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Effect of planting density on growth parameters and fruit yield in guava (*Psidium guajava* L.) cv. Allahabad Safeda cultivated under mild humid conditions of Coorg

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ABSTRACT

A study was carried out in 'Allahabad Safeda' guava (*Psidium guajava* L.) to standardize the effect of planting densities on growth parameters viz., scion girth, plant height, and spread (East – West and North – South), canopy area, canopy volume and fruit yield over a ten years period. The trial was laid out with five planting densities viz., 6x3, 6x4, 6x6, 8x4, 8x3m accommodating 555, 416, 277, 312 and 416 plants/ha respectively with four replications having sixteen plants per treatment in a randomized block design during 1988-89 season. The grafted plants on seedling rootstock were planted and the yield data were recorded from 1992 to 1997. The results indicated that the scion girth was significantly higher in 8x3 or 8x4m configurations. There were no significant differences among treatments for plant height. The plant spread across East-West direction was however significant in 8x3m. The fruit yield in Mrig bahar was significantly higher as compared to that of Hasth bahar in terms of fruit number and weight. Land Use Index (LUI) values exceeding 50% had bearing on the productivity of different configurations. The productivity was nearly double in 6x3m where, the planting density was twice as much in recommended spacing (6x6m) by sixth year of planting after which, yield levels declined. Thus, it was concluded that a spacing of 6x3m having 555 plants/ha, gives the highest productivity in 'Allahabad Safeda' guava by sixth year of planting under North Coorg conditions.

Key words*:* Allahabad Safeda, planting density, growth parameters, land use index (LUI), productivity

INTRODUCTION

Allahabad Safeda is largely grown in plains of Deccan plateau characterized by subtropical climate conditions but rarely under heavy rainfall and humid conditions (Rathore and Singh 1976). Chettalli, located in the hilly region of Karnataka at an elevation of 1000 MSL receives on an average, 1250 mm annual rainfall distributed over six months and is considered to be less suitable for guava cultivation as compared to other known agro-climates of guava production. However, a survey of North Coorg region conducted during late 1980's revealed reasonably successful cultivation of guava in few pockets of Somwarpet taluk under marginal holdings (Anon., 1986). Therefore, it was felt that there existed scope to improve the profitability of such holdings by changing planting densities. Studies in other fruit crops have shown that closer plantings resulted in early productivity leading to early returns on capital invested (Iyer and Kurien, 2006). It was reported that closely planted trees fill their allotted space earlier and the intense root competition increased fruitfulness (Leigh Issell, 1994 and Miles and Guarnaccia, 1999). Under the prevailing land use pattern in Coorg, there is enormous scope for crop diversification. In this background, it was felt to generate information on the effect of planting densities on growth aspects and their influence on fruit yield in guava for the North Coorg region.

MATERIAL AND METHODS

Uniformly aged inarch grafted plants of 'Allahabad Safeda' were procured from the nursery of State Department of Horticulture, Hunsur, Mysore district, for the study. They were planted in June 1988, in pits (0.5 x 0.5 x 0.5 m size) filled with 10 kg farmyard manure and 10 kg sand for easy and quick establishment of the crop. The experiment was laid out with five planting densities along with 6 x 6m spacing as the check (277 plants/ha). The other four configurations included, 6 x 3 m (555 plants/ha), 6 x 4 m (416 plants/ha), 8 x 4 m (312 plants/ha) and 8 x 3 m (416 plants/ha). A total of 240 plants were planted in randomized block design (RBD) with four replications, consisting of 12 plants per replication.

The plants were raised under uniform growth conditions with timely cultural practices including drip irrigation and application of recommended doses of manures twice a year. Recommended NPK fertilizers were applied and appropriate plant protection measures were adopted as and when required. The plants started flowering during 1991 but fruit set was prevented by deblossoming in order to encourage optimum canopy development through training to modified central leader. Regular fruit harvests of 'mrig' and 'hasth' bahar crops were obtained from 1992 onwards.

Observations on different growth parameters viz., scion girth, plant height , plant spread in terms of East - West and North - South directions, canopy size, canopy volume, fruit yields in 'Mrig' and 'Hasth' bahars and productivity were recorded. The effect of planting density was evaluated by the measurement of land use index (LUI), which was expressed as the percentage of the canopy area (m^2) occupied by the plant in relation to the spacing (m^2). The data were statistically analyzed by adopting standard procedures and interpreted using analysis of variance.

RESULTS AND DISCUSSION

Vigour

Scion girth (cm): Scion girth increased from 17.24 cm to 41.56 cm from 1991-1992 to 1997-98 (Table 1). There were no significant differences among the treatments for scion girth during the first four years of observation but significant differences were seen thereafter. The plants under 8 x 3 m configuration showed significantly higher scion girth as compared to the rest during 1996 and 1997 possibly due to wider inter-row space available in the middle of the alleys facilitating maximum light interception. They also showed a higher canopy volume and higher LUI values as compared to plants grown in 6 x 4 m configuration. This is in congruence with the findings of Leigh Issell (1999).

Plant height (m): Height of the plant increased from 2.87 m to 6.99 m from 1992 to 1997 (Table 2) with maximum values recorded in 8 x 3 m by 1997 and a significantly higher LUI value over the recommended spacing (Table 5). This implied that over a period of ten years, the plants under 8 x 3 m spacing could fill their allotted space to a greater extent. Such a situation warrants canopy management strategies to sustain productivity of the system (Robinson *et al*, 2007; Walsh, 1991). Leigh Issell (1999) also reported that closer planting forced the trees to grow taller and fill their allotted space. As a general rule, the height of the hedgerow should not be more than double the width of the alleyway (Leigh Issell, 1999). In this background, plants in 8 x 3 m configuration had attained more than 50% LUI values by sixth to seventh year of planting.

Plant-spread (m): Plant spread in terms of East-West and North-South directions was measured as one of the indices contributing to fill of allotted space by the configurations. Further 8 x 3 m configuration recorded significantly higher East-West spread than the rest up to seventh year of planting (Table 3). This may be attributed to wider inter-row spacing facilitating better light interception (Leigh Issell, 1999). The data on North-South spread (Table 4) however, did not present clear cut trends. The seasonal variations in growth parameters and fruit yield documented by Sahay and Kumar

Table 1. Effect of planting densities on scion girth (cm)

Spacing	1991-92	1993-94	1994-95	1995-96	1996-97	1997-98
6mx3m	17.79	22.93	24.24	26.67	30.46	33.42
6mx4m	17.24	22.71	26.08	28.63	33.29	36.63
6mx6m	19.05	23.92	27.83	30.70	35.11	38.08
8mx4m	18.79	23.70	28.43	33.19	37.19	40.44
8mx3m	17.69	23.65	28.88	33.76	37.75	41.56
SEm	—	—	—	—	1.97	0.53
CD (*P= 0.05)*	NS	NS	NS	NS	6.40	1.72

Table 2. Effect of planting densities on plant height (m)

Spacing	1991-92	1993-94	1994-95	1995-96	1996-97	1997-98
6mx3m	3.19	3.28	3.75	4.48	5.22	6.54
6mx4m	3.09	3.26	3.44	4.40	5.08	6.45
6mx6m	3.18	3.23	3.99	4.59	5.33	6.97
8mx4m	3.20	3.33	3.80	4.49	5.22	6.73
8mx3m	2.87	3.35	3.88	4.58	5.45	6.99
SEm	—	—	—	—	—	—
CD (*P= 0.05)*	NS	NS	NS	NS	NS	NS

Table 3. Effect of planting densities on plant spread (m) in East – West direction

Spacing	1992	1993	1994	1995	1996	1997
6mx3m	2.72	3.01	3.57	4.02	5.28	6.50
6mx4m	2.68	3.06	3.44	3.37	4.96	6.70
6mx6m	3.08	3.05	3.65	4.05	5.40	6.80
8mx4m	2.54	2.94	3.40	3.96	5.44	7.07
8mx3m	3.02	3.77	4.32	4.82	6.15	7.44
SEm	—	—	0.15	0.25	0.23	0.22
CD (*P= 0.05)*	NS	NS	0.49	0.81	0.75	0.71

Table 4. Effect of planting densities on plant spread (m) in North – South direction

Spacing	1992	1993	1994	1995	1996	1997
6mx3m	3.15	3.32	3.69	4.20	5.46	6.86
6mx4m	2.84	3.20	3.59	4.00	5.39	6.84
6mx6m	3.55	3.55	4.08	4.56	5.80	6.98
8mx4m	2.82	3.55	3.93	4.50	5.76	6.67
8mx3m	3.42	3.55	3.87	4.46	5.22	6.14
SEm	0.17	—	—	—	—	0.07
CD (*P= 0.05)*	0.56	NS	NS	NS	NS	0.23

Table 5. Effect of planting density on *Land Use Index (LUI)

Spacing	1993	1994	1995	1996	1997
6mx3m	43.99	57.90	101.06	127.82	195.82
6mx4m	32.66	40.98	71.25	88.96	139.47
6mx6m	24.08	32.70	55.50	70.84	105.32
8mx4m	26.55	33.46	60.25	80.17	114.00
8mx3m	44.16	54.96	84.00	112.86	150.36
SEm	4.01	3.55	6.79	8.70	9.40
CD (*P= 0.05)*	12.99	11.50	21.20	28.18	30.46

* expressed as per cent values

Table 6. Effect of planting densities on number of fruits /tree during Mrig Bahar

Spacing	1992	1993	1994	1995	1996
6mx3m	124.17	203.03	410.67	192.09	143.38
6mx4m	124.75	159.75	368.42	192.50	139.65
6mx6m	144.67	141.33	459.58	198.52	144.20
8mx4m	117.38	107.38	398.38	203.75	151.82
8mx3m	122.50	122.50	463.75	222.38	156.31
SEm	—	7.37	—	—	—
CD (*P= 0.05)*	NS	23.87	NS	NS	NS

(2004) in guava indicated higher yields in winter. Thus, seasonal fluctuations do influence yield as they are influenced by growth dynamics across seasons. The results obtained in the present study are consistent with the earlier studies.

***Land use index (LUI)*:** The land use index values were derived in order to serve as an index for evaluating the capacity of the respective configurations to fill their allotted space over a period of time. LUI also indicates the possible inter-plant competitions for water, nutrients, light and microclimate impacts on the system. In the present study, 8 x 3 and 6 x 3 m configurations, by sixth year of planting had crossed 50% LUI values which were significantly higher over the rest (Table 5). The ultimate cropping potential per unit of land, after the trees have filled their allotted space, depends upon the total volume of the hedgerow mantle where fruiting primarily occurs. The fruit-producing area and depth, or tree mantle, are the result of tree training and depth of penetration of light for cropping (Leigh Issell, 1999). This may possibly explain significantly higher level of productivity (Table 10) attained by the 6 x 3 m configuration that also recorded significantly higher LUI value over the rest by sixth year of planting. From seventh year of planting, the productivity of different configurations showed a declining trend, which highlighted the criticality of LUI values exceeding 50%. This may be due to overlapping of the canopies of the adjacent plants and mutual shading of the branches leading to barrenness arising from low production of new shoots as observed by Walsh (1991) in peach and Bhatia *et al* (2001) in guava. Thus, judicious pruning of canopies is necessary to sustain productivity through higher light interception and promotion of new shoots.

Fruit yield

'Mrig' bahar : The analysis of results indicated that yield performance in sixth year of planting of 'Allahabad Safeda' guava had reached stability. Number of fruits/tree in 'Mrig' bahar across treatments did not vary significantly except during 1993 (Table 6). By sixth year of planting however, maximum number of fruits was recorded in 8 x 3 m. Correspondingly, this treatment also had maximum fruit yield of 49.10 kg/tree in 1994 (Table 7). After 1994, trend of yield decline was apparent. These variations are probably brought about by the dynamics of vegetative growth, crucial to fruiting intensity in guava. Such variations have been reported by other workers also (Sahay and Kumar, 2004; Bhatia *et al*, 2001; and Yadav *et al*, 2001).

'Hasth' bahar : Results indicated that both number as well as weight of fruits/tree was maximum during 1994 (Tables 8 and 9) in 8 x 3 m configuration although differences were not significant. It was observed that 'Mrig' bahar was better than 'Hasth' bahar in terms of number and weight of fruits/tree due to the seasonal influence as it coincided with regular monsoon.

Productivity : The closer configurations of 6 x 3, 6 x 4 and 8 x 3 m gave significantly higher productivity by fourth year of planting, which increased progressively up to sixth year of planting(Table 10). The total fruit yield data suggested that there were significant differences among the

Table 7. Effect of planting densities on weight of fruits/tree (kg) during Mrig Bahar

Spacing	1992	1993	1994	1995	1996
6mx3m	13.04	21.32	43.12	20.17	15.05
6mx4m	13.22	16.92	38.91	20.38	14.79
6mx6m	15.77	15.43	50.24	21.67	15.77
8mx4m	12.68	11.63	42.95	22.07	16.44
8mx3m	12.99	12.98	49.10	23.56	16.56
S Em	—	0.80	—	—	—
CD (*P= 0.05)*	NS	2.59	NS	NS	NS

Table 8. Effect of planting densities on number of fruits/tree during Hasth Bahar

Spacing	1992	1993	1994	1995	1996
6x3 m	68.25	34.42	68.59	23.92	25.50
6x4 m	73.50	22.00	62.92	38.29	24.91
6x6 m	72.25	21.58	53.79	39.25	28.1
8x4 m	61.13	54.25	49.79	33.11	25.44
8x3 m	80.63	23.63	52.5	31.08	25.94
SEm	—	2.14	—	3.4	—
CD (*P= 0.05)*	NS	6.93	NS	11.31	NS

Table 9. Effect of planting densities on weight of fruits/tree (kg) during Hasth Bahar

Spacing	1992	1993	1994	1995	1996
6x3 m	7.17	3.55	7.52	2.51	2.68
6x4 m	7.72	2.33	9.29	4.01	2.62
6x6 m	7.58	2.36	5.71	4.12	2.94
8x4 m	6.42	3.70	5.31	3.48	2.67
8x3 m	8.47	2.51	5.46	3.27	2.72
SEm	—	—	0.87	0.43	—
CD (*P= 0.05)*	NS	NS	2.83	1.30	NS

Table 10. Effect of planting densities on productivity (tons/ha)

Spacing	1992	1993	1994	1995	1996	1997
6x3 m	7.27	13.81	28.97	17.53	10.29	16.64
6x4 m	5.50	8.01	20.78	11.77	7.34	12.35
6x6 m	4.37	4.92	15.06	10.50	5.22	11.03
8x4 m	3.96	4.78	19.86	15.56	6.15	10.48
8x3 m	5.40	6.44	16.58	11.27	8.48	16.08
SEm	0.52	0.51	2.71	0.66	0.24	1.60
CD (*P= 0.05)*	1.14	1.56	6.69	2.15	0.78	3.50

treatments (Tables 6, 7, 8 and 9). The configuration 6 x 3 m recorded higher yield by sixth year of planting suggesting that the high density planting of guava is superior to the conventional planting at 6 x 6 m. The spacing of 6 x 3 m also recorded significantly higher LUI values than the rest by sixth year of planting (Table 5) and continued its superiority even up to ninth year of planting. This is in agreement with the reports of Walsh (1991), Leigh Issell (1999), Robinson and Hoying (2004) and Robinson *et al* (2007). Judicious timely pruning operations to overcome the adverse effects of closer configurations after sixth year of planting may sustain the productivity of the system in the long run.

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