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Effect of Integrated Plant Nutrient Management On Growth and Yield Of Guava (*Psidium guajava* L.) cv. Allahabad Safeda

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ABSTRACT
An experiment was conducted to study the "Integrated Plant Nutrient Management in Guava (Psidium guajava L.)" cv. Allahabad Safeda in the Experimental Farm and Laboratory, Department of Horticulture, Assam Agricultural University, Jorhat during 2015-2017. A total of 9 (nine) treatments including a control with three replications and two seasons were laid out in a Randomized Block Design. During the period of investigation, the treatments showed varied response to flowering, fruiting, yield attributing characters and yield. The highest flowers per branch (22.67), fruit set (79.52%) and the fruits per branch (18.00) were recorded in treatment T_8 (Half of RDF + 10kg Vermicompost +100g microbial consortium + 0.4% $ZnSO_4$ + 0.4% Boric Acid) during the rainy season. The highest fruit length (10.12cm), fruit girth (21.28cm), fruit weight (163.12g), fruit volume (141.42cc) and number of days for maturity (128.29 days) were recorded the highest in T_8 during the winter season while the lowest was recorded in T_0 (Control). The yield was found to be the highest (24.24kg/plant) in T_8 during the rainy season.
Key words: Boric acid, IPNM, microbial consortium, vermicompost, zinc sulphate.

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INTRODUCTION

Guava (*Psidium guajava* L.), "the apple of tropics" is one of the most important fruit crop. It is a sub-tropical fruit, because of its high nutritive value and possibilities of cultivation even under adverse conditions. The fruit is native to Tropical America, stretching from Mexico to Peru, and were domesticated more than 2000 years ago. It was introduced by the Portuguese in India during 17th century. In India, its position is fourth after mango, banana and citrus in terms of area and production. The area under guava cultivation in the country is 1078 thousand hectares with a production of 11147 thousand metric tons. Guava occupies about 14.92 per cent of the total area under fruits and accounts for about 12.5 per cent of the total fruit production in India. Guava occupies a place of considerable importance in the fruit economy of the country [8].

Guava trees are prolific bearer and to maintain its vigour, growth and productivity for a long time, it needs proper nourishment. Without proper management, continuous fruit production reduces nutrient reserves in the soil and thus, affects crop growth and productivity adversely. Replenishment of lost quantities of the nutrients is, therefore, necessary to maintain the fertility status of the soil and to get good crop in the following years. Therefore, a careful management is required to produce a profitable crop which includes cultural practices and obviously the fertilization and nutrition of orchard. Nutrition is most important factor affecting growth, yield and quality of a crop. Unless, it is maintained at an optimum level, higher yield and better fruit quality cannot be maintained. However, the increasing cost of fertilizers and their adverse effects on soil all over the world have made it necessary to think in terms of supplementing the soil with alternative sources which render soil more productive and gave higher yield and better quality [18].

Over the years, the concept of integrated plant nutrient management (IPNM) system is gaining momentum in India with arising threat to the food and nutritional security and loss of natural resources particularly during the last five decades. Integrated plant nutrient management (IPNM) refers to maintenance of soil fertility and plant nutrient supply to an optimum level for sustaining the desired crop productivity through optimization of the benefits form all possible source of plant nutrient in an

integrated manner. It involves proper combination of chemical fertilizers, organic manure and biofertilizers suitable to the system of land use and ecological, social and economic conditions.
There is an urgent need for an alternative nutritional package to attain long term sustainability for fruit production as well as for maintaining soil health and productivity under IPNM system.

MATERIALS AND METHODS

An experiment was conducted in the Experimental Farm and Laboratory, Department of Horticulture, Assam Agricultural University, Jorhat during 2015-2017. The experimental site was situated at 26°47'N latitude and 94°12'E longitude having an elevation of 86.8m above mean sea level. The treatments comprising of T_0: Recommended dose of fertilizers (RDF) and manures as control; T_1: T_0 + 0.4% $ZnSO_4$; T_2: T_0 + 0.4% Boric Acid; T_3: T_0 + 0.4% $ZnSO_4$ + 0.4% Boric Acid; T_4: Half of RDF + 20kg FYM + 100g microbial consortium; T_5: Half of RDF + 20kg FYM + 100g microbial consortium + 0.4% $ZnSO_4$ + 0.4% Boric acid; T_6: Half of RDF + 10kg Vermicompost + 100g Microbial consortium; T_7: Half of RDF + 10kg Vermicompost + 0.4% $ZnSO_4$ + 0.4% Boric Acid; T_8: Half of RDF + 10kg Vermicompost +100g microbial consortium + 0.4% $ZnSO_4$ + 0.4% Boric Acid. The microbial consortium was the mixture of four different groups of biofertilizers (Phosphate solubilizing bacteria, *Azotobacter*, *Azospirillum,* and *Rhizobium*) in 1:1:1:1 ratio.
Among the chemical fertilizers, 500g: 1500g: 400g NPK tree^{-1} was applied as control along with 20kg FYM. NPK along with FYM, Vermicompost and microbial consortium was applied in two seasons, one during the month of October 2015 and other during the last week of April 2016. The trees were sprayed with zinc sulphate (0.4%) and boric acid (0.4%) as per treatments, with the help of a hand sprayer. The sprays were given in November and May (single foliar spray). Rings were prepared at a distance of 1m from the tree trunk for the application of fertilizers and manures. Observation on fruit length, fruit girth, fruit weight, fruit volume, number of days for maturity and yield was recorded and presented in Table 1, 2 and 3.The statistical analysis was carried out to know the variance for each parameter and effect of treatments using the standard procedure.

RESULTS AND DISCUSSION

Flowering and Fruiting Characters

The emergence of flowers per branch was found to be significant under different treatments in both the seasons during the course of investigation. However, less number of flower buds were observed in plants during winter season as compared to the rainy season. Similarly, the fruits per branch were found to be the highest during the rainy season. This may be due to the excessive exhaustion of the tree during the rainy season in both the years. The application of biofertilizers are known to stimulate the rate of biosynthesis of plant growth regulators (auxins, gibberellins and cytokinins), which established the endogenous balance between promoters and inhibitors in favour of fruit promoting process [19]. Therefore, the increase in fruit set in the present study might be due to the role of microbial consortium in producing growth hormones, enzymes, antifungal and antibacterial compounds which in turn enhanced fruit set. The presence of microbial consortium and FYM in soil not only increased the availability of N and P to the plant roots but also increased their mobility from roots to flower. The highest number of flowers were found in T_8 (Half of RDF + 10kg Vermicompost +100g microbial consortium + 0.4% $ZnSO_4$ + 0.4% H_3BO_3) in both the season during the course of investigation. This is simply because of the fact that, with the use of FYM enriched with microbial consortium along with recommended dose of fertilizers, micronutrients are better available to these plants throughout the year. These results were in accordance with the findings of Gautam *et al.* [7], Ahmed *et al*. [1], Naik and Babu [11] and Dutta *et al*. [7].
The per cent fruit set, fruit drop and fruit retention differed significantly among the treatments during the course of investigation. It was clear from the rainy and winter season data that, the highest per cent of fruit set and fruit retention was observed with the treatment T_8 (Half of RDF + 10kg Vermicompost +100g microbial consortium + 0.4% $ZnSO_4$ + 0.4% H_3BO_3) and the lowest was found in control plants which may be due to deficiency of micro elements which is largely required by the plants to set fruits. The results on per cent fruit drop revealed that, there was heavy fruit drop during the rainy season as compared to the winter season. The higher fruit drop in rainy season might be due to lower photosynthetic reserve, less canopy volume to translocate sugar for more number of developing fruits, high humidity and more incidences of insect, pest and diseases during rainy days. On the other hand, for winter season crop, the trend was similar but the fruit drop was reduced. The more fruit retention and lesser fruit drop in winter season might to due to the long crop duration, favourable climatic factors like low temperature, full

sunlight, optimum dry to humid weather, optimum soil moisture level and comparatively less incidence of insect-pests and disease [17,11].

Physical parameters

The highest fruit length, girth, weight and volume were also produced by plants which were treated with T_8 (Half of RDF + 10kg Vermicompost +100g microbial consortium + 0.4% $ZnSO_4$ + 0.4% H_3BO_3) as compared to the control plants, in both the season. Small fruits having the lightest weight were produced by control trees during both rainy and winter season; this might be due to the deficiency of nutrients or optimum soil condition for uptake of nutrients for the growth and development of fruits produced in control plants. Experimental results are also in accordance with the findings of Athani *et al.* [2] and Dudi *et al.* [5].

The increase in fruit length and girth might be due to the optimum supply of plant nutrients, micronutrients and biofertilizers which encouraged better growth and accumulated optimum dry matter with induction of growth hormones, which stimulated cell division, cell elongation, activate the photosynthesis process, enhances translocation of water and nutrients, growth and development of roots as well as energy transformation which in turn caused increase in number and weight of the fruits and other physical characters. The present findings are in accordance with the results reported by RubeeLata *et al*. [16], Ibrahim *et al.* [9], Chandra *et al*. [4] in guava. The nutrient combinations accelerated the metabolic activities of the plant.

Table 1: Effect of IPNM on flowers per branch, fruit set, fruits per branch, fruit length and fruit girth

Treatment	Flowers per branch			Fruit set %			Fruits per branch			Fruit length (cm)			Fruit girth (cm)		
	Rainy	Winter	Pooled	Rainy	Winter	Pooled	Rainy	Winter	Pooled	Rainy	Winter	Pooled	Rainy	Winter	Pooled
T_0	11.00	7.70	9.35	48.74	47.87	48.30	5.33	3.67	4.50	6.30	6.52	6.41	17.82	18.17	18.00
T_1	13.33	10.60	11.97	57.54	56.60	57.07	7.67	6.00	6.83	7.62	7.66	7.64	18.49	18.68	18.59
T_2	12.33	8.66	10.50	54.08	53.94	54.01	6.67	4.67	5.67	7.30	7.59	7.45	18.03	18.56	18.30
T_3	15.00	11.00	13.00	62.18	61.21	61.70	9.33	6.67	8.00	7.80	7.90	7.85	18.77	19.14	18.96
T_4	16.00	13.20	14.60	64.57	63.13	63.85	10.33	8.33	9.33	8.17	8.37	8.27	19.23	19.26	19.25
T_5	18.67	15.00	16.83	75.14	73.71	74.42	14.00	11.00	12.50	9.18	9.30	9.24	20.09	20.12	20.10
T_6	17.33	13.67	15.50	69.21	68.28	68.74	12.00	9.33	10.67	8.46	8.71	8.59	19.78	19.89	19.83
T_7	20.67	16.00	18.33	77.54	77.16	77.35	16.00	12.33	14.17	9.35	9.56	9.45	20.69	20.72	20.71
T_8	22.67	19.33	21.00	79.52	75.79	77.65	18.00	14.67	16.33	9.99	10.12	10.05	21.20	21.28	21.24
Mean	16.33	12.80		65.39	64.19		11.04	8.52		8.24	8.41		19.35	19.54	
S.Ed	0.220	0.329		1.736	3.236		0.160	0.248		0.113	0.089		0.080	0.166	
CD-5%	0.467	0.697		3.681	6.860		0.478	0.525		0.239	0.188		0.170	0.351	
	S.Ed	CD-5%		S.Ed	CD-5%		S.Ed	CD-5%		S.Ed	CD-5%		S.Ed	CD-5%	
Treatment	0.501	1.019		3.246	6.597		0.313	0.636		0.116	0.235		0.152	0.309	
Season	0.236	0.480		1.530	3.110		0.418	0.300		0.054	0.111		0.072	0.146	
Season x Treatment	0.709	1.441		4.591	9.330		.0.443	0.900		0.163	0.332		0.215	0.437	

The possible explanation for increase in pulp weight might be due to higher fruit weight and size. Since seed per fruit was inversely proportional to pulp weight therefore, T_8(Half of RDF + 10kg Vermicompost +100g microbial consortium + 0.4% $ZnSO_4$ + 0.4% H_3BO_3) resulted in the lowest seeds per fruit and also due to their dominating role to the accumulation of flesh in the fruit recorded the lowest seeds per fruit. Lowest seed weight was observed under treatment T_8 which might be due to small size of the seeds. The reason for increasing pulp seed ratio under treatment T_8 might be due to proportionally higher pulp content and reduced seed weight of fruits.

Yield and Yield Attributing Characters

The number of fruits and yield (kg) per tree had been significantly affected by various treatments during the course of investigation. Treatment T_8 (Half of RDF + 10kg Vermicompost +100g microbial consortium + 0.4% $ZnSO_4$ + 0.4% H_3BO_3) shown significant affect on all these characters as compared to control plants in both the seasons. It might be due to huge number of flowers or fruit set in this treatment. Again it is clear that, number of fruits and yield (kg) were higher in rainy season as compared to the winter season. The higher yield with combinations of organic and inorganic sources of nutrients could be attributed to sustain availability of major as well as trace elements which was evident from the higher accumulation of nutrients by guava plant from soil. The similar observation had been reported by Patra *et al.* [14] under integrated nutrient management.

Table 2: Effect of IPNM on fruit weight, fruit volume, pulp weight per fruit, seed weight per fruit and seeds per fruit.

Treatment		T_0	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	Mean	S.Ed	CD-5%		Treatment	Season	Season x Treatment
Seeds per fruit	**Pooled**	355.83	341.50	345.50	332.67	338.00	323.83	317.00	306.33	293.33							
	Winter	355.67	34 1.33	342.33	337.33	339.33	324.33	318.00	305.00	291.67	328.33	3.798	8.051	**CD-5%**	6.999	3.299	9.897
	Rainy	356.00	341.67	348.67	328.00	336.67	323.33	316.00	307.67	295.00	328.11	1.547	3.279	**S.Ed**	3.444	1.623	4.870
Seed weight per fruit (g)	**Pooled**	5.24	5.10	5.17	4.95	5.02	4.86	4.80	4.71	4.62							
	Winter	5.24	5.10	5.18	4.95	5.00	4.88	4.82	4.73	4.61	4.94	0.044	0.093	**CD-5%**	0.090	0.043	0.128
	Rainy	5.23	5.09	5.17	4.94	5.03	4.85	4.78	4.70	4.62	4.94	0.017	0.036	**S.Ed**	0.045	0.021	0.063
Pulp weight per fruit (g)	**Pooled**	103.35	115.16	109.33	123.26	128.03	139.03	133.12	145.26	152.03							
	Winter	106.19	119.70	113.74	127.04	131.95	141.84	135.96	146.56	152.46	130.60	1.326	2.810	**CD-5%**	3.336	1.573	4.718
	Rainy	100.51	110.62	104.93	119.48	124.11	136.23	130.27	143.95	151.59	124.63	0.996	2.112	**S.Ed**	1.642	0.774	2.322
Fruit volume (cc)	**Pooled**	89.67	100.57	94.00	109.86	115.25	128.23	120.82	135.94	140.92							
	Winter	91.24	103.67	95.53	112.81	117.88	128.97	121.97	137.01	141.42	116.72	1.095	2.321	**CD-5%**	3.965	1.869	5.608
	Rainy	88.09	97.47	92.48	106.91	112.62	127.49	119.68	134.86	140.43	113.34	0.763	1.618	**S.Ed**	1.951	0.920	2.759
Fruit weight (g)	**Pooled**	104.62	120.04	115.31	130.97	137.87	147.97	142.31	154.91	161.56							
	Winter	110.98	122.02	122.60	138.79	139.94	148.08	145.16	158.19	163.12	138.88	1.839	3.898	**CD-5%**	5.009	2.361	7.084
	Rainy	98.25	118.07	108.02	123.16	135.79	146.86	139.46	151.63	159.99	131.25	2.505	5.310	**S.Ed**	2.465	1.162	3.486

Table 3: Effect of IPNM on pulp seed ratio, fruit drop, days required for maturity and yield.

Treatment	Pulp seed ratio			Fruit drop (%)			Days required for maturity			Yield (kg/plant)		
	Rainy	Winter	Pooled	Rainy	Winter	Pooled	Rainy	Winter	Pooled	Rainy	Winter	Pooled
T_0	19.21	20.28	19.75	62.33	49.17	55.75	124.17	132.62	128.40	11.00	8.08	9.54
T_1	21.73	23.46	22.60	53.41	47.33	50.37	122.52	132.04	127.28	11.40	9.10	10.25
T_2	20.30	21.98	21.14	55.22	47.67	51.44	123.33	132.33	127.83	12.68	9.78	11.23
T_3	24.17	25.67	24.92	53.38	46.07	49.73	122.37	131.48	126.93	13.32	10.74	12.03
T_4	24.66	26.37	25.51	52.56	45.37	48.97	122.29	131.26	126.78	13.04	10.26	11.65
T_5	28.11	29.08	28.60	48.52	43.52	46.02	120.67	128.55	124.61	18.70	15.25	16.98
T_6	27.24	28.22	27.73	49.18	44.63	46.90	121.67	129.42	125.54	19.30	16.00	17.65
T_7	30.65	31.01	30.83	46.26	41.71	43.99	119.41	127.41	123.41	20.00	16.50	18.25
T_8	32.79	33.07	32.93	43.66	38.70	41.18	120.22	128.29	124.25	24.24	20.00	22.12
Mean	25.43	26.57		51.61	44.91		121.85	130.38		15.96	12.86	
S.Ed	0.204	0.408		0.141	0.207		0.156	0.151		0.215	0.222	
CD-5%	0.432	0.866		0.299	0.439		0.331	0.321		0.465	0.470	
	S.Ed	**CD-5%**		**S.Ed**	**CD-5%**		**S.Ed**	**CD-5%**		**S.Ed**	**CD-5%**	
Treatment	0.381	0.773		0.430	0.874		0.173	0.351		0.245	0.497	
Season	0.179	0.365		0.203	0.412		0.081	0.166		0.115	0.234	
Season x Treatment	0.538	1.094		0.608	1.236		0.244	0.497		0.346	0.703	

There was increased number of fruits per plants in guava during both the seasons with the application of 50 per cent RDF, vermicompost, FYM, microbial consortia, zinc and boric acid. The results of the present findings were in the agreement with the findings of Jadhao *et al.* [10] and Athani *et al.* [2] in guava crop. The possible reason of increase in number of fruit and yield was due to adequate supply of nutrient, better growth and development of plants. The yield in control plants had shown significantly lower value than all other treatment. This was simply due to less availability of nutrients to the control plants. Results of present experiment in respect of yield and yield contributing factors were in close conformity with the findings of Ram *et al.* [15], Pathak and Ram [12] and Patra *et al.* [13].

CONCLUSION

From the above discussions it can be concluded that among all the treatments, treatment T_8 (Half of RDF + 10kg Vermicompost +100g microbial consortium + 0.4% $ZnSO_4$ + 0.4% H_3BO_3) recorded significantly the highest values for most of the growth, flowering, yield and yield attributing characters.

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