.1
Control	1.21	0.121	1.23	1.33	0.21	27.5	46.4	167.6
CD (P=0.5)	NS	NS	NS	NS	NS	NS	6.20	10.21

health in apple orchard and consistent increase in organic carbon even under tropical conditions had been reported by Rao and Krishnan (1963). In another study, Tolanur and Badnur (2003) have reported that organic carbon content, available nitrogen, phosphorus and potassium were significantly influenced by the application of 50 per cent N through subabul and FYM, in conjunction with 50 per cent RDF under pearl millet-pigeonpea cropping system. Rhizospheric soil of untreated trees contained organic carbon- 0.701%, P-52.1 ppm, K-318.50 ppm, Zn-5.60 ppm, Cu-6.08 ppm, Mn-10.1 2 ppm and Fe-6.22 ppm (Table 5).

Leaf samples before the treatment application contained 1.01-1.87% N, 0.10-0.53% P, 1.11-1.68% K, 0.16-0.39% Ca, 0.41-0.54% Mg, 22.3-30.3 ppm Zn, 3.45-30.52 ppm Cu, 6.56-11.30 ppm Mn (Table 6) and after two years of application of different organic inputs, improvement in nutrient status of leaves. Maximum N (1.68%), P (0.244%), K (1.74%), Ca (1.49%) and Zn (33.8 ppm) were recorded with the application of 250 g rhizospheric soil of *Ficus benghalensis* + 5% *Amritpani* + mulching (Table 7). Improvement in Mg (0.63%), Cu (78.7 ppm) and Mn (195.1 ppm) level was observed with the application of 30 kg FYM/tree. From a survey conducted in UP, Khanuja and Garg (1980) arrived at confidence limit of N (1.63 – 1.96%), P (0.18 0.24%), K (1.31 – 1.71%), Ca (0.67- 0.83%) and Mg (0.52-0.65%) for optimum production of guava in north India.

CONCLUSION

Based on above study it is concluded that application of 250 g rhizospheric soil of *Ficus benghalensis* + 5% *Amritpani* + mulching has significantly increased the plant nutrient status and fruit yield in guava. Rhizospheric soil of *Ficus benghalensis* can successfully be used in organic farming as it contains good number of *Azotobacter* (1.50×10^6 cfu/g) and *Azospirillum* (1.40×10^6 cfu/g). Improvement in soil organic carbon status can also be achieved through application of biodynamic compost (30 kg/tree) fortified with BD-500 and cow pat pit.

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