Journal of Applied and Natural Science
11(2): 440 - 444 (2019)
ISSN : 0974-9411 (Print), 2231-5209 (Online)
journals.ansfoundation.org

Nutrient requirement, canopy development and fruit yield of high density guava (*Psidium guajava* L.) production in subtropics of Northern Karnataka

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Abstract
Nutrient requirement for guava under high density planting is much higher than normal planting. Combined application of organic manures and chemical fertilizers will enhance nutrient use efficiency. The field experiment was carried out at Raichur, Karnataka, India during 2017 to standardize rate of fertilizers and organic manures for Guava (*Psidium guajava* L.) cv. Allahabad safeda under high density planting. Treatments consists of application of fertilizers for normal planting compared with 100:40:75 g NPK/plant as recommended dose of fertilizers (RDF), 75% and 50% of high density planting (HDP) along with 25 kg farmyard manure, organic manure alone and foliar application of urea @ 1 % at 2,3 and 4 months after pruning. Results indicated that application of NPK@ 235: 118: 120 g per plant as per the RDF for HDP along with 25 kg FYM has resulted in taller plants, plant spread E-W as well as N-S directions, canopy volume and leaf area index. Higher fruits/plant, average fruit weight, fruit diameter, fruit length, fruit yield per plant and fruit yield (48.58 t ha^{-1}) was recorded by application of NPK@ 235: 118: 120 g per plant same as that of HDP along with 25 kg FYM. Application of 50 % of HDP recommendation along with foliar application of urea @ 1% at 2, 3 and 4 months after pruning and 25 kg FYM was also found effective in achieving higher fruit yield of guava.

Keywords: Canopy volume, Fruit yield, Leaf area index, Guava, HDP

Article Info
DOI:10.31018/jans.v11i2.1668
Received: March 8, 2019
Revised: May 17, 2019
Accepted: June 1, 2019

How to Cite
Mushtaq *et al.* (2019). Nutrient requirement, canopy development and fruit yield of high density guava (*Psidium guajava* L.) production in subtropics of Northern Karnataka. *Journal of Applied and Natural Science*, 11(2): 440 - 444
https://doi.org/10.31018/jans.v11i2.1668

INTRODUCTION

Guava (*Psidium guajava* L.) is one of the most important subtropical fruit crop widely distributed all over the equatorial regions of the tropical and sub tropical climate (Menzel and Poxtoni, 1985). The fruit is used for table and making juice, jellies, jam, paste, baby foods, syrup, wine and other processed products. In India, guava occupies an area of 268.22 thousand hectares with a productivity of 13.7 metric tonnes ha^{-1} (Anon., 2014). Among the various factors nutrient management has significant influence on productivity of guava. Insufficient application of nutrients at flowering and fruit development adversely affect the productivity and quality of produce. Under traditional planting system of guava, nutrient management practices have been well standardized. A sizeable quantity of nutrients is removed by fruits. Required quantity of nutrients must be replenished in the form of manures and fertilizers. Need to standardize rate, method, source and time of fertilizer application under high density planting system to attain long term sustainable fruit yield as well as soil productivity. Information on optimum quantity of nutrient requirement for high density planting guava is very meagre especially in subtropical peninsular India. Keeping these facts, field investigation was conducted with an objective to find out quantity of fertilizers along with organic manure

required for high density guava and its influence on growth and yield.

MATERIALS AND METHODS

Experimental site: Field experiment was conducted at the Main Agricultural Research Station (16°15 N, 77°21' E and 389 m above mean sea level), College of Agriculture, University of Agricultural Sciences, Raichur, Karnataka, India during 2016-17. Treatments were imposed on four years old Guava plants cv. Allahabad Safeda.

Treatment details: Treatments consists of RDF for normal planting @ 100:40:75 g NPK/plant +25 kg FYM (T_1), RDF for high density planting @ 235:118:120 g NPK/plant + 25kg FYM (T_2), 75% of T_2 + 25 kg FYM (T_3), 50% of T_2 +25 kg FYM (T_4), 75% of T_2 + FYM equivalent to 58.75 g N (T_5),50% of T_2+ FYM equivalent to 117.5 g N (T_6), 100% N through FYM (T_7), 50% T_2+25 kg FYM+ foliar application of 1% urea at 2, 3 and 4 month after pruning (T_8) tested in randomized block design with three replications. The N, P and K content of FYM used in the experiment was 0.5, 0.2 and 0.5 respectively. Quantity of fertilizers used in each treatment is provided in table 1. Under high density planting plants are planted at a spacing of 3.0 m x 3.0 m (1,111 plants/ha).

Growth and yield attributes: The growth parameters such as plant height, plant spread, length and girth of new tertiary shoot, productive and unproductive shoots per plant, canopy volume, and physiological parameter such as leaf area, leaf area index were recorded at 60, 120 and 180 days after pruning. Leaf area index was measured by using SunScan Canopy analyzer (Delta-T, UK). The observations on fruits per plant, average fruit weight, fruit length and diameter, yield per plant and hectare were recorded at harvest stage.

Statistical analysis: The data collected on different parameters during the course of investigation were subjected to statistical analysis using randomized complete block design of Fischer method of analysis of variance and interpretation of data was done as per the procedure described by Panse and Sukhatme (2000).

RESULTS AND DISCUSSION

Application of graded levels of NPK fertilizers along with organic manure showed beneficial effect on plant growth as well as fruit yield of guava (Table 2). Significant variation in fruit yield in guava was recorded by varied application of fertilizers, organic manure and foliar spray. Fruit yield was greater by application of fertilizer @ 235:118:120 g/plant and 25 kg FYM (44.61 kg/plant) and 50% of T_2 in addition to 25 kg FYM and foliar application of 1% urea at 2, 3 and 4 month after pruning (42.85 kg/plant). It was 25 and 20 higher than current recommendation of normal planting. It was related to variation in vegetative growth throughout the crop growth period after pruning, the major growth attributes of guava *viz,* plant height, canopy spread, canopy volume, leaf area index, and leaf chlorophyll content (Fig. 1). Significant differences in growth parameters was observed by application of @ 235: 118: 120 g NPK per plant along with 25 kg FYM as per the RDF for high density planting guava, it was followed by 50 % of the recommended dose fertilizers for high density planting along with foliar application of urea @ 1% at 2, 3 and 4 months after pruning and 25 kg FYM. Significant reduction in all the growth parameters was observed in application of organic manure on nitrogen equivalent bases. It might be due to insufficient quantity of nutrients required for plant growth.

Similarly reducing the level of fertilizers of high density planting recommendation either 50 % or 75 % didn't significantly influence on all the growth attributes. Vandana Dwivedi (2013) and Maity *et al*. (2016) also reported that significant improvement in fruit yield of guava was observed by application of graded levels of fertilizers along with organic manures. It was attributed to association of nitrogen in synthesis of protoplasm, primary manufacturing of amino acid and enhanced auxin activity brought about by sufficient nitrogen fertilizers (Atom, 2013 and Reddy *et al.*, 2000). It has resulted in enhanced meristamatic activities in terms of vegetative growth. The phosphorus also involved in photosynthesis and constituent of nucleo- proteins, synthesis of starch, sucrose and protein. Application of sufficient quantity of phosphorus might have helped in synthesis of above growth compounds required for better growth of guava. Similarly potassium also involved in development of canopy

Table 1. Details of N, P_2O_5 and K_2O nutrient applied (g/plant) through chemical fertilizers and farmyard manure per tree of Guava.

Treatment	From Chemical Fertilizers			From FYM			Total		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
T_1	100	40	75	130	57.5	145	230.0	97.5	220.0
T_2	235	118	120	130	57.5	145	365.0	175.5	265.0
T_3	176.25	88.5	90	130	57.5	145	306.3	146.0	235.0
T_4	117.5	59	60	130	57.5	145	247.5	116.5	205.0
T_5	176.25	88.5	90	61.1	27.025	68.15	237.4	115.5	158.2
T_6	117.5	59	60	122.2	54.05	136.3	239.7	113.1	196.3
T_7	0	40	75	100	108.1	272.6	100.0	148.1	347.6
T_8	186.5	59	60	-	-	-	186.5	59.0	60.0

Table 2. Yield and yield attributes of Guava as influenced by integrated nutrient management practices.

Treatment	Plant height at 180 DAP(m)	Number of fruit plant $^{-1}$	Average fruit weight (g)	Fruit diameter (cm)	Fruit length (cm)	Fruit yield (kg plant $^{-1}$)	Yield (t ha $^{-1}$)
T_1-RDF for normal planting (100:40:75 g NPK/plant) +25kg FYM	2.34	150.9	123.70	5.93	6.19	35.68	38.86
T_2- RDF for high density planting (235:118:120 g NPK/ plant) + 25kg FYM	2.92	190.4	158.73	6.66	7.44	44.61	48.58
T_3- 75 % of T_2 + 25 kg FYM	2.57	168.3	139.70	5.79	6.19	38.79	42.25
T_4- 50 % of T_2 + 25 kg FYM	2.43	152.5	125.46	5.95	6.31	34.44	37.50
T_5- 75 % of T_2 + 25 % N through FYM	2.57	166.9	138.80	5.89	5.90	39.67	43.20
T_6- 50 % of T_2 + 50 % N through FYM	2.44	156.6	123.63	5.64	5.87	35.65	38.82
T_7- 100% N from organic sources	2.07	133.1	109.50	4.95	4.95	30.44	33.15
T_8- 50% T_2 + foliar application of urea @1% at 2, 3 and 4 months after pruning + 25kg FYM	2.86	183.9	154.23	6.68	7.08	42.85	46.66
S.Em.±	0.09	5.0	3.99	0.25	0.25	1.12	1.23
C.D. (p=0.05)	0.29	15.2	12.22	0.76	0.79	3.45	3.76

by way of enhanced root growth, stem and fruiting bodies development, osmoregulation in canopy and movement of photosynthesis. Supply of sufficient quantity of potassium also responsible for enhancement of growth of guava further in addition to fertilizers application of farmyard manure also contributed in mineralization of available nutrients by way of improving physical and chemical properties (Chandra *et al*., 2016; Shukla *et al*., 2009 and Sharma *et al*., 2009, 2013).

The results from study indicated that fertilizer supply 50 % of the high density planting recommendation along with foliar nutrition of urea @ 1 % repeated spray enhanced growth parameters mainly because of sufficient supply of nutrients during early part of the growth period as well as intermittent supply. Sarker and Rahim (2013) reported that the yield and yield attributes were significantly influenced by organic manures and fertilizers along with foliar application of urea. Higher number of fruits, average fruit weight, fruit diameter, fruit length, fruit yield per plant and hectare were observed by application of NPK@ 235: 118: 120 g per plant as per the recommended dose fertilizer for high density planting along with 25 kg FYM. It was followed by 50 % recommended dose of fertilizers for high density planting along with foliar application of urea @ 1% at 2, 3 and 4 months after pruning and 25 kg FYM per plant.

Growth attributes of guava canopy volume, canopy spread both in N-S and E-W directions and leaf area index was significantly influenced by nutrient management (Fig.1). Application of NPK@ 235: 118: 120 g per plant as per the recommended dose fertilizer for high density planting along with 25 kg FYM was significantly enhanced growth attributes recorded at 60, 120 and 180 days after pruning. Maximum canopy spread 4.1 m and lowest 2.8 m was recorded in organic manure applied plots. Considerable influence of nutrient management on LAI of guava was observed throughout the season (Fig. 1). Graded fertilizer application as per the HDP has produced better canopy resulted in higher LAI. Whereas, reduced LAI was observed in organic manure applied plot alone. Differential absorption of PAR and extent of canopy cover were responsible for variation in LAI. Significant reduction in growth attributes by supply of organic manure alone may not be sufficient to met out require quantity of nitrogen.

Similarly reducing the level of fertilizers of high density planting recommendation either 50 % or 75 % didn't significantly influenced on all the growth attributes. The results from the study further evidence by significant positive correlation between fruit yield and growth attributes like plant height (0.808), length of the new shoot (0.76), number of productive shoots (0.864) and leaf area index (0.883). This emphasized importance of

Table 3. Relationship between growth, yield and quality parameters of guava as influenced by integrated nutrient management practices.

Treatment	Plant height 120 DAP(m)	Shoot Length 120 DAP(cm)	Leaf Area Index	Average fruit wt(g)	Fruits/ plant	Fruit yield (t/ha)
Plant height (m) at 120 DAP	1.00					
Shoot length (cm) 120 DAP	0.801**	1.00				
Leaf Area Index	0.846**	0.824**	1.00			
Average fruit wt (g)	0.677**	0.584**	0.607**	1.00		
Fruits/plant	0.808**	0.760**	0.883**	0.569**	1.00	
Fruit yield (t/ha)	0.808**	0.760**	0.883**	0.569**	1.000**	1.00

**- significant at p=0.05

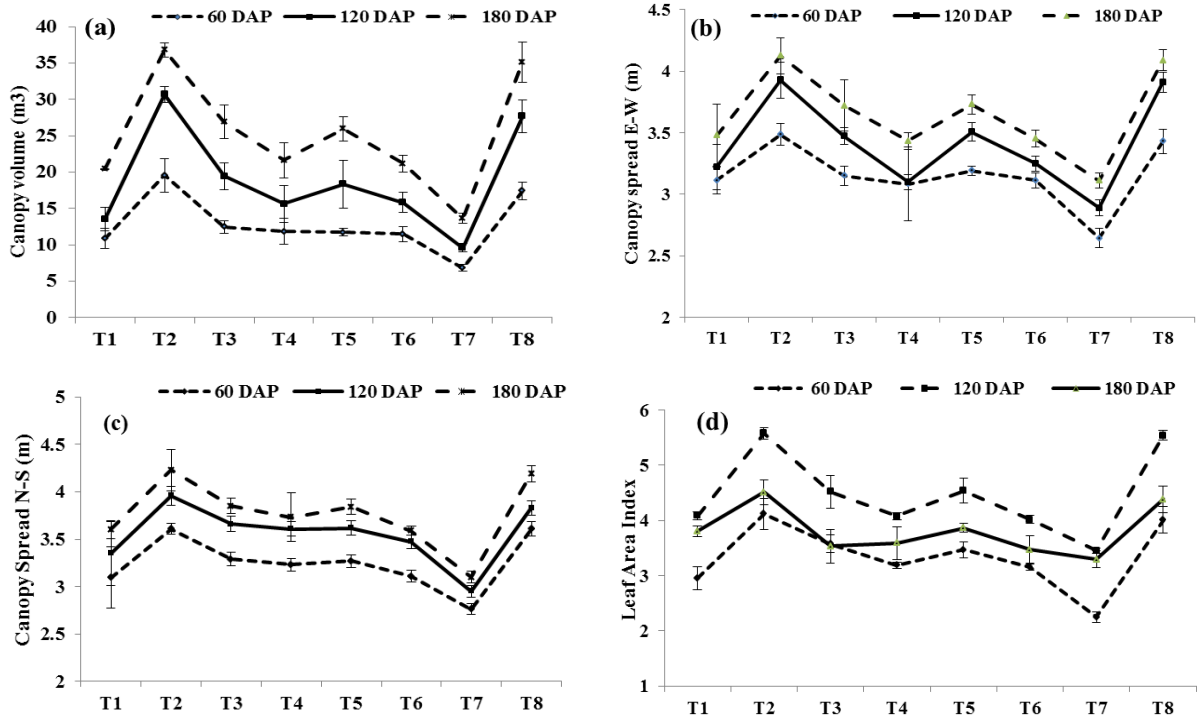

Fig. 1. *Canopy volume (a), Canopy spread E-W direction (b), Leaf area index (c) and canopy spread N-S direction (d) as influenced by nutrient management practices in guava (Details of T_1 to T_8 in Table 1).*

these parameters in achieving higher fruit yield (Table 3).

For high density planting nutrient requirement was obviously much higher than normal planting. Application of fertilizers as well as foliar nutrition through urea was found sufficient to meet nutrient requirement of high density guava. Further improvement in yield is governed by several attributes throughout growth period, the factors which have directly influenced on yield and yield components *viz*., number of fruits per plant, average fruit weight, fruit diameter, fruit length, fruit yield per plant and number of productive shoots. Garhwal *et al*. (2014) and Imran Arshad (2015) also reported fruit yield per plant, fruit diameter, and individual fruit weight and fruit yield of guava were significantly influenced by integrated nutrient management. Further, recent evidences also indicated that application of fertilizers along with organic manure and bio-fertilizers have significant influence on guava fruit yield reported by Shukla *et al.* (2009). Application of nutrients through foliar spray at different intervals after pruning enhance fruit yield, was mainly due to intermittent supply of nutrient that may enhance fruiting bodies as indicated by more number of reproductive shoots. The result of present study also confirm of with the finding of Jat and Kacha (2014).

Conclusion

Results of the study indicated that application of graded @ 235:118:120 g NPK/plant + 25 kg FYM per plant enhanced 25% higher fruit yield in high density planting as compared to present recommendation. Further, quantity of chemical fertilizers

can be reduced by substitution of 50% of recommended N along with foliar application of urea @1% at 2, 3 and 4 months after pruning + 25kg FYM. It also enhanced growth of individual plants measured by canopy spread, volume and leaf area index.

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