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Effect of bio-fertilizers on physico-chemical qualities and leaf mineral composition of guava grown in alluvial zone of West Bengal

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ABSTRACT

An investigation was carried out to study the effect of bio-fertilizers on physico-chemical qualities and leaf mineral composition of guava cv. L-49 grown in New Alluvial Zone of West Bengal, India during 2010-12. The experiment was conducted at the Horticultural Research Station, Mondouri in RCBD considering eight treatments with three replications. Among different treatments Azospirillum + Azotobacter + VAM was most effective in improving the fruit quality followed by Azotobacter + VAM. This treatment also resulted maximum content of leaf minerals (N, P and K). It may be concluded that bio-fertilizer combination Azospirillum + Azotobacter + VAM can be applied for quality fruit production of guava in New Alluvial Zone.

***Keywords*:** Bio-fertilizer, guava, leaf mineral composition and physico-chemical qualities

Guava (*Psidium guajava* L.) in considered to be one of the exquisite, nutritionally valuable and remunerative crops. The trees are quite hardy, prolific bearer and grow without much care. It is claimed to be fourth most important tropical fruits crop in India after mango, banana and citrus. Its' fruits have good taste, nourishing value and lot of vitamins and minerals. It is a rich and cheap source of vitamin C and pectin. Guava cultivation is getting popularity due to increasing international trade, nutritional contents and value added products. Indiscriminate use of inorganic chemical fertilizers resulted in high amount of chemical residues in field as well as in the crop produces leading to various environmental and health hazards along with socio-economic problem. Bio-fertilizers can be considered as the nutrient inputs of biological origin for plant growth. The beneficial effect of bio-fertilizers is now well established in many fruit crops like papaya (Sukhade *et al*., 1995), banana (Gogoi *et al.*, 2004) and mango (Ahmad *et al.*, 2004). But, scanty information is available on effect of bio-fertilizer on organic fruit production of guava particularly in the new alluvial zones of West Bengal. Keeping this view the present investigation was undertaken to produce residue free guava.

MATERIALS AND METHODS

The present investigation was carried out at the Mondouri, Horticultural Research Station located at the new alluvial zones of West Bengal during 2010-12. Twelve years old air layered L-49 guava plants having uniform vigour were selected for the study. Three types of bio-fertilizers were applied to the plants either alone or in combinations consisting of total eight treatments with three replications. The treatments were T_1-*Azospirillum*, T_2-*Azotobacter*, T_3-VAM, T_4-T_1+T_2, T_5- T_1+T_3, T_6- T_2+T_3, T_7-T_1+ T_2+T_3, T_8-control. The biofertilizers were collected from Nodule Research Centre of Bidhan Chandra Krishi Viswavidyalaya. Each plant received 50g of bio-fertilizer mixed with 5 kg of FYM in the month of August. Control plants were provided only with 5 kg FYM. Data on fruit weight, length of fruit and yield were recorded at maturity. Bio-chemical constituents like TSS, total sugar, acidity and ascorbic acid were estimated by following the standard method as described in A.O.A.C. (1984). Leaf mineral content was estimated by standard methods for nitrogen (Black, 1965), phosphorus (Jackson, 1960) and potassium (Piper, 1956). For leaf analysis third pair of leaves from apex of the shoot was collected in the month of November.

One way ANOVA technique was used to compare the means of different variables following Duncan's test at 5% level of significance. Stepwise discriminate analysis (DA) technique of replicated data was used following Wilk's lambda method with probability of F-in as 3.84 and F-out as 2.71. First two discriminant functions were used for displaying unstandardized coefficients and treatment wise group centroid values. Scatter diagram was drawn for these centroid values to show the relative positions of all treatments discriminated by key variables as selected by stepwise method. Principal component analysis (PCA) based

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upon correlation matrix technique was further used on mean values of all the variables to validate the classification resulted by discriminant analysis. Component loading for first two factors with Eigen values more than one is included and scatter diagram of regression factor scores was drawn. Discriminant analysis actually helps to diagnose the significant discriminators and precisely categorize the treatments. Thus such technique can very well represent the total variation of the experiment (Dillon and Goldstein, 1984). SPSS for Windows Standard Version 10.0.1 was used for all the analysis under analyze menu (i) Compare means sub-menu was used for ANOVA with Duncan';s test results; (ii) Data reduction sub-menu was used for Principal Component Analysis (PCA) and (iii) Classify sub-menu was used for discriminant analysis (DA).

RESULTS AND DISCUSSION

Significant improvement in fruit weight, length of fruit and yield (t ha^{-1}) were recorded (Table 1). Plants treated with *Azospirillum* + *Azotobacter* + VAM showed maximum (132.4 g) fruit weight followed by the treatment *Azotobacter* + VAM (T_6) while control recorded minimum fruit weight. Like fruit weight, maximum fruit length (5.92 cm) and yield (6.95 t ha^{-1}) were obtained in T_7 followed by T_6 while control recorded least. An increased yield of 7.38-18.63 % over the untreated control was recorded with the application of biofertilizers. Improved size and yield of guava with the application of bio-fertilizers were also obtained by earlier workers (Nath, 2001; Ram and Rajput, 1998). Motsara *et al.* (1995) reported 10-35 % increased yield with *Rhizobium* and 15-30 % increased yield with *Azospirillum* or *Azotobacter*.

Table 1: Effect of bio-fertilizers on yield of guava cv. L-49

Treatment	Fruit wt. (g)	Fruit length (cm)	Yield (t ha^{-1})	Increase in yield (%)
T_1	110.15 ^{c}	5.17 ^{c}	5.95 ^{c}	9.78
T_2	111.72 ^{c}	5.23 ^{c}	5.97 ^{c}	10.15
T_3	109.60 ^{c}	5.11 ^{c}	5.82 ^{cd}	7.38
T_4	112.15 ^{c}	5.32 ^{bc}	6.10 ^{bc}	12.50
T_5	124.00 ^{b}	5.60 ^{ab}	6.17 ^{b}	14.21
T_6	125.42 ^{b}	5.72 ^{a}	6.27 ^{b}	15.68
T_7	132.40 ^{a}	5.92 ^{a}	6.43 ^{a}	18.63
T_8	105.10 ^{d}	5.11 ^{c}	5.42 ^{d}	—
SEm (±)	**0.82**	**0.10**	**0.08**	—
LSD(0.05)	**3.38**	**0.43**	**0.32**	—

Note: Similar alphabets denote homogenous means due to Duncan's test at 5%

T_1-Azospirillum, T_2-Azotobacter, T_3-VAM, T_4-Azospirillum + Azotobacter, T_5-Azospirillum + VAM, T_6-Azotobacter + VAM, T_7-Azospirillum + Azotobacter + VAM, T_8-Control

Table 2: Physico-chemical qualities and leaf mineral content of guava cv. L-49

Treatment	TSS (^{0}Brix)	Total sugar (%)	Acidity (%)	Ascorbic acid (mg 100^{-1} g)	Nitrogen (% dry wt.)	Phosphorus (% dry wt.)	Potassium (% dry wt.)
T_1	8.20 ^{d}	6.13 ^{e}	0.30 ^{c}	155.10 ^{bc}	1.37 ^{a}	0.27 ^{d}	1.39 ^{b}
T_2	8.60 ^{bc}	6.70 ^{cd}	0.31 ^{b}	159.27 ^{b}	1.39 ^{a}	0.29 ^{d}	1.42 ^{b}
T_3	8.40 ^{cd}	6.60 ^{d}	0.33 ^{ab}	149.00 ^{d}	1.12 ^{b}	0.37 ^{bc}	1.19 ^{c}
T_4	8.90 ^{ab}	6.90 ^{bc}	0.34 ^{a}	151.22 ^{d}	1.47 ^{a}	0.34 ^{c}	1.40 ^{b}
T_5	8.40 ^{cd}	6.72 ^{bcd}	0.33 ^{ab}	153.45 ^{c}	1.29 ^{ab}	0.37 ^{bc}	1.42 ^{b}
T_6	8.90 ^{ab}	6.92 ^{b}	0.29 ^{c}	155.29 ^{bc}	1.31 ^{ab}	0.39 ^{ab}	1.45 ^{ab}
T_7	9.20 ^{a}	7.77 ^{a}	0.29 ^{c}	167.22 ^{a}	1.49 ^{a}	0.42 ^{a}	1.52 ^{a}
T_8	8.10 ^{d}	6.12 ^{e}	0.33 ^{ab}	142.55 ^{e}	1.02 ^{c}	0.23 ^{e}	1.11 ^{c}
SEm (±)	**0.10**	**0.07**	**0.01**	**1.40**	**0.07**	**0.01**	**0.03**
LSD (0.05)	**0.42**	**0.28**	**0.03**	**5.77**	**0.29**	**0.04**	**0.12**

Fruit quality in respect of total soluble solids, total sugar and ascorbic acid were significantly improved (Table 2). Maximum total soluble solids (9.20^0 brix), total sugar (7.77 %) and ascorbic acid (167.22 mg 100^{-1} g pulp) were obtained from plants treated with *Azospirillum* + *Azotobacter* + VAM followed by *Azotobacter* + VAM. The titratable acid content of fruit also varied significantly due to different treatments of bio-fertilizers. Both the treatments like T_7 and T_6 resulted minimum (0.29%) acidity in fruits while T_4 (*Azospirillum* + *Azotobactor*) showed maximum (0.34%) acidity in fruit (Table 2). The improved fruit quality may be attributed to better vegetative growth of the treated plants, which resulted in higher quantities of photosynthates (starch, carbohydrates etc.) and the translocation to the fruits thus increasing the contents of various fruits quality parameters (Naik and Haribabu, 2007). Result similar to present findings has also been reported with application of FYM and biofertilizers by Pathak and Ram (2004). The beneficial effect of bio fertilizers was also obsesced by Dutta and Kundu (2012) in Himsagar mango.

Leaf mineral (N, P, and K) content was also influenced by the application of bio-fertilizers. The treatment T_7 (*Azotobacter* + *Azospirillum* + VAM) exhibited maximum nitrogen (1.49%), phosphorus (0.42%) and potassium (1.52%) content in leaves (Table 2). This is in agreement with the findings of Ram *et al.* (2007) who obtained increased leaf mineral content of guava with the application of bio-fertilizer and organic manures.

Table 3: Unstandardized canonical discriminant function coefficients

Variables	Function	
	1	2
Fruit weight	0.55	0.15
Total sugar	4.24	6.67
Acidity	-77.35	87.64
Ascorbic acid	0.25	-0.29
Phosphorus	20.16	33.74
Potassium	16.49	-26.93
Constant	-136.53	-19.40
Eigen value	**215.76**	**34.18**
% of variance	**82.40**	**13.10**
Cumulative %	**82.40**	**95.40**

Table 4: Component matrix showing factor loading for first two factors (Principal components) and accounted for variances

Variables	Component	
	1	2
Fruit weight	0.94	0.17
Fruit length	0.93	0.20
Yield	0.96	0.14
TSS	0.88	0.22
Total sugar	0.90	0.29
Acidity	-0.65	0.56
Ascorbic acid	0.89	-0.37
Nitrogen	0.83	-0.47
Phosphorus	0.86	0.44
Potassium	0.89	-0.27
Eigen value	**7.66**	**1.15**
% of variance	**76.61**	**11.49**
Cumulative %	**76.61**	**88.09**

Stepwise discriminant analysis (DA) afforded 100% correct assignations of treatments on the basis of 6 variables out of 10 variables where acidity was in contrast to other variables showing that the treatments T_7 (*Azospirillum* + *Azotobacter* + VAM), T_6 (*Azotobacter* + VAM) and T_5 (*Azospirillum* + VAM) are responsible for low amount of acidity where as remaining treatments are high in acidity as described by the first function explaining 82.40 % of total variance. Second function described another 13.10 % of total variance where leaf K and fruit ascorbic acid content were high due to treatments like T_1 (*Azospirillum*), T_2 (*Azotobacter*) and T_6(*Azotobacter* + VAM). Such classification can be very well expressed by the unstandardized canonical discriminant function coefficients (Table 3) and scatter diagram of group centroids (Fig. 1) as resulted by DA.

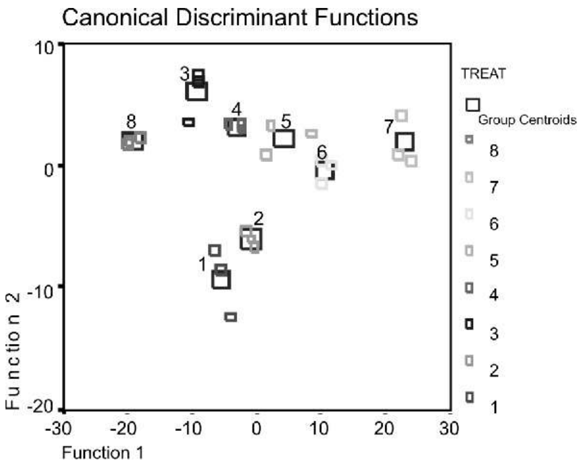

Fig 1: Scatter diagram of Centroids showing the discrimination of treatments

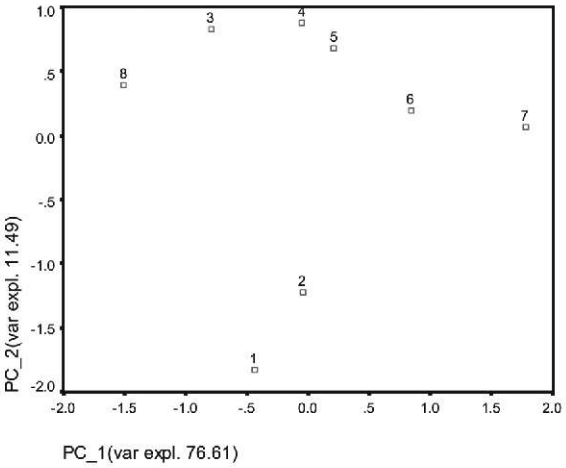

Fig 2: Scatter diagram showing relative position of eight treatments of bio-fertilizers for first two principal components

Principal component analysis (PCA) extracted component matrix along with accounted for variances and are displayed in table 4. This result revealed that 88.09% of total variances were accounted for first two components. First component alone explained about 76.61% of variance and all characters were positively and highly loaded in contrast to one character namely acidity. Second component explained more than 11.49% of variance further and fruit weight, length, yield, TSS, total sugar, acidity and P content were loaded positively in contrast to other characters.

Regression factor scores of all treatments for first two components were further expressed by a scatter diagram (Fig. 2). Such diagram clearly showed that T_7 (*Azospirillum* + *Azotobacter* + VAM) and T_6 (*Azotobacter* + VAM) were optimum in respect of all quality characters with minimum acid content.

It can be inferred from the present findings that the bio-fertilizer combination namely *Azotobacter* + *Azospirillum* + VAM can be applied for organic and quality guava production in New Alluvial Zone of West Bengal.

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