The Bioscan 11(4): 2679-2682, 2016 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

INFLUENTIAL ROLE OF BIOZYME ON YIELD, LEAF NUTRIENT AND QUALITY OF GUAVA (*PSIDIUM GUAJAVA* L.) CV. ALLAHABAD SAFEDA

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KEYWORDS
Guava
Biozyme
yield
quality

Received on :
11.11.2016

Accepted on :
07.12.2016

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ABSTRACT

A field experimentation was carried out in guava at Horticulture Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, West Bengal with focal aim of assessing the relative effect of Biozyme on yield, leaf nutrient, quality and economics of guava during the years of 2013-14 and 2014-15. The experiment was designed in Randomized Block Design replicated five times with four Biozyme treatments (0, 5, 10 and 15 ppm) along with recommended doses of NPK fertilizers. Experimental findings showed that the maximum fruit set (65.26%), retention (53.31%), fruit yield (13.23 kg/tree) with least fruit drop (45.11%) and unmarketable fruit (19.97%) obtained from plants treated with Biozyme @ 10 ppm. Same treatment appeared with higher leaf nutrient concentration like N (1.856%), P (0.23%), K (1.52%), B (19.30 ppm) and Zn (35.96 ppm). Foliar fertilization of Biozyme @ 10 ppm recorded best fruit quality parameters like total soluble solids (11.26 °Brix), total sugar (9.31%) and vitamin C content (195.75 mg/100g), thereby producing high quality fruits and fetches highest benefit:cost ratio (5.69). So, for getting higher yield and quality produce from guava, Biozyme may be a good option for the guava-growers.

INTRODUCTION

Guava (*Psidium guajava* L.) is one of the most delicious and popular fruit in tropical and subtropical region of the country (Sharma *et al.*, 2013). It has gained considerable prominence on account of its high nutritive value, availability at moderate price with pleasant aroma and flavour (Goswami *et al.*, 2014). In subtropical climate, growth and fruiting of guava occurs in three distinct periods (Gaur *et al.*, 2014) namely; 'Ambe bahar' (February to March flowering and fruit ripens in July- August), 'Mrig bahar'(June to July flowering and fruit ripens October to December) and 'Hasta bahar' (October to November flowering and fruit ripens in February to April). Due to its wider adaptability in diverse soil and agro climatic condition as well as lower cost of cultivation (Waskela *et al.*, 2013), it has gained popularity among the marginal and small fruit growers of West Bengal. Majority of the guava growers of West Bengal recently faced problem of yield stagnation and sub-optimal quality of the fruit for following conventional management practices. For proper growth and development any plants needs an optimum availability of all macro and micronutrients. In this context, the use of eco-friendly bio-products has emerged as alternative strategies for sustainable horticultural crops. Now-a-days, application of bio-growth regulators is one of the most potential tool not only for increasing yield but also quality and sensory parameters of fruits (Latimer, 1992). Biozyme is an eco-friendly non-toxic commercial growth stimulator known to be rich in cytokinins and auxin precursor, enzymes and hydrolyzed protein which influences plants physiological system at low concentrations (Kumar *et al.*, 2000). Though Biozyme is produced and marketed in different trade names by different agro-input agencies, the composition is more or less same and *i.e.* 78.7% biological active extracts of plant origin and growth regulators (32.2 ppm GA_3, 32.2 ppm IAA and 82.2 ppm Zeatine), 1.88% plant micro-nutrients (0.49% Fe, 0.37% Zn, 0.12% Mn, 0.14% Mg, 0.30% B and 0.44% S), 19.27% Solvents and Conditioners (Hassan *et al.*, 2009). Influential role of Biozyme on guava in Gangetic alluvial plains is not studied in depth so far. Thus, the present experiment was undertaken to find out the effect of biozyme on yield traits, leaf nutrient status, quality and economic benefit of guava production system.

MATERIALS AND METHODS

Experimental site

The experiment was carried out in rainy season crop of two consecutive years i.e. 2013-2014 and 2014-2015, in Horticulture Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India (22°56′ N, 88°31′ E, 9.75 m above mean sea level). Soil at the experiment site was sandy clay loam type (sand 64.8%, silt 10.4% and clay 24.8%) with a neutral pH of 6.8 and low organic carbon content (0.56%,). Available N, P and K of the experimental site was 131.58, 20.50 and 170.63 kg/ha respectively. The climate of the region is humid sub-tropical with hot-humid summers and cool winters. The mean annual rainfall is 1,750 mm, out of which 80-90% is normally received from June to September.

Experimental design

Five years old well managed guava orchard (cv. Allhabad Safeda) spaced at 4 m × 4 m (625 trees/ha) in both ways was identified and healthy plants with almost uniform growth were selected for the treatments. The experiment comprised of soil application of recommended dose of fertilizer (RDF) along with foliar application of Biozyme. The treatment combinations are: RDF (T_1); RDF+ Biozyme @ 5 ppm (T_2); RDF+ Biozyme @ 10 ppm (T_3) and RDF+ Biozyme @ 15 ppm (T_4). The experimental design was randomized complete block design with five replicates (Two guava plants for replication, so total 40 plants were subjected to treatment combinations). RDF of NPK fertilizer with a dose of 250:375:250 g N, P_2O_5 and K_2O per plant was applied in two splits, one at before flowering (2nd week of March) and rest amount during fruit set of guava (2nd week of May) in both the years. According to the treatment combinations, guava plants were subjected to two times foliar application of Biozyme i.e. one during flowering (3rd week of March) and second spray one month after first spray (last week of April) in both the years using a knapsack sprayer having a spray volume of 800 litre/ha through a flat fan nozzle at a spray pressure of 140 kPa.

Plant measurements

Yield indicators of guava such as fruit set %, fruit drop%, fruit retention % and unmarketable fruit % were worked out using following formula (Sau *et al.,* 2016; Siddiqui *et al.,* 2015):

$$\text{Fruit set\%} = \frac{\text{No. of developed fruitlets}}{\text{Total no. of flower at full bloom stage}} \times 100$$

$$\text{Fruit drop \%} = \frac{\text{No.of dropped fruits at 30 DAF(days after fruits set)}}{\text{Total no. of fruits initially}} \times 100$$

$$\text{Fruit retention \%} = \frac{\text{No. of retained fruits (at harvest)}}{\text{No. of fruits at 30 DAF(days after fruit set)}} \times 100$$

$$\text{Unmarketable fruit\%} = \frac{\text{No. of discarded fruits at harvest}}{\text{Total no. of fruits at harvest}} \times 100$$

Total fruits from trees were harvested (in 2-3 intervals) as per the treatment combination and fruit yield per tree and hectare was calculated accordingly.

Determination of macro and micro-elements of leaves

To estimate the concentrations of macro and micronutrients in guava leaf, samples were collected, cleaned, chopped and oven-dried (80ºC for 4 h). Dried and ground leaf samples were analyzed for total recoveries of N, P and K following standard protocols. Boron concentration in leaf sample was recovered through the dry-ashing method followed by the estimation through azomethine-H colorimetric method (Gaines and Mitchell, 1979) estimated through a UV-VIS spectrophotometer (VARIAN CARY-50). Available Zn and Cu content of the leaf samples was extracted with DTPA-TEA (pH 7.3) extractant following the method of Lindsay and Norvell (1978) and the concentration of Zn and Cu in the extracted solution was measured using atomic absorption spectrophotometer (AAS). The total soluble solids content of fruits were measured with the help of a digital refractometer, by the principle of total refraction. A few drops of muslin cloth strained juice of fresh guava were taken for estimating the total soluble solid (TSS) which was expressed in ºBrix. Ascorbic acid content of the guava was estimated by using 2, 6 *di-chlorophenolindophenol* dye titration method (Casanas *et al.,* 2002). The total sugar (fresh weight basis) of guava fruit was determined by universal felling reagent method as stated by AOAC, 2000.

Statistical analysis was performed by the analysis of variance (ANOVA) for randomised block design (RBD) using SAS software version 9.2 applying analysis of variance (PROC GLM) with subsequent multiple comparisons of means for both of the experimental years. The effect of the years was non-significant and there were no significant interactions between treatments and years. Therefore, the data were combined over the years and subjected to ANOVA. The significant difference between treatment means was tested by Tukey's Honest Significant Difference (HSD) test at $p \leq 0.05$. The Excel software (version 2007) was used to draw graphs and figures.

RESULTS AND DISCUSSION

Effect of Biozyme on yield and yield attributes of guava

The data presented in Table 1 revealed that the yield and yield attributing traits varied significantly due to different treatments of Biozyme. All the treatments consisting of different doses of Biozyme significantly increased the fruit set %, fruit retention %, yields (kg/plant and t/ha) and reduced fruit drop% and unmarketable fruit % as compared to the plants received only recommended doses of NPK (control). The highest fruit set % (65.26 %), total no. of fruits per tree (142.60) and fruit yield (8.20 ton /ha) were recorded in the guava plants treated with Biozyme @ 10 ppm along with RDF, which was statistically superior to rest of the treatments (Table 1). Interestingly application of higher doses of Biozyme (15 ppm) failed to improve yield of guava than plants treated with 10 ppm Biozyme solution. Sharma (1990) recorded positive influences to the Biozyme application by increased fruit yield in Apple cv. Red Delicious. The positive impact of Biozyme on fruit yield can be explained by reduced fruit drop and increase in fruit retention due to delay in abscission (the effect of cytokinins and auxins) through preservation of loss of pectin material in middle lamella (Kachave and Bhosale., 2007), enhance resistance to water as well as nutrient stress (Fujioka, 1997), enhanced photosynthesis and mobilization of metabolites to the developing fruits (Bhatia and Kaur, 1997). Production of minimum number of unmarketable fruit from Biozyme treated plant may be for its sustaining ability in environmental stress condition (Zhang and Schmidt, 2000; Zhang *et al.,* 2003) and activity against broad range of pathogenic viral, bacterial and fungal diseases and enhanced resistance to insect attack (Portillo *et al.,* 2007; Percival, 2010).

Effect of Biozyme on leaf nutrient content of guava

The leaf nutrient content of guava trees was significantly ($p \leq 0.05$) changed as influenced by foliar Biozyme application than from control plants (without Biozyme) (Table 2). Plants treated with Biozyme recorded significantly higher macro and

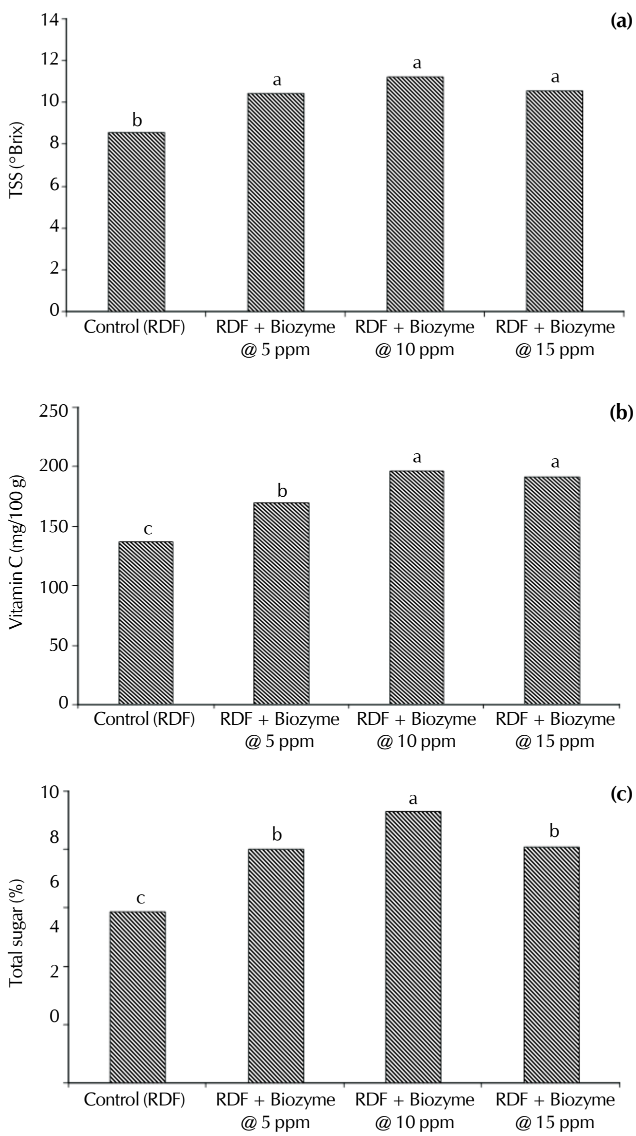

Figure 1: Effect of Biozyme on (a) TSS, (b) Vitamin C and (c) Total sugar content of guava. Vertical column followed by different letters are significantly different by Tukey's HSD (honest significant difference) test

micro nutrient concentration *i.e.* N, P, K, B, Zn and Cu in their leaves than those found in the control plants. An increase rate of 32.19% N, 43.75% P, 33.33% K, 36.49% B, 32.40% Zn recorded from the leaf sample of guava plants treated with RDF + Biozyme @ 10 ppm while maximum leaf Cu concentration (43.27% higher than control) recorded from the plants treated with RDF + Biozyme @ 15 ppm. Similar results were observed by Kumar and Palani (1991) reported the significant response of Biozyme for increasing leaf nutrient content (N, P, K, Ca and Mg) in tea. The increase in leaf nutrient content of guava for treatment of Biozyme may be due to supply of higher amount of these nutrients from source to sink in supporting improved growth and yield (Rao, 1991; Smitte, 1991) traits of the of the plant that achieved with Biozyme spraying.

Economic feasibility

Data presented in Table 3 clearly suggest that the application of Biozyme @ 10 ppm along with RDF was found to be the promising treatment for guava production in the economic point of view. All the treatments were found economically superior over control and the same treatment combination *i.e.* RDF + Biozyme @ 10 ppm recorded the highest net return (Rs. 2,09,225.50/ha) and maximum benefit over cost (5.69 Benefit:Cost ratio) than rest other treatments.

Effect of Biozyme on chemical qualities of guava fruits

Fruit chemical quality parameters were improved significantly improved with foliar Biozyme application along with RDF of NPK fertilizer. Highest TSS (11.26 °Brix) and total sugar (9.31%) were recorded from guava plants subjected to application of RDF + Biozyme @ 10 ppm, which were statistically superior over the fruits obtained from control plants. Ascorbic acid content was also found to be highest under the same treatment (195.75 mg/ 100 g) followed by the plants received RDF + Biozyme @ 15 ppm (191.42 mg/ 100 g) (Fig 1). The present result are in conformity with the findings of increased TSS in 'Grand Nain' banana (Hassan *et al.,* 2009), increased total sugar % in pear (Inomata *et al.,* 1992) and higher ascorbic acid content in tomato (Reeta *et al.,* 2010) due to Biozyme application. Due to the application of Biozyme the functioning of number of enzymes might have been stimulated, affecting the physiological processes, which in turn hydrolysed starch and helped in the metabolic activity during the change of

Table 1: Effect of Biozyme application on yield attributes and yield of guava (Mean data of 2013-14 and 2014-15)

Treatments	Fruit set percentage (%)	Fruit drop percentage (%)	Fruit retention percentage (%)	Total number of fruits /tree	Unmarketable fruit percentage (%)	Fruit yield (kg /tree)	Fruit yield (t/ha)
Control (RDF)	39.46 c	63.98 a	43.29 b	104.00 c	25.95 a	7.27 c	4.50 c
RDF + Biozyme @ 5 ppm	55.36 b	47.37 b	51.42 a	127.20 b	22.61 ab	10.79 b	6.68 b
RDF + Biozyme @ 10 ppm	65.26 a	45.11 b	53.31 a	142.60 a	19.97 b	13.23 a	8.20 a
RDF + Biozyme @ 15 ppm	54.72 b	45.62 b	50.37 a	130.80 b	21.50 b	11.56 ab	7.16 ab

Means followed by a different letter are significantly different at p≤0.05 by Tukey's HSD (honest significant difference) test

Table 2: Effect of Biozyme on leaf nutrient contents of guava (Mean data of 2013-14 and 2014-15)

Treatments	Total nitrogen (%)	Total phosphorus (%)	Total potassium (%)	Total boron (ppm)	Total zinc (ppm)	Total copper (ppm)
Control (RDF)	1.404 c	0.16 b	1.14 b	14.14 b	27.16 b	45.94 c
RDF + Biozyme @ 5 ppm	1.546 b	0.18 ab	1.48 a	18.58 a	31.74 ab	52.04 bc
RDF + Biozyme @ 10 ppm	1.856 a	0.23 a	1.52 a	19.30 a	35.96 a	61.52 ab
RDF + Biozyme @ 15 ppm	1.764 a	0.19 ab	1.43 a	18.60 a	33.18 ab	65.82 a

Means followed by a different letter are significantly different at p≤0.05 by Tukey's HSD (honest significant difference) test

Table 3: Effect of Biozyme on economic returns of guava

Treatments	Common cost for cultivation* (Rs. /ha)	Treatment cost$ (Rs. /ha)	Total cost of cultivation (Rs. /ha) [A]	Gross return **(Rs. /ha) [B]	Net return (Rs./ha) [B-A]	Net return per rupee of investment (Benefit : Cost ratio) [B-A]/[A]
Control (RDF)	31974.5	0	31974.5	135000.00	103025.50	3.22
RDF + Biozyme @ 5 ppm	31974.5	2400	34374.5	200400.00	166025.50	4.83
RDF + Biozyme @ 10 ppm	31974.5	4800	36774.5	246000.00	209225.50	5.69
RDF + Biozyme @ 15 ppm	31974.5	7200	39174.5	214800.00	175625.50	4.48

Common cost of cultivation was estimated considering all the inputs in guava cultivation, except treatment cost; $Treatment cost varies only due to difference in micronutrient fertilization levels; **Gross return is calculated by multiplying fruit yield with selling price *i.e.* Rs. 20/kg

available starch into sugar, thereby resulted into higher TSS and total sugar content (Jain, 2006).

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