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Effect of different spacing on newly planted guava cv. L- 49 under ultra high density planting system

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Trees of guava (*Psidium guajava* L.) cv. Sardar were planted in September, 2010 at 2.0 x 2.0, 2.0 × 1.5, 1.5 × 1.5, 2.0 x 1.0 and 1.0 × 1.5 m spacing in 6.0 x 6.0 m size blocks to determine the effect of planting distance on tree growth, light interception, chlorophyll content, leaves Nitrogen, Phosphorous, and Potash (Potassium) (NPK), flowering, yield and quality parameters. The experiment was laid out in randomized block design with four replications at Instructional Farm, Department of Horticulture, Rajasthan College of Agriculture, Udaipur, Rajasthan, India. Vegetative growth characters of guava plant thou not influenced at the early stage by plant density however, at later stage, it was significantly influenced by various spacing treatments. Difference in two measurements was taken as "gain" and pruning was done during 11 September (first); 12 February; 12 September and 13 February (fourth). Mean maximum gain of shoot (46.7, 67.1 and 76.5 cm, respectively) and (53.7, 77.2 and 90.4 cm, respectively) at 60, 120 and 180 days second to third pruning (September, 2011 to February, 2012) and third to fourth (February, 2012 to September, 2012) respectively were recorded under treatment T_1 (2.0 × 2.0 m) and minimum recorded under treatment T_5 (1 × 1.5 m). Similarly, after two years of planting maximum plant; E-W (1.19 m) and N-S (1.32 m), girth of stem (3.75 cm), leaf area (97.16 cm^2), light interception below canopy (356 μ Mol / m^2 S), flowers $plant^{-1}$ (88.40), number of fruits $plant^{-1}$ (17.20), fruit weight (77.50 g), yield $plant^{-1}$ (1.32 kg) and TSS/acid ratio (33.14) recorded under 2.0 × 2.0 m spacing and minimum under 1.0 x 1.5 m spacing, maximum plant height (1.58 m), leaf area index (LAI) (3.29) and estimated yield (5.72 t ha^{-1}) were recorded under 1.0 × 1.5 m spacing and minimum plant height recorded under 2.0 × 2.0 m spacing. Further, trees spaced at 2.0 × 2.0 m produced better quality fruits as compared to other spacing treatment.

Key words: Guava, Ultra High Density Planting (UHDP), planting spacing,

INTRODUCTION

The continuing decline in the availability of cultivable land, rising energy, taxes, production cost and land cost together with the mounting demand of horticultural produce, have given thrust to the concept of high density planting of horticultural crops. It is an intensive form of horticulture production which has high relevance to the nutritional security of our ever-increasing population. In general, guava is cultivated mainly through a traditional

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system, under which it is difficult to achieve desired levels of production because large trees provide low production per unit area and needs high labour inputs (Araujo et al., 1999; Reddy et al., 1999; Singh et al., 2003). Getting increased yield of guava per unit area can be made possible by increasing the plant population (Singh et al., 1980; Mitra et al., 1984). Moreover, large trees take several years before they come into bearing and overall cost of production per unit area is further increased. Ultra high density planting not only provides higher yield but also provides higher net economic returns per unit area in the initial years and also facilitates more efficient use of inputs (Reddy, 2004).

One of the ways used for efficient and profitable land use is to work on tree spacing. Its basic function is to confine the exploitation zone of the plant with regard to light, water and nutrients so that the highest total yield potential can be reached in the smallest possible area (Singh, 2005). Studies on high-density planting in guava have increased and the results were published by Chapman et al. (1979), Singh et al. (1980), Lal et al. (1996) and Singh (2004).

MATERIALS AND METHODS

Experimental site and climate

The field experiment was conducted at Instructional-Cum-Research Farm, Department of Horticulture, Rajasthan College of Agriculture (MPUAT) Udaipur, India, situated at 24° 35' N latitude and 73° 42' E longitude at an elevation of 582.17 m above mean sea level. The region falls under agro climatic Zone IV A (Sub-humid Southern Plain and Aravalli Hills) of Rajasthan. It has a typical sub-tropical climate, characterized by mild winters and summers. The average rainfall of this tract ranges from 592.5 mm to 650 mm year^{-1}. More than 90% of rainfall is received from Southwest Monsoon during the months of June to September with scanty showers during winter months. The minimum temperature may reach the extreme of 0°C in winter and the maximum temperature may reach another extreme of 43°C during summer. The relative humidity varies from 75.0 to 95.0% in Monsoon, with the annual/average being 57.8%. The winter season rudiments from second half of October and continues up to February. The summer season lasts longer compared to winter, beginning from March to the middle of July. Mechanical analysis of soil showed that the soil contains 37.01% sand, 29.10% silt and 33.89% clay portion. Organic carbon, available nitrogen, phosphorus and potassium of soil were 0.67%, 201.1, 19.5 and 272.9 kg ha^{-1}, respectively.

Treatment application

Trees of guava (*Psidium guajava* L.) cv. Sardar were planted in September, 2010 at 2.0 × 2.0 m (T_1), 2.0 × 1.5 m (T_2), 1.5 × 1.5 m (T_3), 2.0 × 1.0 m (T_4) and 1.0 × 1.5 m (T_5) spacing in 6.0 × 6.0 m size blocks and replicated four times in a randomized block design. The number of plants at different plant density ranges from 2,500 to 6,666 plants ha^{-1}. In February, 2011 all the trees were topped at a uniform height of 50 cm from ground level and all side shoots and branches were removed (first pruning). Further, in September, 2011 as shoot mature, they reduced 50% of their total length and 3 to 4 equally spaced shoots plant^{-1} were retained (second pruning). New emerging shoots were pruned by cutting back 50% of their total length in February, 2012 (third pruning). Further in September, 2012 all plants were pruned by hedging and topping (non-selective pruning) (fourth pruning). Difference in two measurements was taken as "gain" and pruning was done during 11 September (first), 12 February, 12 September and 13 February (fourth) respectively.

Observations recorded

The data on shoot gain (cm), plant spread (m), plant height from north-south and east-west (m), stem girth (cm), new emerging shoot diameter (mm), leaf area (cm^2), light interception above and below canopy and LAI were measured before second (September, 2011), third (February, 2012) and fourth (September, 2012) pruning. Whereas, total chlorophyll content and Leaf NPK content were measured during November, 2011 and November, 2012. Further, flowering, yield and quality parameters, that is, number of flower plant^{-1}, fruit set (%), number of fruit plant^{-1}, fruit weight (g), yield plant^{-1} (kg), estimated yield ha^{-1} (t), TSS (%), acidity (%), TSS/acid ratio, ascorbic acid (mg 100 g^{-1} pulp), total sugar (%), organoleptic score were measured during *mrig bahar* (October to November, 2012). The data on gain of shoot after each pruning (cm), tree height (m) and plant spread (E-W and N-S) (m) were recorded using meter scale. Stem girth and new emerging shoot diameter were recorded with vernier callipers and leaf area (cm^2) was measured by a leaf area meter (Systronics). Light interception was measured between 10 to 12 AM by canopy analyzer (LP 80) under natural radiation and expressed in μ mol m^{-2} s^{-1}. Leaf area index was taken with a canopy analyzer (LP-80, LAI meter) between 10 to 12 AM. Total chlorophyll content was analyzed by N-dimethylformamide (DMF) method. NPK content in leaves was measured by Nesseler's reagent colorimetric method (Linder, 1944), Ammonium vanadomolybdo phosphoric acid yellow color method (Richards 1968) and Flame photometer method (Richards 1968) respectively. The total number of flowers set into fruits was counted. Average fruit weight was recorded with the help of electronic balance. Mature fruits were harvested periodically in each treatment separately and weighted on an electronic balance and then the yield per plant was calculated. Estimated yield ha^{-1} was calculated by multiplying the yield plant^{-1} by number of plants per ha^{-1}. Fruit quality (TSS, acidity and ascorbic acid) attributes were analyzed as prescribed standard methods (A.O.A.C., 1990). Total sugar content was determined by using Anthrone reagent method (Dubois et al., 1951).

Statistical analysis

The data obtained on various characters were subjected to reliability block diagram (RBD) analysis and interpretation of the data was carried out in accordance to Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Growth characteristics

The results of the present investigation revealed that vegetative growth characters of guava plant were not much influenced at the early stage by different plant densities (Tables 1 and 2). However, at later stage (after 2 years of planting) they were significantly influenced by various spacings treatment except new emerging shoot diameter, light interception above canopy, these

Table 1. Effect of different spacings on gain of shoot after first, second and third pruning and plant spread in guava under ultra high density planting system.

Treatment	Gain of shoot after first pruning (cm) (Feb., 2011 to Sept., 2011)			Gain of shoot after second pruning (cm) (Sept., 2011 to Feb., 2012)			Gain of shoot after third pruning (cm) (Feb., 2012 to Sept., 2012)			Plant spread E-W (m)			Plant spread N-S (m)		
	60 DAP	120 DAP	180 DAP	60 DAP	120 DAP	180 DAP	60 DAP	120 DAP	180 DAP	September, 2011	February, 2012	September, 2012	September, 2011	February, 2012	September, 2012
T_1 (2.0 x 2.0 m)	47.8	68.2	79.7	46.7	67.1	76.5	53.7	77.2	90.4	0.82	1.03	1.19	0.84	1.06	1.32
T_2 (2.0 x 1.5 m)	50.0	70.2	81.3	43.1	62.0	70.2	48.9	71.2	84.0	0.88	0.98	1.16	0.82	1.02	1.22
T_3 (1.5 x 1.5 m)	45.9	67.0	77.8	42.7	60.5	68.4	50.0	70.7	82.8	0.81	0.96	1.12	0.76	0.92	1.14
T_4 (2.0 x 1.0 m)	48.7	68.4	80.0	41.2	59.9	67.2	45.9	64.6	76.2	0.89	0.99	0.97	0.81	0.90	1.16
T_5 (1.0 x 1.5 m)	44.7	65.2	76.4	37.1	53.3	59.7	43.7	60.9	70.3	0.78	0.87	0.92	0.77	0.88	1.15
SEm ±	1.318	1.812	2.344	1.109	1.609	1.800	1.257	1.862	2.156	0.029	0.038	0.053	0.021	0.045	0.031
CD at 5%	NS	NS	NS	3.417	4.957	5.546	3.874	5.738	6.644	NS	NS	0.163	NS	NS	0.096

Note: Feb. – February, Sept. – September.

Table 2. Effect of different spacings on plant height, stem girth, new emerging shoot diameter, leaf area and light interception above canopy in guava under ultra high density planting system.

Treatment	Plant height (m)			Girth of stem (cm)			New emerging shoot diameter (mm)			Leaf area (cm^2)			Leaf area index (%)		
	Sept., 2011	Feb., 2012	Sept., 2012	Sept., 2011	Feb., 2012	Sept., 2012	Sept., 2011	Feb., 2012	Sept., 2012	Sept., 2011	Feb., 2012	Sept., 2012	Sept., 2011	Feb., 2012	Sept., 2012
T_1 (2.0 x 2.0 m)	0.79	0.94	1.32	1.28	2.35	3.75	6.27	6.18	6.93	95.18	87.34	97.16	3.10	2.93	2.80
T_2 (2.0 x 1.5 m)	0.86	1.01	1.38	1.18	2.31	3.54	6.50	6.14	6.84	88.13	77.42	89.99	3.17	3.06	3.02
T_3 (1.5 x 1.5 m)	0.84	1.06	1.37	1.24	2.24	3.49	6.22	6.23	6.81	84.92	81.58	86.62	3.21	3.15	3.13
T_4 (2.0 x 1.0 m)	0.94	1.14	1.47	1.27	2.28	3.46	6.28	6.11	6.80	82.49	79.16	85.29	3.25	3.22	3.17
T_5 (1.0 x 1.5 m)	0.97	1.19	1.58	1.26	2.28	3.33	6.21	6.14	6.69	83.15	77.84	83.31	3.32	3.27	3.29
SEm ±	0.047	0.059	0.038	0.033	0.060	0.082	0.165	0.161	0.154	2.307	2.207	2.355	0.085	0.083	0.082
CD at 5%	NS	NS	0.118	NS	NS	0.252	NS	NS	NS	7.108	6.801	7.258	NS	NS	0.253

Note: Feb. – February, Sept. – September.

parameter significantly were not influenced by various spacing treatments throughout the study period.

After two years of planting, the plant height and LAI increased with the increase in plant density, that is, 2,500 to 6,666 plant ha^{-1} (1.32 to 1.58 m and 2.80 to 3.29, respectively), while the spread of the plant E-W (1.19 to 0.92 m) and N-S (1.32 to 1.15 m), girth of stem (3.75 to 3.33 cm) and light interception below canopy (356 to 276 μ Mol / m^2 S) decreased with the increase in plant population (Tables 1 to 3). Further, leaf area decreased with increasing plant density and maximum (95.18, 87.34 and 97.16 cm^2 respectively, before second, that is, September 2011, third, that is, February, 2012 and fourth pruning, that is, September, 2012) recorded under treatment T_1 (2.0 × 2.0 m) (Table 2). Gain of shoot at 60, 120 and 180 days

Table 3. Effect of different spacings on light interception below canopy, LAI, total chlorophyll content in leaves and leaves NPK content in guava under ultra high density planting system.

Treatment	Light interception above canopy (µ Mol / m^2 S)			Light interception below canopy (µ Mol / m^2 S)			Total chlorophyll content (mg 100 g^{-1} fresh weight)		Leaf N content (%)		Leaf P content (%)		Leaf K content (%)	
	Sep., 2011	Feb., 2012	Sep., 2012	Sep., 2011	Feb., 2012	Sep., 2012	Nov., 2011	Nov., 2012	Nov., 2011	Nov., 2012	Nov., 2011	Nov., 2012	Nov., 2011	Nov., 2012
T_1 (2.0 x 2.0 m)	961	840	941	328	252	356	2.30	2.36	2.68	2.85	0.190	0.192	1.56	1.78
T_2 (2.0 x 1.5 m)	980	828	958	337	269	338	2.14	2.24	2.62	2.77	0.192	0.189	1.60	1.73
T_3 (1.5 x 1.5 m)	964	825	951	339	272	315	2.16	2.22	2.71	2.71	0.180	0.192	1.58	1.72
T_4 (2.0 x 1.0 m)	955	836	940	369	285	286	2.18	2.30	2.58	2.70	0.180	0.175	1.53	1.62
T_5 (1.0 x 1.5 m)	972	815	960	346	260	276	2.10	2.17	2.60	2.62	0.172	0.177	1.60	1.58
SEm ±	25.34	21.81	24.89	11.15	7.638	7.258	0.057	0.060	0.069	0.072	0.006	0.005	0.042	0.057
CD at 5%	NS	NS	NS	NS	NS	22.36	NS	NS	NS	NS	NS	NS	NS	NS

Note: Feb. – February, Sept. – September.

after first to second pruning (February, 2011 to September, 2011) was non-significantly affected due to different spacings treatment. However, mean maximum gain of shoot (46.7, 67.1 and 76.5 cm, respectively) and (53.7, 77.2 and 90.4 cm, respectively) at 60, 120 and 180 days second to third pruning (September, 2011 to February, 2012) and third to fourth (February, 2012 to September, 2012), respectively were recorded under treatment T_1 (2.0 × 2.0 m) and minimum was recorded under treatment T_5 (1 × 1.5 m) (Table 1).

Results similar to present findings are reported earlier by Gaikwad et al. (1981), Mitra et al. (1984), Kundu et al. (1993) in guava, Kumar et al. (2010) in apricot and Dalal et al. (2012) in kinnow. Phillips (1969) reported that the closest spaced trees in Florida, 702 ha^{-1} were significantly taller as compared to 216 trees ha^{-1}. Bharad et al. (2012) reported that plant height would not be directly related to planting density in guava. The plant spread decreased with increasing plant density, while the height of plant increased with increase in plant population in guava (Yadav et al., 1981; Bharad et al., 2012). The girth and volume of tree showed decreasing trend with increasing tree density while tree height increased with increasing tree density in Allahabad Safeda guava (Kumar and Singh, 2000). Increase in plant density markedly increased the plant height while, the basal girth of the plant and spread of the crown decreased in guava cv. L-49 (Kundu, 2007). Singh et al. (2007) recorded maximum plant height and trunk circumference, while minimum canopy spread (NS/EW) in closely spaced guava trees (1.5 × 3.0 m). A possible explanation is the competition for water and soil nutrients (Policarpo et al., 2006), but mainly the competition for light (Johnson and Robinson, 2000; Policarpo et al., 2006), being under higher planting density plant canopies overlap into the rows, reducing light incidence on leaves. Consequently, great part of the canopy contributes little or nothing to the synthesis of carbohydrates necessary for growth. Thus, the competition between plants for light, water and nutrition under closer spacing resulted to less increase in gain of shoot after pruning, spread of the plant, girth of stem and leaf area.

Further under closer spacing, increase in height might be due to competition for light because of insufficient space. Trees spaced at 6×6 m intercepted significantly higher radiation on per tree basis than 6 × 5 m and 6 × 4 m spaced trees (Singh and Dhaliwal, 2007). Better light penetration was observed in the trees planted at 6.0 × 6.0 and 3.0 × 6.0 m than the other distances (3.0 × 3.0 and 3.0 × 1.5 m) at NS/EW canopy edge, inside tree centre, centre between tree in the rows and centre between rows in guava (Singh et al., 2007).

Flowering, yield and yield attributing characteristics

The results obtained in the present investigation revealed that different spacings treatment had significant influence on the number of flowers $plant^{-1}$, per cent fruit set, number of fruits $plant^{-1}$, fruit weight, yield $plant^{-1}$ and ha^{-1}. After two years of planting among the different spacing treatment,

Table 4. Effect of different spacings on number of flower plant^{-1}, percent fruit set, number of fruit plant^{-1}, fruit weight, yield plant^{-1}, estimated yield ha^{-1}, TSS, acidity, TSS/acid ratio, vitamin C and total sugar in guava under ultra high density planting system.

Treatment	No. of flower plant^{-1}	Fruit set (%)	Number of fruit plant^{-1}	Fruit weight (g)	Yield plant^{-1} (kg)	Estimated yield ha^{-1} (t.)	TSS (%)	Acidity (%)	TSS/acid ratio	Vitamin C (mg/ 100g pulp)	Total sugar (%)	Organo-leptic score
T_1 (2.0 x 2.0 m)	88.40	43.82	17.20	77.50	1.32	3.30	11.40	0.34	33.14	195.40	8.52	7.20
T_2 (2.0 x 1.5 m)	83.40	45.00	16.50	75.40	1.25	4.17	11.00	0.33	33.04	189.00	8.10	7.00
T_3 (1.5 x 1.5 m)	77.50	41.56	14.20	71.20	1.12	4.97	10.60	0.38	27.89	177.80	7.76	6.50
T_4 (2.0 x 1.0 m)	76.95	40.12	13.81	73.00	1.05	5.25	10.80	0.35	30.58	181.20	7.82	6.90
T_5 (1.0 x 1.5 m)	69.79	38.11	12.20	68.05	0.86	5.72	9.40	0.40	23.75	172.20	7.64	6.20
SEm ±	3.803	1.5057	0.7091	1.8462	0.0658	0.2063	0.433	0.0163	1.1845	5.1454	0.2066	0.2467
CD at 5%	11.719	4.6396	2.1851	5.6888	0.2027	0.6356	NS	NS	3.6497	NS	NS	NS

maximum number of flowers plant^{-1} (88.40), number of fruits plant^{-1} (17.20), fruit weight (77.50 g), yield plant^{-1} (1.32 kg) were recorded under widest spacing treatment (2.0 × 2.0 m), whereas highest fruit set (45.00) was recorded under 2.0 x 1.5 m spacing. Further, minimum values of these parameters were recorded under closest spacing treatment (1.0 × 1.5 m). Estimated yield ha^{-1} showed increasing trend with increasing plant density and maximum (5.72 t) obtained under 1.0 × 1.5 m spacing treatment which remained at photosynthetic active radiation (PAR) with T_4 (2.0 × 1.0 m) (Table 4).

Higher fruit setting in plants under wider spacing seems to be due to greater photosynthetic activity, because of exposure of more number of leaves to sun light, that availability of proper sunlight to the lower branches of the trees at close spacing becomes a limiting factor and it adversely affects the flowering and fruiting. In our study, clear cut relationship was observed in light penetration due to different tree densities. Increase in density delayed the emergence of flower and reduced the flowering period and fruit setting. The maximum fruit set was at the population of 278 plants ha^{-1} (76.8%), while it was low (68.8%) at 1600 plants ha^{-1} (Kundu, 2007). The number of fruits plant^{-1} was found inversely related to planting density. Maximum mean number of 17.20 fruits plant^{-1} were harvested from tree planted at 2.0 × 2.0 m spacing which was significantly higher than the number of fruits harvested from the plant spaced at 1.5 × 1.5; 2.0 × 1.0 and 1.0 × 1.5 m. Higher number of fruits plant^{-1} in wider spacing (2.0 x 2.0 m) might be due to larger canopy volume, further number of flower plant^{-1}, and per cent fruit set were maximum recorded at wider (2.0 × 2.0 m) spacing, therefore, number of fruit plant^{-1} ultimately increased in this treatment. These findings are in consonance with the findings reported by Wagenmaker and Callesen (1989) in apple and Singh and Dhaliwal (2007) in guava.

Maximum fruit weight (77.50 g) was recorded with 2.0 × 2.0 m spacing, which was found at par with T_2 (2.0 × 1.5 m) and T_4 (2.0 × 1.0 m) treatments and minimum at 1.0 x 1.5 m spacing which is accordance with the studies of Feungchan et al. (1992); Kumar and Singh (2000); Singh et al. (2007); Kundu (2007); Singh and Dhaliwal (2007) in guava, Srivastava et al. (2010) in cherry and Kumar et al. (2010) in apricot. This might be due to less per cent radiation interception on per tree basis in closely spaced (1.0 × 1.5 m) trees which led to severe competition for metabolites and caused reduction in fruit weight. An increase in fruit weight in widely spaced (2.0 × 2.0 m) trees may be due to the fact that this part intercepted maximum radiation which inturn had more efficient photosynthetic activities resulting in higher availability of net photosynthesis which enabled the trees to produce fruits with more weight (Singh, 2001). Further, higher fruit weight and higher number of fruit plant^{-1} were observed in T_1 treatment (2.0 × 2.0 m) which was one of the reasons for achieving higher yield of guava (1.32 kg) under this treatment. However, it remained at par with treatments T_2 (2.0 × 1.5 m) and T_3 (1.5 × 1.5 m). Further, at closer spacing, yield was poor due to lower number of flower buds and low fruit set. Number of plant ha^{-1} increased with increasing planting densities (2,500 to 6,666) therefore maximum estimated yield ha^{-1} obtained from closest spacing that is, 1.0 x 1.5 m (T_5) which remained statistically at par with treatment T_4 (2.0 × 1.0 m). Result of present finding are supported by Singh et al. (1980), Mohammed et al. (1984), Chundawat et al. (1992), Kalra et al. (1994), Bal and Dhaliwal (2003) in guava, Kumar et al. (2010) in apricot and Dalal et al. (2012) in kinnow. Closed spacing treatment decreased the fruit weight and size but the yield per unit area increased considerably in guava (Mitra et al., 1984; Kundu et al., 1993).

Trees at 2 × 2 m had a lower yield tree^{-1} than those at 8 × 8 m but produced a 10-fold higher yield ha.$^{-1}$ in guava (Lal et al., 1996). Yield of individual tree showed decreasing trend, whereas yield ha.$^{-1}$ showed increasing trend with increasing tree densities (Kumar and Singh, 2000).

Chemical characters of fruits

Increasing planting density did not change significantly most variables related to fruit quality, such as TSS, acidity, ascorbic acid, sugar content and organoleptic score, however these parameter were recorded higher under wider spacing. Only TSS/acid ratio was significantly different with the planting densities. TSS/acid ratio was maximum (33.14) obtained under 2.0 × 2.0 m spacing and minimum under 1.0 × 1.5 m spacing (Table 4). Therefore, in the present study, high density planting had little influence on fruit quality. Availability of proper sunlight to the lower branches of the trees at close spacing becomes a limiting factor and it adversely affects the fruit quality. Further, under high planting density, besides the changes in the quantity and quality of intercepted light, the partitioning of assimilates between vegetative and reproductive shoots may be responsible for the effects on fruit quality (Policarpo et al., 2006). Similar result was obtained by Kundu (2007) who reported that TSS/acid ratio of fruits were slightly higher in the fruits from the plants under wider spacing in guava. The present results are also supported by the finding of Kumar et al. (2010) in apricot; Singh et al. (1980); Gaikwad et al. (1981); Bal and Dhaliwal (2003); Singh et al. (2007) and Bharad et al. (2012) in guava. The objective of high density planting is the accommodation of maximum plants with higher yield per unit area with normal physico-chemical attributes. Maximum plants can accommodate 1 × 1 m spacing with higher yield per unit area, but will produce poor quality attributes. For growth and fruit weight with yield spacing 2 × 1.5 m closely followed by 1.5 × 1.5 m. 2 × 1 m spacing will be recorded as a satisfactory growth and with significantly higher fruit weight, quality (TSS/acid), yield ha^{-1} and higher accommodation of plants per unit area. Yield level per hectare non significant with 1 × 1 m (T5) and 2 × 1 m (T4), fruit weight non significant with 2 × 2 m (T1) and 2 × 1 m (T4) and fruit quality as TSS/acid non significant with 2 × 2 m (T1), 2 × 1.5 (T2) and 2 × 1 m (T4).

Conclusion

Intensive density of planting system, that is, 2 × 1 m spacing recorded satisfactory growth, light interception below canopy and significantly higher number of flower plant^{-1}, fruit weight, TSS/ acid ratio and estimated yield ha^{-1} with optimum plant per unit area (5000 ha^{-1}).

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Conflict of Interest

The authors have not declared any conflict of interest.

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