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Effect of integrated nutrient management on growth and quality of guava (*Psidium guajava* L)

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ABSTRACT

The field experiment was conducted at IHITC, Jaipur, Rajastahan during 2017 and 2018. The experiment consisted of 24 treatment combinations comprising four levels of recommended dose of fertilizers, two levels of bio-fertilizers and three levels of micronutrients under factorial randomized block design with three replications. The results revealed that application of 125 per cent NPK, 50 g *Azotobacter* and 0.4 per cent $ZnSO_4$ significantly increased the vegetative parameters like plant height and plant spread (E-W and N-S). Significant increase in qualitative attributes like total soluble solids, ascorbic acid, total sugars, reducing sugar, sugar-acid ratio, pectin content and minimum acidity content were also recorded in the same treatment.

Keywords: Growth; quality; micronutrients; bio-fertilizers; INM

INTRODUCTION

Guava (*Psidium guajava* L) is the most important, highly productive, delicious and nutritious fruit grown commercially throughout tropical and sub-tropical zones of India. The fruit (berry) is wonderful source of vitamin C (210-305 mg/100 g fruit pulp) and pectin (0.5-1.8%) but has low energy (66 cal/100 g). The ripe fruits contain 12.3-26.3 per cent dry matter 77.9-86.9 per cent moisture, 0.51-1.02 per cent ash, 0.10-0.70 per cent crude fat, 0.82-1.45 per cent crude protein and 2.0 to 7.2 per cent crude fiber. The fruit is also sound in minerals like phosphorus (22.5-40.0 mg/100 g pulp), calcium (10.0-30.0 mg/100 g pulp) and iron (0.60-1.39 mg/100 g pulp) as well as vitamins like niacin (0.20-2.32 mg/100 g pulp) (Mitra and Bose 2001).

Integrated nutrient management (INM) includes the combined use of organics (viz manures, compost, bio-fertilizers, green manure, crop residues etc) and inorganic fertilizers to increase crop yield and farmers' profits, improve crop quality and lower the nutrient losses to environment. INM in guava refers to prolongation of soil fertility and plant nutrient supply to a perfect level for supporting the desired crop productivity and fruit quality through maximizing of benefits from all possible sources in an integrated manner.

Zn has important role in starch metabolism and acts as compound for many enzymes, affects photosynthesis reaction, nucleic acid metabolism and protein biosynthesis (Alloway 2008). Similarly boron is vital element for cell division and development in the growth zones of the apex of shoots and roots. It also influences sugar transport and seems to be associated with the functions of calcium. Iron is essential for vital plant metabolic function such as chlorophyll synthesis, various enzymatic reactions, respiration and photosynthesis. Given that the main product of photosynthesis is sugar, so increasing the photosynthesis leads to increase in the sugar compounds and causes more total soluble solids in fruit juice (Ram and Bose 2000).

Amongst various organic manures, vermicompost is an environmentally sound natural fertilizer prepared from re-cyclable organic wastes and lacks chemical inputs. Vermicompost is wealthy in favourable micro-flora such as N fixers, P solubilizers, cellulose decomposing micro-flora etc. It contains earthworm cocoons which improve the inhabitant and activity of earthworms in the soil and also contains valuable vitamins, enzymes and hormones like auxins, gibberellins etc that improve the decomposition of organic matter in soil, soil structure, texture, aeration and moisture holding capacity and prevent soil erosion. It also improves nutrient status of soil both micro and macronutrients, water retention capacity of soil due to its high organic matter content and improves healthier root growth and nutrients absorption (Sinha et al 2009). Bio-fertilizers contain microorganisms which have potential of mobilizing nutrient elements from immovable to movable through biological processes.

Azotobacter and PSB are the bio-fertilizers which nourish the plants and soil by exudating the growth encouraging chemicals and vitamins. *Azotobacter* is helpful in fixing the atmospheric nitrogen in the rhizosphere of the plants whereas PSB solubilise insoluble fixed phosphates found in the soils. These bio-fertilizers are organic in nature hence they are absolutely attentive and provide mechanical assist, vigour and soundness of the seedlings (Tilak and Annapurna 1993).

MATERIAL and METHODS

The experiment was conducted on grafted guava plants in the orchard of International Horticulture Innovation and Training Center (IHITC), Durgapura, Jaipur, Rajasthan during June to December months of 2017 and 2018. Geographically this place is situated at 75^{o} 47’ East longitude and 26^{o} 51’ North latitude at an altitude of 390 m amsl in Jaipur district of Rajasthan. This region falls under agro-climatic zone IIIa (semi-arid eastern plain zone) of Rajasthan.

The experiment was laid out in factorial randomized block design with 24 treatment combinations having three replications. The treatments consisted of four levels of RDF viz F_1 (50% NPK + 50% organic on N equivalent through vermicompost), F_2 (75% NPK), F_3 (100% NPK) and F_4 (125% NPK); two bio-fertilizers viz B_1 (*Azotobacter* 50 g/plant) and B_2 (PSB 50 g/plant) and three micronutrients viz M_1 ($ZnSO_4$ 0.4%), M_2 (H_3BO_3 0.4%) and M_3 ($FeSO_4$ 0.4%).

RESULTS and DISCUSSION

Effect of INM on growth parameters

Application of F_4 (125% NPK) was found to be the best treatment in respect of gain in plant height and gain in plant spread in guava as shown in Table 1.

This increment in vegetative growth might be due to more absorption of nitrogen, phosphorus and potassium by the plant which combined with carbohydrates in the leaves lead to formation of amino acids, proteins, chlorophyll and other amides. These effects increase the photosynthetic activity of the plants and greater synthesis of carbohydrates which are responsible for building up of new tissues and are associated with a number of metabolic processes which in turn favour better development of plants hence enhance the stem growth.

Similar results have been reported by Khan et al (2018) in guava where highest plant height was obtained through the application of NPK (120% RDF). Sahu et al (2015), Kumar et al (2010), Baksh et al (2008) and Bhobia et al (2005) also reported similar findings in guava.

Application of bio-fertilizers significantly increased plant height and plant spread (N-S and E-W) in guava. *Azotobacter* (50 g) proved most effective in the increment of plant height and plant spread followed by PSB (50 g). The results of present findings are also corroborated with the findings of Singh et al (2020), Kumar et al (2017) and Shukla et al (2014) in guava.

Different micronutrient sprays had significant influence on the growth characters of guava by registering positive response with increase in plant height and plant spread. Similar to the present results, significant increase in plant growth characters was also reported in guava by Kumar et al (2010), Waskela et al (2013) and Arshad and Ali (2016) in guava.

Effect of INM on quality attributes

In any production system, the primary goal is to obtain maximum fruit yield per unit area without affecting the fruit quality. In guava, apart from average fruit weight, the quality is determined by pectin content, total soluble solids, total sugars and sugar-acid ratio. The results presented in Table 2 clearly indicate that the application of recommended doses of fertilizers,

Table 1. Effect of integrated nutrient management on plant height and plant spread of guava

Treatment	Growth attribute		
	Gain in plant height (m)	Gain in plant spread E-W (m)	Gain in plant spread N-S (m)
RDF level			
F_1	0.77	0.60	0.59
F_2	0.86	0.69	0.69
F_3	0.92	0.74	0.76
F_4	0.95	0.77	0.78
SEm±	0.01	0.01	0.01
$CD_{0.05}$	0.04	0.03	0.03
Bio-fertilizer			
B_1	0.95	0.81	0.80
B_2	0.80	0.59	0.61
SEm±	0.01	0.01	0.01
$CD_{0.05}$	0.03	0.02	0.02
Micronutrient			
M_1	0.95	0.74	0.75
M_2	0.92	0.73	0.74
M_3	0.77	0.64	0.64
SEm±	0.01	0.01	0.01
$CD_{0.05}$	0.04	0.02	0.03
CV (%)	10.16	8.15	9.33

F_1: 50% NPK + 50% organic on N equivalent through vermicompost, F_2: 75% NPK, F_3: 100% NPK, F_4: 125% NPK; B_1: *Azotobacter* 50 g/plant, B_2: PSB 50 g/plant; M_1: ZnSO 0.4%, M_2: H_3BO_3 0.4%, M_3: $FeSO_4$ 0.4%

Table 2. Effect of integrated nutrient management on quality attributes of guava

Treatment	Attribute						
	TSS (ºBrix)	Acidity (%)	Ascorbic acid (mg/100 g pulp)	Total sugars (%)	Reducing sugar (%)	Sugar-acid ratio	Pectin content (%)
RDF level							
F_1	10.37	0.47	212.23	7.06	3.78	20.71	0.92
F_2	11.50	0.46	261.23	8.40	4.29	20.76	1.14
F_3	12.32	0.41	302.70	9.39	4.62	21.10	1.24
F_4	12.59	0.31	310.66	9.57	4.79	23.57	1.26
SEm±	0.07	0.01	1.95	0.06	0.03	0.16	0.01
$CD_{0.05}$	0.19	0.01	5.44	0.16	0.08	0.46	0.02
Bio-fertilizer							
B_1	12.59	0.38	286.53	8.81	4.51	22.76	1.22
B_2	10.81	0.44	256.88	8.41	4.23	20.31	1.06
SEm±	0.05	0.01	1.38	0.04	0.02	0.12	0.00
$CD_{0.05}$	0.13	0.01	3.85	0.11	0.06	0.32	0.01
Micronutrient							
M_1	12.49	0.41	294.37	9.20	4.66	23.30	1.22
M_2	12.25	0.42	286.83	8.91	4.44	21.51	1.13
M_3	10.35	0.40	233.91	7.71	4.01	19.80	1.07
SEm±	0.06	0.01	1.69	0.05	0.03	0.14	0.01
$CD_{0.05}$	0.16	0.01	4.71	0.14	0.07	0.40	0.02
CV (%)	3.47	4.91	4.30	3.97	4.02	4.56	3.71

F_1: 50% NPK + 50% organic on N equivalent through vermicompost, F_2: 75% NPK, F_3: 100% NPK, F_4: 125% NPK; B_1: *Azotobacter* 50 g/plant, B_2: PSB 50 g/plant; M_1: ZnSO 0.4%, M_2: H_3BO_3 0.4%, M_3: $FeSO_4$ 0.4%

bio-fertilizers and micronutrients in different combinations had pronounced effect on quality attributes viz TSS, acidity, ascorbic acid, total sugars, reducing sugar, total sugar-acid ratio and pectin content of guava fruit.

Optimum nutrition is the most important factor governing sweetness of fruits. Among the various treatments of recommended doses of fertilizers, application of 125 per cent dose of NPK (F_4) registered highest fruit quality whereas the lowest levels of these traits were noticed in the treatments providing lower dose of NPK. Therefore it is self-explanatory that to attain a higher fruit quality of guava, the major nutrients like NPK should be given at optimum doses. The quality improvement might be due to the involvement of potash in carbohydrate synthesis, breakdown and translocation of starch, synthesis of protein and neutralization of physiologically important organic acids (Tisdale and Nelson 1966). Kumar et al (2008) reported that nitrogen application along with higher doses of potassium gave higher ascorbic acid content. Sharma et al (2014) reported that nitrogen and phosphorus improved the total sugars and pectin content of guava.

Qualitative parameters such as sugar/acid ratio of guava fruit were found best with the application of *Azotobacter* (50 g). The improved fruit quality might be attributed to better vegetative growth of the treated plants which resulted in higher quantities of photosynthates (starch, carbohydrates etc) and their translocation to the fruits thus increasing the contents of various fruit quality parameters (Naik and Babu 2007). Dutta et al (2014) also reported that different treatments of *Azospirillum* + *Azotobacter* + VAM were most effective in improving the fruit quality followed by *Azotobacter* + VAM.

Increase in physico-chemical parameters of fruits might be on account of influential role of bio-fertilizer in higher nitrogen fixation and uptake of nitrogen thereby stimulating the catalytic activity for number of enzymes in the physiological processes and increasing production of sugars and amino acids that ultimately increased the total soluble solids, sugar and ascorbic acid content of the fruits (Dutta and Kundu 2012).

Higher percentage of sugars (total sugars and reducing sugar) might be due to efficient translocation of phytosynthates to the fruits by regulation of boric acid (Singh and Brahmachari 1999). Rawat et al (2010) reported that boron (0.4%) significantly increased the vitamin C and pectin content of L-49 guava fruits. Kumar and Bhusan (1980) reported that foliar application of $ZnSO_4$ increased the TSS content by increasing photosynthetic activity of the plants resulting into the production of more sugars. Foliar application of zinc sulphate alone at the higher concentration enhanced the total sugar content of the fruits in comparison to other nutrients and their combinations.

The maximum content of ascorbic acid (294.37 mg/100 g) was noted under zinc sulphate (0.4%) treatment. Singh and Brahmachari (1999) in guava and Singh et al (2001) in aonla also found an increase in vitamin C content of fruits with boron spray.

The findings of these investigations are indicative of beneficial effects of single foliar application of micronutrients at full bloom stage on physico-chemical properties of guava fruits cv L-49. On the basis of overall qualitative assessment of fruits, it can be concluded that the spray of zinc sulphate (0.4%) enhanced the TSS, total sugars, total sugar/acid ratio and reduced the acidity of the fruits. Present findings are in agreement with the findings of Thangaselvabai et al (2009) and Jawed et al (2016). Same results were also observed by Rawat et al (2010), Yadav et al (2011), Waskela et al (2013) and Arshad and Ali (2016) in guava.

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