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Effect of plant geometry and nutrients on nutrient status and fruit quality of guava (*Psidium guajava* L) cv. Sardar

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Abstract
Field investigations carried out to know the effect of spacing and nutrients on nutrient status and fruit quality of eight years old guava plants in hasth bahar during 2017-2018. With respect to spacing, the highest level of nitrogen, phosphorus and potassium were found in S_5 and with respect to nutrition the highest level of nitrogen, phosphorus and potassium level was found highest in F_1. The highest soil pH, electrical conductivity, organic carbon, nitrogen, phosphorus and potassium level were highest in S_5, whereas the highest level of soil pH, electrical conductivity, organic carbon, nitrogen, phosphorus and potassium level was found highest in F_1. Pulp weight, seed weight, TSS and ascorbic acid mg/100 g) were significantly higher in the wider spacing of 6 m x 6 m. The minimum value for titratable acidity was significantly lower in wider spacing (6 m x 6 m). The results revealed that the highest pulp weight, seed weight, TSS, ascorbic acid, and lowest titratable acidity were recorded in the plants supplied with F_1. In interaction effect, significantly highest TSS, ascorbic acid and lowest titratable acidity was observed in the S_5F_1.

Keywords: Guava, plant geometry, nutrition, quality, NPK

Introduction

Guava (*Psidium guajava* L.) belongs to Mytaceae family, is known as apple of the tropics, poor man's apple and is fourth in area and production after mango, banana and citrus. Guava is highly remunerative without much care. Being very hardy, it gives an assured crop even with very little care. Its cost of production is low, nutritive value is very high and it is an ideal fruit for the nutritional security. Guava is also grown as a backyard fruit. The traditional system of cultivation has often posed problems in attaining desired levels of productivity due to large tree canopy. Hence, a need arose to improve the existing production system, besides increasing its productivity. Currently, there is a worldwide trend to plant fruit trees at higher density or meadow orcharding to control tree size and maintain desired architecture for better light interception by adopting proper spacing and balanced nutrition.

The present investigation was carried out with an objective to study the influence of plant spacing and nutrients on nutrient status and quality of guava.

Material and Methods

The experiment was carried out at Kittur Rani Channamma College of Horticulture, Arabhavi (University of Horticultural Sciences, Bagalkot), Gokak taluk of Belagavi district, Karnataka, India during 2016-2018 on eight year old guava plants in hasth bahar. The experiment consisted of 15 treatments executed in 3 replications in factorial randomized block design. The treatments included five spacing and three fertilizer combinations *viz.*, S_1 – 2 m x 1 m, S_2 – 3 m x 1.5 m, S_3 – 3 m x 3 m, S_4 – 6 m x 3 m, S_5 – 6 m x 6 m, F_1– 200:80:150 g NPK/plant (100% RDF), F_2– 150:60:110 g NPK/plant (75% RDF) and F_3– 100:40:75 g NPK/plant (50% RDF). Recommended doses of fertilizer were applied on per plant basis according to the treatment details in two split doses. The first as a basal dose, where only 50 per cent urea was applied in the month of July and the remaining second dose consisting of 50 per cent urea and full dose of single super phosphate and muriate of potash was applied during October.

Results and Discussion

Leaf Chlorophyll Content (Table 1)

Total chlorophyll content in the leaf was found significantly different among the different spacings. The highest total chlorophyll content in the leaf (2.13 mg/ 100 g) was recorded in S_5 (6 m x 6 m) spacing. Results on chlorophyll content showed significant among the different spacings (Table 12). These findings are contradictory to Yadav *et al.* (1981) [18] who reported that as plant population increases the chlorophyll content decreases.

The total chlorophyll content in leaf was found significantly high in F_1 nutrition which was found significant with F_2 nutrition. Higher N may be due to more dry matter accumulation. However, Arora *et al*. (1983) [1] and Singh and Bal (2002) [16] reported no significant effect on leaf N, P and K in guava. Findings of Singh (2003) [14] are contrary reported significantly lesser leaf Fe content in guava plants at wider spacing.

The interaction had shown non-significant results for chlorophyll content in the leaf. But the higher level of chlorophyll content was recorded in 6 m x 6 m spacing with 200:80:150 NPK g/plant nutrition.

Leaf Nutrient Status (Table 1)

The leaf nutrient status regarding nitrogen, phosphorus and potassium showed significant results among the different spacings. The highest level of nitrogen (1.74%), phosphorus (0.31%) and potassium (1.33%) level was found highest in S_5 which was on par with S_4 spacing. Nitrogen, phosphorus and potassium contents have shown increasing trend with increasing spacings.

Significant results were observed for leaf nutrient status by application of 200:80:150 g NPK/plant. The highest level of nitrogen, phosphorus and potassium level was found highest in F_1 which was followed F_2 level of nutrition. These results are in contrary with the findings of Singh *et al*. 2013 [17] in sapota. Phosphorous and potassium content of leaves decrease with increasing levels of nitrogen.

The interaction effect of spacing and nutrition had shown the non-significant results for nutrient status in the leaf.

Soil Nutrient Status (Soil analysis) (Table 2)

The soil pH and electrical conductivity was found non significant in among different spacings but the soil nutrient status regarding organic carbon, nitrogen, phosphorus and potassium showed significant results among the different spacings. The highest level of soil pH (7.37), electrical conductivity (0.34 dS/m)**,** organic carbon (0.72%), nitrogen (263.21 kg/ha), phosphorus (18.80 kg/ha) and potassium (185.46 kg/ha) level was found highest in S_5 which was on par with S_4 spacing. These results are in contrary with the findings of Singh *et al.* 2013 [17] in sapota.

Significant results were observed for leaf nutrient status by application of 200:80:150 g NPK/ plant. The highest level of soil pH (7.36), electrical conductivity (0.34 dS/m)**,** organic carbon (0.73%), nitrogen (262.81 kg/ha), phosphorus (18.82 kg/ha) and potassium (186.52 kg/ha) level was found highest in F_1 which was on par with F_2 level of nutrition. The increased organic carbon was due to enhanced root growth, which leads to accumulation of organic residues and direct incorporation of organic matter in soil. Nitrogen, phosphorus and potassium contents have shown increasing trend with increasing levels of the respective nutrients. A build up of nitrogen and organic carbon in soil with different nitrogen sources and levels combined with bio-fertilizers has also been reported by Mishra *et al*. (1990). It is evident that application of higher dose of fertilizers resulted in more uptake of nitrogen, phosphorus and potassium from the soil which ultimately led to better fruit growth and development. Similar findings were reported by Rajput and Singh (2004) [11], and Kotur *et al.* (1997) [5].

The interaction effect of spacing and nutrition had shown the non-significant results for nutrient status in the soil.

Fruit Quality Parameters (Table 3)

The results regarding the pulp weight, seed weight and pulp seed ratio were significantly different among the different spacings. The highest pulp weight (208.17 g) and seed weight (8.17 g) were recorded in S_5 (6 m x 6 m) spacing and the lowest (174.05 g and 7.17 g respectively) were observed in S_1 (2 m x 1 m) spacing. This may be ascribed to the larger and more open canopies allowing the entry of more light and air thereby changing the micro-climate affecting the pollen germination *in vivo*. Similar findings were reported by Singh and Bal, 2002 [16] and Singh, 2003 [14] in guava.

Significantly highest pulp weight (205.54 g) and seed weight (8.24 g) were recorded in F_1 (200:80:150 g NPK/ plant) nutrition. The lowest pulp weight (183.44 g) and seed weight (7.16 g) was recorded in F_3 level. Optimum vegetative growth increases the synthesis of food materials. These activities of nitrogen and phosphorus might have been interacted positively and stimulated the physical characters of the guava fruit positively.

The interaction effect had shown non-significant results for pulp weight and seed weight. The highest pulp weight (222.28 g) and seed weight (8.50 g) was noticed in S_5F_1 treatment combination and lowest (166.09 g and 6.40 g respectively) in S_1F_3 treatment combination.

Data highlighted on total soluble solids, ascorbic acid content and brix to acid ratio showed significant difference among the different spacings as well as among different nutrition. The maximum level of total soluble solids (12.71 °Brix) and minimum level of titratable acidity (0.25%) was recorded in S_5 (6 m x 6 m). The highest TSS and lowest acidity under wider spacing may be due to better light penetration which increases more photosynthetic activities and resulted into conversion of higher photosynthates which ultimately improve the fruit quality. These results are in line with the results recorded by Gaikwad *et al.* (1981) [3], Lal *et al*. (2000) [7], Singh (2003) [14] and Singh *et al.* (2007) [15].

Similarly the maximum total soluble solids (13.08 °Brix) was recorded in F_1 (200:80:150 g NPK/ plant) This is because adequate use of nitrogen stimulates the functioning of number of enzymes in the physiological process which may have increased the total soluble solid content of the fruits. The findings are in conformity with Kumar *et al.* (2009) [6], Kotur *et al.* (1997) [5] and Mitra and Bose (1990) [9] in guava.

The interaction effect had shown non significant results for total soluble solids. The maximum level of total soluble solids (13.50 °Brix) was recorded in S_5F_1 which was followed by S_4F_1 (13.43 °Brix), whereas the minimum level of total soluble solids (10.68 °Brix) in S_1F_3.

The highest ascorbic acid content (178.78 mg/100 g) was recorded in S_5 (6 m x 6 m). Increase in vitamin C content of widely spaced plants may be due to better availability of nutrition and photosynthates in comparison to the plants at closer spacing. Gaikwad *et al.* (1981) [3] and Singh *et al.* (2007) [15] found that vitamin C was significantly reduced with the higher plant density in guava.

The maximum ascorbic acid content (184.09 mg/100 g) was recorded in treatments of F_1 nutrition level and the minimum in F_3 nutrition level (161.84 mg/100 g), respectively. This might be due to catalytic activity of several enzymes which participate in the biosynthesis of ascorbic acid and precursor.

The data pertaining to ascorbic acid content in the fruit showed non significant difference in the interaction effect. The maximum ascorbic acid content (192.78 mg/100 g) was recorded in S_5F_1, which was on par with S_5F_1 (189.66 mg/100 g). Whereas, the minimum (158 mg/100 g) in S_1F_3.

The minimum level of titratable acidity (0.25%) was recorded in S_5 (6 m x 6 m) spacing. In general, it is increased with the increasing plant population and decreased with wider spacing. Minimum acidity in wider spacing fruits might be due to less competition for food materials and more availability of sunlight for photosynthesis. The results are in agreement with Bose *et al.* (1992) [2] and Joshi *et al.* (2004) [4].

The minimum level of titratable acidity (0.22 %) was noticed in the F_1 and the maximum level of acidity (0.33 %) was noticed in F_3 level. This is due to increased synthesis and translocation of organic acids in the fruits as cited by Prasad and Mali (2000) [10] in pomegranate. Similar finding where earlier reported by Sharma *et al* (2013) [13] in guava.

The data on titratable acidity was found non significant in the interaction effect. The minimum level of titratable acidity was observed in S_5F_1 (0.19%) and the maximum level in S_1F_3 (0.35%) treatment combination.

Significant result was noticed for brix acid ratio among different spacings and nutrition. The maximum brix acid ratio (54.30) was found in S_5 (6 m x 6 m) spacing, while the minimum (40.23) was found in S_1 (2 m x 1 m). Effect of nutrients also showed significant results for brix acid ratio. These results are in accordance with Mishra *et al* (2014) [8] and Sah (2013) [12]. The brix acid ratio showed significant difference in interaction effect. The maximum (71.19) brix acid ratio was observed in S_5F_1 and the minimum (30.24) was observed in S_1F_3.

Table 1: Effect of plant geometry and nutrients on leaf nutrient status of guava cv. Sardar

Treatments	Chlorophyll 'a' (mg/100 g of leaf)	Chlorophyll 'b' (mg/100 g of leaf)	Total chlorophyll (mg/100 g of leaf)	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Spacing (S)						
S_1	1.20	0.71	1.92	1.60	0.26	1.24
S_2	1.25	0.73	1.97	1.63	0.25	1.24
S_3	1.25	0.73	1.98	1.67	0.28	1.28
S_4	1.32	0.74	2.06	1.70	0.28	1.28
S_5	1.34	0.79	2.13	1.74	0.31	1.33
SEm ±	0.03	0.03	0.04	0.03	0.01	0.01
CD @ 5%	0.07	0.07	0.11	0.09	0.04	0.04
Nutrition (F)						
F_1	1.38	0.83	2.20	1.78	0.32	1.30
F_2	1.27	0.73	2.01	1.66	0.26	1.28
F_3	1.17	0.66	1.83	1.56	0.25	1.25
SEm ±	0.02	0.02	0.03	0.02	0.01	0.01
CD @ 5%	0.06	0.06	0.08	0.07	0.03	0.03
Interactions (S x F)						
S_1F_1	1.26	0.77	2.03	1.73	0.28	1.24
S_1F_2	1.21	0.72	1.93	1.57	0.25	1.27
S_1F_3	1.14	0.64	1.79	1.50	0.25	1.21
S_2F_1	1.35	0.82	2.17	1.75	0.30	1.27
S_2F_2	1.21	0.71	1.92	1.61	0.22	1.24
S_2F_3	1.18	0.65	1.84	1.54	0.24	1.22
S_3F_1	1.37	0.83	2.20	1.77	0.34	1.30
S_3F_2	1.23	0.74	1.97	1.66	0.26	1.28
S_3F_3	1.14	0.63	1.78	1.57	0.24	1.26
S_4F_1	1.44	0.85	2.29	1.80	0.32	1.34
S_4F_2	1.35	0.72	2.06	1.70	0.28	1.27
S_4F_3	1.17	0.66	1.83	1.60	0.25	1.25
S_5F_1	1.46	0.86	2.32	1.85	0.37	1.37
S_5F_2	1.37	0.79	2.16	1.77	0.30	1.34
S_5F_3	1.19	0.71	1.91	1.60	0.27	1.29
SEm ±	0.04	0.04	0.06	0.05	0.02	0.02
CD @ 5%	0.16	NS	NS	NS	NS	NS

*NS- non significant

S1 – 2 m x 1 m F1– 200:80:150 g NPK/plant (100% RDF)
S2 – 3m x 1.5 m F2– 150:60:110 g NPK/plant (75% RDF)
S3 – 3 m x 3 m F3– 100:40:75 g NPK/plant (50% RDF)
S4 – 6 m x 3 m
S5 – 6 m x 6 m

Table 2: Effect of plant geometry and nutrients on soil nutrient status of guava cv. Sardar

Treatments	pH	Electrical conductivity (dS/m)	Organic Carbon (%)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
Spacing (S)						
S_1	7.12	0.32	0.63	243.72	17.09	180.48
S_2	7.11	0.31	0.68	248.55	17.50	182.18
S_3	7.28	0.32	0.71	251.44	18.33	183.52
S_4	7.30	0.33	0.71	255.20	18.31	184.40
S_5	7.37	0.34	0.72	263.21	18.80	185.46
SEm ±	0.09	0.01	0.01	1.64	0.10	0.53
CD @ 5%	NS	NS	0.03	4.76	0.30	1.52
Nutrition (F)						
F_1	7.36	0.34	0.73	262.81	18.82	186.52
F_2	7.29	0.33	0.68	250.18	18.19	183.17
F_3	7.05	0.32	0.66	244.28	17.00	179.93
SEm ±	0.07	0.00	0.01	1.27	0.08	0.41
CD @ 5%	0.20	0.01	0.03	3.68	0.23	1.18
Interactions (S x F)						
S_1F_1	7.37	0.33	0.71	255.06	18.01	185.22
S_1F_2	7.36	0.32	0.60	245.05	17.40	180.16
S_1F_3	6.63	0.32	0.58	231.05	15.85	176.05
S_2F_1	7.26	0.32	0.72	259.25	18.30	186.04
S_2F_2	7.26	0.32	0.67	247.33	17.81	182.29
S_2F_3	6.82	0.30	0.65	239.07	16.38	178.22
S_3F_1	7.30	0.33	0.73	263.10	18.91	186.25
S_3F_2	7.28	0.32	0.69	249.07	18.33	183.18
S_3F_3	7.26	0.32	0.70	242.17	17.75	181.13
S_4F_1	7.37	0.34	0.74	267.32	19.13	187.02
S_4F_2	7.28	0.34	0.72	250.22	18.50	184.16
S_4F_3	7.24	0.33	0.68	248.05	17.30	182.02
S_5F_1	7.52	0.36	0.76	269.32	19.77	188.08
S_5F_2	7.30	0.33	0.71	259.25	18.91	186.04
S_5F_3	7.30	0.31	0.69	261.06	17.71	182.25
SEm ±	0.15	0.01	0.02	2.84	0.18	0.91
CD @ 5%	NS	NS	NS	NS	NS	NS

*NS- non significant

S1 – 2 m x 1 m   F1– 200:80:150 g NPK/plant (100% RDF)
S2 – 3m x 1.5 m   F2– 150:60:110 g NPK/plant (75% RDF)
S3 – 3 m x 3 m   F3– 100:40:75 g NPK/plant (50% RDF)
S4 – 6 m x 3 m
S5 – 6 m x 6 m

Table 3: Effect of plant geometry and nutrients on fruit quality parameters of guava cv. Sardar

Treatments	Pulp weight (g)	Seed weight (g)	Pulp: seed ratio	TSS (°B)	Ascorbic acid (mg/100g)	Titrable acidity (%)	Brix: acid ratio
Spacing (S)							
S_1	174.05	7.17	24.39	11.74	164.59	0.30	40.23
S_2	186.67	7.53	24.84	12.30	166.59	0.28	45.63
S_3	195.66	7.70	25.42	12.38	171.26	0.26	48.71
S_4	204.50	7.93	25.78	12.61	175.04	0.26	49.66
S_5	208.17	8.17	25.47	12.71	178.78	0.25	54.30
SEm ±	1.77	0.03	0.25	0.05	0.92	0.004	0.75
CD @ 5%	5.13	0.08	0.73	0.15	2.68	0.01	2.17
Nutrition (F)							
F_1	205.54	8.24	24.93	13.08	184.09	0.22	59.87
F_2	192.45	7.70	24.97	12.51	167.82	0.26	47.93
F_3	183.44	7.16	25.65	11.46	161.84	0.33	35.32
SEm ±	1.37	0.02	0.19	0.04	0.72	0.003	0.58
CD @ 5%	3.98	0.06	0.56	0.11	2.07	0.01	1.68
Interactions (S x F)							
S_1F_1	185.00	8.00	23.13	12.55	174.44	0.24	51.71
S_1F_2	171.07	7.10	24.10	12.00	161.33	0.31	38.74
S_1F_3	166.09	6.40	25.95	10.68	158.00	0.35	30.24
S_2F_1	196.16	8.20	23.92	12.90	177.67	0.23	56.16
S_2F_2	184.83	7.50	24.64	12.43	164.00	0.27	46.72
S_2F_3	179.03	6.90	25.95	11.56	158.11	0.34	34.02
S_3F_1	209.04	8.20	25.49	13.00	185.89	0.22	59.17
S_3F_2	190.10	7.70	24.69	12.53	167.78	0.25	49.48
S_3F_3	187.82	7.20	26.09	11.61	160.11	0.31	37.48
S_4F_1	215.23	8.30	25.93	13.43	189.67	0.22	61.13

S_4F_2	205.11	8.00	25.65	12.70	170.11	0.25	50.86
S_4F_3	193.17	7.50	25.76	11.70	165.33	0.32	37.00
S_5F_1	222.28	8.50	26.15	13.50	192.78	0.19	71.19
S_5F_2	211.16	8.20	25.75	12.91	175.89	0.24	53.84
S_5F_3	191.07	7.80	24.50	11.73	167.67	0.31	37.87
SEm ±	3.07	0.05	0.43	0.09	1.60	0.01	1.30
CD @ 5%	NS	NS	1.54	NS	NS	NS	NS

*NS- non significant

S1 – 2 m x 1 m F1– 200:80:150 g NPK/plant (100% RDF)
S2 – 3m x 1.5 m F2– 150:60:110 g NPK/plant (75% RDF)
S3 – 3 m x 3 m F3– 100:40:75 g NPK/plant (50% RDF)
S4 – 6 m x 3 m
S5 – 6 m x 6 m

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