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Influence of nutrient sources on growth, fruit quality and economics of guava under Chhattisgarh plain

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ABSTRACT

An experiment was conducted to find out the effect of organic and inorganic sources of fertilizers on growth, quality and benefit cost ratio of winter guava. The two years pooled data revealed that highest tree height (4.94m), trunk girth (67.05cm), North-South spread (7.00m), East-West spread (6.88m), number of flowers/m^2 (15.72), number of fruits/m^2 (12.70), fruit set (80.80%), fruit length and diameter (7.45 and 7.73cm), fruit volume (207.24 cc), TSS (12.49°B), total sugars (8.37%), reducing & non-reducing sugars (4.46% and 3.92%), ascorbic acid (236.42 mg/100g pulp) and sugar/acid ratio (29.61) respectively, was obtained in treatment T_6 comprising 75% RDF + cowdung slurry @10 litre tree^{-1} + *Azospirillum* 100 g tree^{-1} + PSB 100 g tree^{-1} . This treatment also resulted in the lowest peel weight (9.20 g), seed weight (4.84 g) and acidity (0.28 %). The pooled analysis of two year data also indicated that 75% RDF + cowdung slurry @10 litre tree^{-1} + *Azospirillum* 100 g tree^{-1} + PSB 100 g tree^{-1} (T_6) was found the best over most of the treatments in respect of yield parameters like yield per hectare (13.48 MT), gross returns (Rs. 3,34,000 ha^{-1}), net returns (Rs. 2,76,076 ha^{-1}) and highest benefit : cost ratio (5.77). Treatment having 75% RDF + 25% NPK tree^{-1} blended with cowdung slurry @ 10 litre tree^{-1} (T_4) proved the next best treatment, However, lowest values for all the parameters were recorded under the control.

Key words: *Psidium guajava*, growth, benefit: cost ratio, biofertilizers.

INTRODUCTION

Guava (*Psidium guajava* L.) is one of the most exquisite and valuable fruits of the tropical and sub tropical climate. Due to its wide adaptability in diverse soil and agroclimatic regions, low cultivation cost, prolific bearing and being highly remunerative with fruit nutritive values it has gained more popularity among the fruit growers. Chhattisgarh state has covered an area of 21.89 million hectare with an annual production of 197.18 metric tonnes (Anonymous, 2). In India, it occupies an area of 264.9 million hectares and production of 4053.5 million tonnes with a productivity of 15.3 metric tonnes ha^{-1} (Anonymous, 3). On the other hand, excess supply or continuous use of inorganic fertilizers as source of nutrient in imbalanced proportion is also a problem, causing economic inefficiency, damage to the environment and in certain situations, harm the plants themselves and also to human being who consume them. 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. The use of biofertilizers in enhancing plant growth and yield has gained momentum in recent years because of higher cost of hazardous effect of chemical fertilizers. Nitrogen fixing bacteria were found to enhance the growth and production of various fruits significantly besides improving the microbial activity of rhizosphere (Ghazi, 8). *Azospirillum* is known to add nitrogen to the soil through biological nitrogen fixation, which plays significant role in fruit production (Goswami *et al.*, 7). Keeping this in view the importance of organic amendments, the present study was undertaken to study the effect of organic amendments on growth, yield and quality of guava.

MATERIALS AND METHODS

The present study was conducted at Horticulture Research Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) on 15-year-old guava cv. Sardar during winter season. The orchard was located in the tropical zone at 21º 16' N latitude and 81º 36' E longitude. The altitude of the place is 289.56 m above sea level. The maximum temperature of this region may reach as high as 46 ^{0}C during summer and the minimum may fall to 10 ^{0}C during winter. The soil of the experimental field was classified as *vertisol* and texturally known as clay. The experiment was laid out in randomized block design with three replications. There were ten treatment combinations namely, absolute control (T_0), 100% RDF600:300:300 g NPK tree^{-1} (T_1), 75% RDF + cowdung slurry @ 10 litre tree^{-1} (T_2), 50%

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RDF + cowdung slurry @10 litre tree^{-1} (T_3), 75% RDF + 25% NPK tree^{-1} blended with cowdung slurry @10 litre tree^{-1} (T_4), 50% RDF + 25% NPK tree^{-1} blended with cowdung slurry @10 litre tree^{-1} (T_5), T_2 + *Azospirillum* 100 g tree^{-1} + PSB 100 g tree^{-1} (T_6), T_3 + *Azospirillum* 100 g tree^{-1} + PSB 100 g tree^{-1} (T_7), T_4 + *Azospirillum* 100 g tree^{-1} + PSB 100g tree^{-1} (T_8) and T_5 + *Azospirillum* 100 g tree^{-1} + PSB 100 g tree^{-1} (T_9). Organic manure was applied to the trees around the trunk during first week of July. *Azospirillum* and PSB with a uniform dose of 100 g tree^{-1} were separately given to each experimental tree in the active root zone. The urea was applied in two split doses. The half dose was given before one month of flowering and the rest after fruit set. Phosphorus (P_2O_5) and Potassium (K_2O) were worked out after subtracting the quantity of nutrients supplied by organics, and remaining full quantity was applied through single super phosphate (SSP) and muriate of potash (MOP) in the mid of July. Observations on fruit size, fruit weight were recorded on random five fruit samples. Fruit quality parameters, *viz*., total soluble solids and total sugars (reducing and non reducing sugar) were determined as per standard procedures given in A.O.A.C. (1). The data generated during the course of study was subjected to statistical analysis as prescribed by Panse and Sukhatme (10).

RESULTS AND DISCUSSION

The combined application of bio-fertilizers, organic and inorganic fertilizers was found to be more effective than their individual application. Pooled data of two years (Table 1) revealed that the maximum tree height (4.94 m), trunk girth (67.05 cm), north-south spread (7.00 m), east-west spread (6.88 m), number of flowers/m^2 (15.72), number of fruits/m^2 (12.70) and fruit set (80.80%) with the treatment receiving 75% RDF + cowdung slurry @10 litre tree^{-1} + *Azospirillum* 100 g tree^{-1} + PSB 100 g tree^{-1} (T_6) followed by treatment 75% RDF + 25% NPK tree^{-1} blended with cowdung slurry @ 10 litre tree^{-1} (T_4) and it was minimum with the control (T_0). The observation of maximum tree height and trunk girth might be due to increased nutrient availability and uptake by application of 75% RDF + cowdung slurry @10 litre tree^{-1}and other biofertilizers. The maximum tree spread (N-S to E-W), number of flowers/m^2, number of fruits/m^2 and fruit set may be attributed due to the increased vegetative growth in terms of shoot length, number of leaves and number of branches with the application of 75% RDF + Cowdung slurry @10 litre tree^{-1} + Azospirillum 100 g tree^{-1} + PSB 100 g tree^{-1} (T_6). Cowdung slurry improves microbial distribution and increased moisture retention capacity in soil that results in greater enzymatic activities which improves the growth parameters (Binepal *et al.*, 4). The above result supported by the findings of Dhomane *et al.* (5) who described that due to the ample supply of nutrients had induced flowering and fruit set. The result are good agreement with the finding of Shinde and Malshe (11) who reported rapid growth of *Khirni* plant, might be due to the presence of growth promoting substances and nutrient by the application of cow dung slurry.

With regards to physical characteristics of guava fruits, pooled data presented in the Table 2 showed significant variation due to various integrated nutrient application treatments. The maximum fruit length (7.45 cm), diameter (7.73 cm), volume (207.24 cc) and pulp weight (186.16 g) were recorded with the treatment receiving 75% RDF + Cowdung slurry @10 litre tree^{-1} + *Azospirillum* 100 g tree^{-1} + PSB 100 g tree^{-1} (T_6) and minimum with the control (T_0). Seed

Table 1. Influence of integrated nutrient sources on growth and reproductive parameters of guava.

Treatment	Tree height (m)	Trunk girth (cm)	Tree Canopy spread (m)		Number of flowers/m^2	Number of fruits/m^2	Fruit set (%)
			N-S	E-W			
T_0	3.77	60.07	4.68	5.25	10.16	6.17	60.83
T_1	3.89	61.06	5.14	5.39	11.52	7.78	67.96
T_2	4.65	64.80	6.34	6.16	14.61	11.55	79.00
T_3	4.10	62.43	5.54	5.59	12.63	9.29	73.82
T_4	4.82	65.94	6.53	6.54	15.16	12.18	80.32
T_5	4.23	63.25	5.69	5.76	13.18	9.84	74.49
T_6	4.94	67.05	7.00	6.88	15.72	12.70	80.80
T_7	3.98	62.25	5.33	5.48	12.08	8.35	69.68
T_8	4.38	64.29	5.92	6.04	14.05	11.00	78.32
T_9	4.34	63.59	5.83	5.95	13.74	10.46	76.26
CD at 5%	0.10	0.30	0.11	0.05	0.26	0.32	0.40

Table 2. Influence of integrated nutrient sources on physical parameters of guava.

Treatment	Fruit size		Fruit volume (cc)	Pulp weight (g)	Peel weight (g)	Seed weight (g)
	Length (cm)	Diameter (cm)				
T_0	5.71	5.68	146.77	134.69	16.21	7.42
T_1	5.94	5.98	155.27	142.15	13.77	7.22
T_2	6.98	7.04	187.73	173.69	10.14	5.33
T_3	6.26	6.35	165.16	158.47	11.85	6.83
T_4	7.11	7.30	198.59	180.05	9.70	5.10
T_5	6.41	6.53	170.97	162.21	11.35	6.39
T_6	7.45	7.73	207.24	186.16	9.20	4.84
T_7	6.11	6.16	161.20	152.13	12.34	7.11
T_8	6.70	6.75	182.53	170.70	10.58	5.43
T_9	6.57	6.68	179.10	166.75	10.74	5.86
CD at 5%	0.38	0.31	4.23	2.69	0.30	0.10

weight (4.84g fruit^{-1}) and peel weight (9.20g fruit^{-1} were the lowest with the treatment (T_6) followed by T_4 + Azospirillum 100 g tree^{-1} + PSB 100 g tree^{-1} (T_8) and the highest value were recorded under the control (T_0). The increase in physical parameters by the application of chemical fertilizers, organics manure and biofertilizers might be due to optimum supply of plant nutrients in right amount during the entire crop period caused optimum vegetative growth and ultimately production of more photosynthates and the nutrient combinations that accelerate the metabolic activities of the plant (Shinde and Malshe, 11). The results are in conformity with the findings of Sharma *et al.*(12) who reported that increase in fruit length and fruit diameter was due to the balanced availability of macro and micro nutrients and also with the growth promoting substances by biofertilizers and organic manures. The minimum number of pulp and seed weight are good agreement with Mahapatra *et al.*, (9) who reported that the improvement in quality might be attributed to the improvement in soil physical properties like water holding capacity, structure, porosity, bulk density, hardiness and chemical as well as biological properties.

Integrated application of chemical fertilizers, organics manure and biofertilizers significantly influenced the chemical constituents of the fruit (Table 3). Results showed that significantly the highest total soluble solids (12.49 ^{0}B), ascorbic acid (236.42 mg 100 g^{-1} pulp), total sugars (8.37 %), reducing sugars (4.46%), non-reducing sugars (3.92%) and sugar: acid ratio (29.61) as well as the minimum values of acidity (0.28%) were recorded with the treatment receiving 75% RDF + Cowdung slurry @10 litre tree^{-1} + Azospirillum 100 g tree^{-1} + PSB 100 g tree^{-1} (T_6) and these parameters were found to be the minimum with the control except acidity (T_0). The improvement in ascorbic acid content, total soluble solids, total sugars and reduced acidity by the application of optimum dose of 75% RDF and cowdung slurry may be explained by the fact that phosphorus enters into the composition of phospholipids and nucleic acids, the latter combines with proteins that resulted in the formation of nucleo proteins which are important constituents of the nuclei of the cells (Sahu *et al.*, 14). Potassium acts as a catalyst in the formation of more complex substances and in the acceleration of enzyme activity. These carbohydrates and coenzymes are beneficial in the improvement of fruit quality. Nitrogen enhanced the uptake of phosphorus and potassium. The chain reactions in these components and beneficial effect of worms which is brought about by mucosal deposit of epidermal cells and coelomic fluids of earthworms, rich in plant growth substances and through rapid mineralization and transformation of plant nutrients in soil. Also exertion of 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.*, 12). Similar findings were also reported by (Shukla *et al.*, 15) in mango.

It is revealed from the pooled data given in Table 4 that the highest weight of fruit yield per tree (48.68 kg) and yield per hectare (13.48 tonnes) were recorded with the treatment receiving 75% RDF + cowdung slurry @10 litre tree^{-1} + *Azospirillum* 100 g tree^{-1} + PSB 100 g tree^{-1} (T_6) followed by treatment 75% RDF + 25% NPK tree^{-1} blended with cowdung slurry @ 10 litre tree^{-1} (T_4). The growth and yield in the combined application of organic and inorganic fertilizers is a result of the interaction between them which helped

Table 3. Influence of integrated nutrient sources on quality parameters of guava.

Treatment	TSS (°Brix)	Titratable acidity (%)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)	Ascorbic acid (mg/100g pulp)	Sugar: Acid ratio
T_0	9.60	0.53	6.88	3.78	3.10	192.57	12.97
T_1	10.09	0.50	7.09	3.85	3.24	201.82	14.07
T_2	11.38	0.33	8.08	4.30	3.78	227.44	24.24
T_3	10.14	0.46	7.33	4.02	3.31	216.36	15.99
T_4	11.93	0.31	8.15	4.38	3.77	230.22	26.69
T_5	10.56	0.38	7.56	4.11	3.39	220.19	19.75
T_6	12.49	0.28	8.37	4.46	3.92	236.42	29.61
T_7	10.16	0.49	7.21	3.93	3.28	212.75	14.77
T_8	11.22	0.36	7.85	4.21	3.64	224.28	22.19
T_9	10.69	0.37	7.71	4.18	3.53	222.98	21.13
CD at 5%	0.16	0.02	0.07	0.06	0.10	3.12	1.54

Table 4. Influence of integrated nutrient sources on economics of guava.

Treatment	Treatment cost (Rs.)	Total cost ha^{-1} (Rs.)	Yield (kg) per tree	Yield ha^{-1} (MT)	Gross returns (Rs.)	Net returns (Rs.)	B:C
T_0	0.00	45598.8	25.08	6.94	184000.0	138401.21	4.04
T_1	7997.88	53596.7	27.37	7.58	201750.0	148153.33	3.76
T_2	6638.77	52237.6	41.86	11.59	292250.0	240012.44	5.59
T_3	4662.76	50261.6	31.94	8.84	230000.0	179738.45	4.58
T_4	8624.51	56223.3	46.23	12.80	319000.0	262776.70	5.67
T_5	6648.5	52247.3	35.78	9.90	262250.0	210002.71	5.02
T_6	12325.37	57924.2	48.68	13.48	334000.0	276075.84	5.77
T_7	10349.36	55948.2	29.45	8.15	216250.0	160301.85	3.87
T_8	14311.11	59909.9	39.70	10.99	283000.0	223090.10	4.72
T_9	12335.1	57933.9	38.32	10.61	276500.0	218566.11	4.77
CD at 5%	-	-	1.21	0.33	49833.4	47209.5	0.73

in increasing the soil nutrient availability and their uptake by the plants that result in better vegetative growth which have produced the higher quantum of carbohydrates needed for the development of fruits thereby, increase in number, size and weight of fruits which ultimately leads towards getting higher yield in these treatment. However the next best treatment considered of the combinations of organics and biofertilizers i.e., 75% RDF + 25% NPK/tree blended with Cowdung slurry @10 litre/tree alone, may further be explained that it could be a result of inhibitor before chemical and organic fertilizers (K). The results were supported by the findings of (Sharma *et al*, 12) who reported that integrated application of organic manures made available nutrients directly to the trees, which had solublizing effect on fixed form of nutrients in soil and had improved physicochemical and microbial environmental leading to better excretion of response to applied chemical fertilizers. The increase in average fruit weight due to the integrant of organic sources nutrients occurrence due to accelerated nobility of photosynthesis from sources to sink as influenced by the growth hormones, released or synthesized due to organic sources of nutrients. Similar results were also reported by Sahu *et al*. (14) in guava.

An inquisition of the pooled data in Table 4 also depicted the general cost of guava cultivation was Rs. 45,598.8 per hectare including labour cost, cost of various inputs and over head costs. The gross returns from sale of guava fruits were calculated at an average price of Rs. 10000 per tonne. The net profits from cultivation under different treatments were worked out after subtracting the cost of cultivation from gross returns. The data revealed that the maximum net profit of Rs. 2,76,075.84 ha^{-1} was obtained under the treatment T_6 followed by T_4, whereas the minimum net profit was in control (1,38,401.21 ha^{-1}). As far as B: C ratio is concerned treatment T_6 gave B: C ratio of which means the gain of Rs. 5.77 per rupee of the cost incurred. Therefore, it may be inferred that T_6 was the most economical treatment because it gave the highest net returns and B: C ratio (5.77:1). The present study indicated that considering the benefit: cost ratio, the levels of inorganic fertilizers can be reduced by 25% and replaced by cowdung slurry without much reduction in the benefit: cost ratio in areas of non-availability of inorganic fertilizers. Beneficial effects of organic manures with high benefit: cost ratio was also reported in guava (Sharma *et al* 12; Shivakumar *et al.,* 13; Dhomane and Kadam, 6). Thus, from the present investigation, it may be concluded that among various combination of organic and inorganic sources and biofertilizers, the treatment of 75% RDF + cowdung slurry @10 litre $tree^{-1}$ + *Azospirillum* 100 g $tree^{-1}$ + PSB 100 g $tree^{-1}$ (T_6) was found to be superior to the other nutritional treatments as regards yield and B: C ratio of Sardar guava.

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