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Effect of organic manure, micronutrients with microbial inoculants application on bio-chemical and post-harvest quality of guava (*Psidium guajava* L.) cv. Allahabad Safeda

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Abstract
In Karnataka, Allahabad Safeda, Sardar (Lucknow-49) and red fleshed are the important varieties of guava. Majority of guava growing areas are nutrient deficient, shallow and gravel soils with low organic matter and fertility. In order to improve the fertility and nutrition status of soil with improving the fruit quality, a field investigation was carried out to study the effect of organic manure, micronutrients with microbial inoculants application on bio-chemical and post-harvest quality of guava cv. Allahabad Safeda at Main Agriculture Research Station, University of agricultural Sciences, Raichur, Karnataka, India during 2018-2019. Plants are supplemented with FYM slurry at basal along with micronutrients and microbial inoculants showed higher total soluble solids (19.53 ^{o} Brix), TSS: Acid ratio (87.7), reducing sugar (9.48%), non-reducing sugar (4.18%), total sugars (13.7%) ascorbic acid (199.96 mg/100 g of pulp) content lowest titratable acidity (0.22%), fruit pH (4.2), fruit puncturing strength (5 N), fruit firmness (61.15 N), shelf life days (6.54), physiological loss in weight and overall acceptability of fruit found in the treatment having FYM slurry at basal along with micronutrients and microbial inoculants.

Keywords: Organic, manure, micronutrients, microbial, inoculants, *Psidium guajava* L.

Introduction
Guava (*Psidium guajava* L.) is basically a hardy crop which can be grown satisfactorily on marginal soil with minimum care. It is one of the most important fruit crops of tropical and sub-tropical regions of India. Guava belongs to the family Myrtaceae, having chromosome number 2n=22. It is otherwise known as 'Apple of Tropics' and the fifth most important fruit in area and production (0.261 million ha, 3.91mt. respectively) NHB, 2017-18. Uttar Pradesh is the highest guava producing state accounting for about half of the total area of guava in the country. Allahabad has the reputation of growing the best guava of the world. The other important guava growing states are Karnataka, Bihar, Madhya Pradesh, Maharashtra, West Bengal and Andhra Pradesh. In Karnataka, Allahabad Safeda, Sardar (Lucknow-49) and red fleshed are the important varieties of guava. Majority of guava growing areas are nutrient deficient, shallow and gravel soils with low organic matter and fertility status. For improvement of soil organic matter necessary to apply organic manure which are scarly available in region. At present farmers applying organic manure in most unscientific manner and in most of case it is raw, undecomposed and placed above the soil in the form heap or simple dumped below plant canopy. It does not reaches root zone of plants. Hence major portion of organics remain unutilized due to lack of moisture and lead to loss of N, P, K due to leaching, washing, volatilization. Hence, an experiment is designed to standardise an efficient method of application of organic manure directly in the root zone in guava plant in light textured soils (Marathe *et al*., 2016).

Material and Methods
Field investigation was carried out at Main Agriculture Research Station, University of agricultural Sciences, Raichur, Karnataka, India during 2018-2019 to study the effect of method and time of organic manure applications, micronutrients with microbial inoculants on growth and yield of guava (*Psidium guajava* L.) cv. Allahabad Safeda. Treatments consist of T_1-FYM, normal practice, T_2-FYM slurry at basal, T_3-FYM slurry + micronutrients, T_4-FYM slurry two split application (basal dose + one month after first spilt), T_5-FYM slurry two split applications (basal dose + one month after first spilt) + micronutrients, T6-FYM slurry basal

Dose + Microbial inoculants, T_7-FYM slurry two split applications (basal dose + one month after first spilt) + microbial inoculants, T_8-FYM slurry + micronutrients + microbial inoculants, T_9-FYM slurry two split applications (basal dose + one month after pruning) + micronutrients+ microbial inoculants and T_{10}-Control. The experiment was laid out in Randomized Block Design (RCBD), with three replications under each treatment.

Total soluble solids of fruits was determined by using digital refractometer (ATAGO POCKET REFRACTROMETER PAL-1). Acidity was estimated by simple acid-alkali titration method as described in A.O.A.C. in (1970). Total soluble solids per cent was divided by acidity per cent to obtain TSS: Acid ratio. Titrimetric method described by Ranganna (1979) [5] was adopted for estimation of ascorbic acid. The reducing sugars content in the fruit sample was estimated by Nelson′s Somogyi method (Nelson, 1944). The non-reducing sugar content in the sample was worked out by deducting the value of reducing sugars from the value of total sugars in the sample. The pH of guava fruit was measured by using digital pH meter (make: Systronics; model: 361). The Hunter lab colorimeter (Model: Colour Flex EZ) was used to determine the colour of fruit. The firmness of the guava fruit was determined using the Texture Analyzer (Make: Stable Micro System; Model: Texture Export Version 1.22). The number of days taken from harvest to marketable stage was counted by keeping the fruits at ambient temperature. Observation was recorded every day in respect of the physiological loss in weight of fruits. The weights of the fruits were measured by using a weighing balance of ±0.001 g accuracy. Physiological loss in weight was expressed as per cent loss in weight using the formula given below (Kurubar, 2007).

$$\text{PLW (\%)} = \frac{\text{Initial fruit weight (g)-weight of fruits on the date of observation (g)}}{\text{Initial weight of fruit (g)}} \times 100$$

Organoleptic evaluation of guava fruit was done by a panel of five members. The observation was recorded based on hedonic scale.

Results and Discussion

Quality parameters

Plants are supplemented with FYM slurry at basal along with micronutrients and microbial inoculants. Higher total soluble solids (19.53 o Brix), TSS: Acid ratio (87.7), reducing sugar (9.48%), non-reducing sugar (4.18%), total sugars (13.7%) ascorbic acid (199.96 mg/100 g of pulp) content lowest titratable acidity (0.22%), fruit pH (4.2), fruit puncturing strength (5 N), fruit firmness (61.15 N), shelf life days (6.54), physiological loss in weight and overall acceptability of fruit found in the treatment having FYM slurry at basal along with micronutrients and microbial inoculants. Which was also on par with FYM slurry two split applications (basal + one month after pruning) with micronutrients and microbial inoculants FYM slurry with micronutrients, FYM slurry with microbial inoculants.

The improvement in ascorbic acid, total soluble solids, reducing and non-reducing sugars by the application of FYM slurry with micronutrients and microbial inoculants may be explained by the fact that phosphorus enters into the composition of phospholipids and nucleic acids, the latter combines with proteins and result in the formation of nucleo-proteins which are important constituents of the nuclei of the cells. Potassium acts as a catalyst in the formation of more complex substances and in the acceleration of enzyme activity. These carbohydrates and co-enzymes are beneficial in the improvement of fruit quality. Significantly increase in TSS may be attributed to increased absorption of nutrients by the plants as a result of improved physico-chemical and biological activities in the soil and the combined role of these inputs upon the better partitioning of metabolites from source to the sink. Similar results have also been reported by Binepal *et al.* (2013) [2] in mango. Fruit quality for consumption and fruit firmness is related with K nutrition, since, according to K supports the maintenance of cell turgor and it contributes to tissue resistance, but the NK combination affects fruit firmness along the maturation stages. Additionally, the bio-fertilizer enhanced the K uptake, which probably favored the fruit firmness increasing with a maximum value. The fruit colour increased by the combined application of nutrients may be explained that the phosphorus enters into the composition of phospholipids and nucleic acids were combine with proteins and results in formation of nucleo proteins which are important constituents of nuclei of the cells. Which was also on par with FYM slurry two split applications (basal + one month after pruning) with micronutrients and microbial inoculants FYM slurry with micronutrients, FYM slurry with microbial inoculants and minimum reducing sugars of guava was recorded in absolute control.

The results from the study on shelf life and organoleptic evaluation of guava fruit indicated that higher shelf life, better fruit colour, firmness, taste, aroma and overall acceptability score were high in application of FYM slurry with micronutrients and microbial inoculants. It was mainly because of enhanced vegetative growth of the plant which led to more photosynthates and their translocation in to the fruits by way of supplying of sufficient quantity of nutrients. Similar results are also reported by Shukla *et al.* (2009) [7], Sharma *et al.* (2013) [6] and Chandra *et al.* (2016) [3] in guava.

Table 1: Fruit quality characteristics as influenced by application of FYM slurry, micro-nutrients and microbial inoculants

	Treatment	TSS (^{0}Brix)	Titrable acidity (%)	TSS/Acid ratio	Ascorbic acid mg/100g of pulp	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)	pH
T1	FYM, normal practice.	15.83	0.32	49.83	163.92	4.38	3.5	7.89	4.1
T2	FYM slurry.	15.67	0.27	57.97	173.58	6.56	3.93	10.4	4.1
T3	FYM slurry +Micronutrients.	17.11	0.31	55.34	185.09	9.08	4.06	13.1	4.2
T4	FYM slurry two split application (basal + one month after first split).	15.83	0.34	47.47	172.86	7.1	3.86	11	4.1
T5	FYM slurry two split applications (basal + one month after first split) +Micronutrients.	16.47	0.36	46.06	179.44	8.32	4.05	12.4	4
T6	FYM slurry basal+ Microbial inoculants.	17.01	0.32	52.94	184.83	8.94	4.06	13	4.1

T7	FYM slurry two split applications (basal + one month after first split) + Microbial inoculants.	14.93	0.35	36.69	167.9	7.07	4.02	11.1	4.1
T8	FYM slurry + Micronutrients + Microbial inoculants.	19.53	0.22	87.7	199.96	9.48	4.18	13.7	4.2
T9	FYM slurry two split applications (basal +one month after first split) +Micronutrients+ Microbial inoculants.	16.53	0.25	65.4	177.48	8.64	4.11	12.7	4.2
T10	Control	12.6	0.37	40.89	161.27	4.02	3.26	7.29	4.1
	Mean	16.15	0.31	54.03	176.63	7.36	3.9	11.3	4.1
	S.Em ±	0.42	0.02	3.66	1.26	0.04	0.04	0.08	0
	CD (p=0.05)	1.23	0.05	10.88	3.75	0.12	0.13	0.23	0.1

RDF: Recommended dose of fertilizers.

Table 2: Fruit quality characteristics as influenced by application of FYM slurry, micro-nutrients and microbial inoculants

	Treatment	Fruit Firmness (N)	Colour			Fruit puncture strength (N)
			a*	b*	L*	
T_1	FYM, normal practice	41.06	56.69	-2.42	2.44	3.60
T_2	FYM slurry	36.85	52.66	-4.78	3.3	3.65
T_3	FYM slurry +Micronutrients	52.91	59.84	-2.49	3.34	4.85
T_4	FYM slurry two split application (basal + one month after first split)	39.91	39.68	-2.54	3.36	4.00
T_5	FYM slurry two split applications (basal + one month after first split) +Micronutrients	32.66	61.38	-4.51	3.98	3.70
T_6	FYM slurry basal+ Microbial inoculants	42.11	61.33	-3.96	3.32	3.85
T_7	FYM slurry two split applications (basal + one month after first split) + Microbial inoculants	39.23	51.66	-4.38	2.58	3.76
T_8	FYM slurry + Micronutrients + Microbial inoculants	61.15	61.95	-1.18	5.35	5.00
T_9	FYM slurry two split applications (basal + one month after first split) + Micronutrients + Microbial inoculants	61.14	61.38	-1.81	4.20	4.9
T_{10}	Control	37.65	32.32	-6.56	3.25	3.51

RDF: Recommended dose of fertilizers.

Table 3: Shelf life and organoleptic evaluation as influenced by application of FYM slurry, micro-nutrients and microbial inoculants

	Treatment	Shelf life days	Colour	Firmness	Taste	Aroma	Overall Acceptability
T_1	FYM, normal practice	5.98	7.00	7.50	6.50	6.50	8.00
T_2	FYM slurry	5.96	6.00	6.50	6.00	7.00	7.00
T_3	FYM slurry +Micronutrients	6.19	7.00	7.00	7.00	7.50	8.00
T_4	FYM slurry two split application (basal + one month after first split)	6.02	6.50	6.00	6.50	7.00	7.00
T_5	FYM slurry two split applications (basal + one month after first split) + Micronutrients	6.05	6.50	7.00	6.50	7.00	7.00
T_6	FYM slurry basal + Microbial inoculants	6.07	6.50	7.50	7.00	7.00	7.50
T_7	FYM slurry two split applications (basal + one month after first split) + Microbial inoculants	6.06	7.00	7.00	7.00	6.50	8.50
T_8	FYM slurry + Micronutrients + Microbial inoculants	6.54	8.00	8.50	7.50	8.00	9.00
T_9	FYM slurry two split applications (basal + one month after first split) + Micronutrients + Microbial inoculants	6.28	7.50	8.00	8.50	8.50	8.50
T_{10}	Control	5.94	6.50	5.00	6.35	6.00	6.50

RDF: Recommended dose of fertilizers.

Table 4: Physiological loss in weight as influenced by application of FYM slurry, micro-nutrients and microbial inoculants

	Treatment	Physiological loss in weight (%)					
		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
T_1	FYM, normal practice	5.26	7.53	14.94	19.05	29.87	40.85
T_2	FYM slurry	6.38	8.70	14.94	19.05	25.00	29.87
T_3	FYM slurry +Micronutrients	3.09	6.38	14.94	14.94	21.95	28.21
T_4	FYM slurry two split application (basal + one month after first split)	4.17	6.38	14.94	19.05	31.58	42.86
T_5	FYM slurry two split applications (basal + one month after first split) +Micronutrients	2.04	5.26	9.89	13.64	25.00	29.87
T_6	FYM slurry basal+ Microbial inoculants	3.09	5.26	11.11	14.94	25.00	28.21
T_7	FYM slurry two split applications (basal + one month after first split) + Microbial inoculants	3.09	6.38	17.65	21.95	26.58	31.58
T_8	FYM slurry + Micronutrients + Microbial inoculants	2.04	6.38	12.36	14.94	20.48	23.46
T_9	FYM slurry two split applications (basal +one month after first split) + Micronutrients + Microbial inoculants	3.09	5.26	11.11	14.94	25.00	28.21
T_{10}	Control	3.09	7.53	16.28	20.48	26.58	31.58
	Mean	0.97	0.94	0.88	0.85	0.80	0.76
	S.Em ±	0.01	0.01	0.02	0.02	0.03	0.03
	CD (p=0.05)	0.04	0.04	0.06	0.04	0.09	0.10

RDF: Recommended dose of fertilizer.

Conclusion

By enhancing the soil organic matter and easy availability, will helps to micro-organisms and also restoring soil fertility and biology, indirectly it will reduce side effects of chemical fertilizers and also help in releasing fixed plant nutrition from soil. Hence organic manure and bio-fertilizer help in soil fertility, also provide beneficial microbes to soil to make nutrients available to root zone with method of organic manure application. This study helped to understand the efficiency in nutrient application and method of application by applying (FYM slurry at basal along with micronutrients and microbial inoculants) has resulted maximum yield and quality of guava, which is due to that FYM slurry has reached effectively to the rhizosphere and increased the activity of applied bio-fertilizers and these instances made the plant to uptake nutrient effectively. While the pruning plants also resulted in better accumulation of nutrients in the productive shoots as it is balanced by providing the available carbohydrates to productive shoots. Substantially increased microbial population in the soil helped to fixed the atmospheric nitrogen and solubilize the fixed nutrients in the soil.

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