DOI : 10.5958/0974-0112.2020.00010.9
Indian J. Hort. 77(1), March 2020: 106-111

Cultural manipulation for the yield and quality enhancement of Pant Prabhat guava

Reena Prusty[*,], Rajesh Kumar, Satish Chand and Ratna Rai**
Department of Horticulture, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar 263145, Uttarakhand

ABSTRACT

An experiment was conducted on seven year old guava cv. Pant Prabhat with four different canopy heights and three different planting densities, along with their interactions to study their impact on yield and quality for winter season crop. Canopy height with 1.25 m was incomparable over other treatments with respect to fruit yield, fruit weight and chemical qualities *viz.* TSS, total sugars, pectin and sugar: acid ratio. Unpruned (control) trees reported earliest flower bud initiation. Among planting densities, 3333 plants ha^{-1} was recorded as best in terms of fruit set, fruit yield, fruit weight and quality of fruits. Of different interactions studied, plants of canopy height 1.25 m with density of 3333 plants ha^{-1} revealed their superiority against other combinations. It is, therefore concluded that plant population of 3333 plants ha^{-1} with canopy height of 1.25 m is best for higher yield of quality fruits of guava cv. Pant Prabhat.

Key words: *Psidium guajava*, canopy height, planting density, quality traits.

INTRODUCTION

Guava (*Psidium guajava* L.), one of the widely grown fruits in tropical and subtropical zone, is honored as the “Super fruit” because of nutritional and therapeutic values. Besides being rich in vitamin C and minerals, availability of fruits at cheaper price throughout the year compared to other fruits has given the status to guava as “Poor man’s fruit”. Furthermore, high concentration of pectin and fibre play a pivotal role in reduction of cholesterol, and thereby decrease the risk of cardiovascular disease, and make it suitable for value added products (Joseph and Priya, 8).

An increasing demand of guava among people contributing high nutrition, urged the productivity of crop to be increased. Keeping this fact in view, high density planting or meadow orcharding has been emerged out to meet the productivity of fruit crops. Although, in past few years, productivity of guava has been elevated towards top by adoption of high density planting, but quality of the produce remains concern. Mismanagement of canopy architecture among bearing trees has been expected as the major reason behind production of poor quality fruits as guava bears fruits on current season growth and response equally to pruning techniques. Furthermore, overcrowding and excessive shading in high density planting drastically reduce the fruit production, which require the intensive management of canopy architecture to achieve the desired productivity (Pratibha *et al.*, 12).

Production of two or three guava crops in a year is itself a unique phenomenon of the tropical and subtropical regions. The fruits produced in the rainy season are poor in quality and storability with severely past infested fruits over the crop of winter season. As guava is a pruning responsive crop, hence requires regular pruning for flowering and fruiting. The major objective of canopy management is to expose the larger canopy area to sun thereby increasing light interception which not only tends to optimize growth and productivity but also prevents the building up of disease and pest inoculums. This can be achieved by reducing tree size and removing intermingling branches for proper management of bearing trees. Pruning severity and planting distance have positive influence on growth, yield and quality of fruits (Pratibha and Lal, 11). Therefore, the present study was undertaken to standardize the canopy height and planting densities for improving the yield of quality of winter season guava under *Tarai* condition of Uttarakhand state.

MATERIALS AND METHODS

The experiment was conducted at Horticulture Research Centre, Patharchatta, Department of Horticulture of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar during 2016-2017 on uniform 7 year old guava trees of Pant Prabhat. The experimental site is characterized by

*Corresponding author’s E-mail: reenaprusty005@gmail.com
**ICAR-Indian Agricultural Research Institute, New Delhi 110012

humid sub-tropical climate with availability of high humidity during both summer and winter months. It experiences *Tarai* region characterized by high rainfall with wide variation in temperature. The experiment was laid out in Randomized Block Design (RBD) with four replications. In the present study, four canopy heights [1.25m (H_1) ,1.5m (H_2), 1.75m (H_3) maintained from ground level by pruning and lastly plants without pruning treated as control (H_4)] and three planting densities [5000 plants ha^{-1} spaced at 2×1m (D_1), 3333 plants ha^{-1} spaced at 2×1.5m (D_2) and 4444 plants ha^{-1} spaced at 1.5×1.5m (D_3)] were tested. Pruning was carried out in 1st week of May 2016 to maintain desired canopy heights.

Growth parameters like tree volume and number of shoots were recorded one month after pruning. The time of emergence of flower buds was recorded after pruning through visuall from 2nd week of August to 1st week of October. The number of flower buds was recorded at the time of maximum bud emergence on the selected trees. The total number of fruits per tree was recorded just before harvesting and mean value was calculated. Fruit set per cent was calculated by using the formula given by Westwood *et al*. (15).

The titratable acidity and sugar contents (reducing sugars, non reducing sugar and total sugars) in the fruits were determined by methods described in A. O. A. C. (1). Ascorbic acid content of guava fruits was determined by 2, 6-dichlorophenol indophenols titration method described by Ranganna (13). The total pectin content of fruits as calcium pectate was estimated as per the method of Bhat and Singh (4).

The data were analysed statistically using two-way analysis of variance, followed by Turkey's Honest Significant Difference (HSD) test available in SAS software version 9.3 (SAS Institute, Cary, NC, USA). *P values* ≤ 0.05 were considered significant.

RESULTS AND DISCUSSION

The data presented in Table 1, revealed that highest tree volume (1.01 m^3) and number of shoots/tree (48.31) were recorded from planting density of 3333 plants ha^{-1}, but was statistically similar with other planting densities. However, minimum tree volume (0.96 m^3) and number of shoots/tree (45.94) were reported under 4444 and 5000 plants ha^{-1} planting densities, respectively. Canopy height 1.25 m showed highest tree volume (1.03 m^3), which did not differ significantly from other height treatments, whereas, highest number of shoots/plant (59.42) was found at 1.25 m, which was significantly superior than others. Increase in number of shoots as a consequence of low canopy height resulted in increasing cytokinin levels, thereby promoting growth by means of retarding apical dominance caused by auxin. These finding are in accordance with Dhaliwal *et al*. (5) better on guava. Interaction effect of canopy heights and planting densities on tree volume and number of shoots were observed to be significant. Among various interactions, highest shoot number (61.50/ tree) was registered at 1.25m canopy height under 3333 planting density ha^{-1} (H1 × D2) and tree volume (1.22 m^3) was observed with 3333 plants ha^{-1} at 1.75 m canopy height (H3 × D2).

The flowering and fruiting characters were significantly influenced by tree height, planting density

Table 1. Pruning induced changes in tree growth of Pant Prabhat guava planted at different densities

Canopy height/ density	Tree volume	Number of shoots/tree
Canopy height		
1.25 m (H1)	1.03a	59.42a
1.5 m (H2)	0.89a	39.33c
1.75 m(H3)	1.03a	41.83c
Unpruned (H4)	0.97a	49.08b
LSD≤0.05	NS	5.17
Density (trees/ha)		
5000 (D1)	0.97a	45.94a
3333(D2)	1.01a	48.31a
4444(D3)	0.96a	48.00a
LSD≤0.05	NS	NS
Canopy height (H) ×Density (D)		
H1 × D1	0.95ba	57.00a
H1 × D2	1.04ba	61.5a
H1 × D3	1.09ba	59.75a
H2 × D1	0.77b	54.5ba
H2 × D2	0.75b	27.75e
H2 × D3	1.16ba	35.75de
H3 × D1	1.13ba	36.5de
H3 × D2	1.22a	46.75bc
H3 × D3	0.75b	42.25dc
H4 × D1	1.17ba	35.75de
H4 × D2	0.89ba	57.25a
H4 × D3	0.85ba	54.25ba
LSD≤ 0.05	0.44	8.96

Mean values in each column and for each canopy height, density or canopy height × density combination followed by different lower-case letters were significantly different at P ≤ 0.05 by Turkey's HSD test.

and their interactions (Table 2). Unpruned trees took the short duration for flowering (64.42 days) which differ statistically from canopy height 1.5 m, with longest duration for initiation of flowering (71.83) after pruning. The planting density at 3333 plants ha^{-1}, was registered earliest to bloom (61.19 days) after pruning. Planting density of 3333 plants ha^{-1} without pruning (H4 × D2) registered best in respect of early blooming (59.50 days), with significantly superior than other treatment combinations.

Plants with 1.25 m canopy height, exhibited highest flower buds/tree (65.42), fruits/tree (31.92), fruit set (65.77%), yield (4.66 kg/tree and 191.88 q/ha) and fruit weight (145.19 g) of Pant Prabhat guava, which was significantly superior than other canopy heights, except for number of flower buds/tree and fruit weight, showing statistically at par with canopy height 1.5 m. Unpruned trees found worse in respect of various flowering and fruiting characters studied.

Of the various densities tested, planting density of 3333 plants ha^{-1} tended to show the highest number of flower buds/tree (58.50), fruits/tree (25.19), fruit set (61.89 %), fruit yield (3.88 kg/tree) and fruit weight (151.67 g). Highest fruit yield per hectare (160.76 q) was recorded under planting density of 5000 plants ha^{-1} due to increase in number of plants per unit area, significantly differing from others. The data are in conformity with the findings of Shukla *et al.* (14). Among various interactions of tree height and density of Pant Prabhat guava, planting density of 3333 plants ha^{-1} at canopy height 1.25m (H1 × D2)

Table 2. Pruning induced changes in flowering and fruiting of Pant Prabhat guava planted at the different densities

Canopy height/ density	Duration from pruning to start of intiation of flower buds (days)	Flowerbuds/ tree	Fruits/ tree	Fruit set (%)	Yield/tree (kg)	Yield/ha (q)	Fruit weight (g)
			Canopy height				
1.25m (H1)	65.92b	65.42a	31.92a	65.77a	4.66a	191.88a	145.19a
1.5m (H2)	71.83a	60.75a	23.33b	56.48b	3.39b	143.90b	138.98a
1.75m (H3)	67.08b	48.50b	23.58b	57.24b	3.26b	137.01b	145.04a
Unpruned (H4)	64.42b	47.17b	16.83c	47.92c	2.10c	89.22c	124.58b
LSD≤ 0.05	3.53	5.42	3.57	5.00	0.52	22.29	7.68
			Density (trees/ha)				
5000 (D1)	70.75a	57.56a	24.63ba	55.33b	3.22b	160.76a	129.41b
3333 (D2)	61.19b	58.50a	25.19a	61.89a	3.88a	129.79b	151.67a
4444 (D3)	70.00a	50.31b	21.94b	53.34b	2.96b	131.60b	134.27b
LSD≤ 0.05	3.06	4.69	3.09	4.34	0.46	19.30	6.66
			Canopy height (H) × Density (D)				
H1 × D1	69.25cbd	75.50a	32.50a	57.61cbd	4.20b	210.04a	128.81c
H1 × D2	60.50e	65.50b	37.50a	77.36a	6.22a	207.14ba	168.75a
H1 × D3	68.00cbd	55.25dc	25.75b	62.34cb	3.57cbd	158.47dc	138.00cb
H2 × D1	79.75a	60.25bc	23.25cb	57.02cbd	3.34cbd	167.13c	143.75b
H2 × D2	64.25ced	66.25ba	26.00b	64.44b	3.76cb	125.18dfe	144.19b
H2 × D3	71.50b	55.75dc	20.75cebd	47.98fe	2.67fed	118.72fe	129.00c
H3 × D1	70.75b	49.75de	26.00b	63.52cb	3.43cbd	171.39bc	132.81cb
H3 × D2	60.50e	47.50de	22.00cbd	52.66ed	3.54cbd	118.10fe	162.00a
H3 × D3	70.00cb	48.25de	22.75cbd	55.54ced	3.20ced	142.21dce	140.31cb
H4 × D1	63.25ed	44.75e	16.75ed	43.16f	1.89f	94.49gf	112.25d
H4 × D2	59.50e	54.75dc	15.25e	53.09ed	1.99f	66.33g	131.75cb
H4 × D3	70.50b	42.00e	18.50ced	47.50fe	2.40fe	106.84fe	129.75c
LSD≤ 0.05	6.12	9.38	6.18	8.67	0.90	38.60	13.31

Mean values in each column and for each canopy height, density or canopy height × density combination followed by different lower-case letters were significantly different at $P \leq 0.05$ by Turkey's HSD test.

showed the highest number of fruits/tree (37.50), fruit set (77. 36%), fruit yield (6.2 kg/tree) and fruit weight (168.75 g). Besides, highest number of flower buds/ tree (75.50) and fruit yield per hectare (210.04 q) was noticed at canopy height 1.25 m with planting density of 5000 plants ha^{-1}.

The fruit quality parameters of Pant Prabhat guava as significantly influenced by different pruning height, planting densities and their interactions are given in Table 3. The most dwarf trees with canopy height 1.25 m produced the best quality guava in respect of TSS (11.64 °B), total sugars (10.85%), reducing sugars (4.25%), non-reducing sugar (6.30%), ascorbic acid (223.67 $mg100g^{-1}$), pectin (0.99%) and sugar: acid ratio (51.99). However, it was statistically similar to 1.5 m canopy height for TSS and reducing sugars and 1.75 m for non-reducing sugar contents. Fruits with least acidity (0.21%) were obtained from 1.25 m canopy height, whereas unpruned trees produced the most acidic fruit (0.25%) of guava. The results were in confirmation with Bhagawati *et al.* (3), who stated that increase in titratable acidity in the unpruned plants was due to deposition of higher quantum of acid that is synthesized in leaves during fruit development.

Of the three densities, planting density of 3333 plants ha^{-1} produced the fruits having highest TSS (11.34 °B), total sugars (10.52%), non-reducing sugar (6.20%), ascorbic acid (216.69 mg $100g^{-1}$), pectin (1.01%) and sugar: acid ratio (48.62), without showing any significant difference with planting

Table 3. Pruning induced changes in fruit quality of Pant Prabhat guava planted at the different densities.

Canopy height/ density	TSS (°B)	Acidity (%)	Total sugars(%)	Reducing sugars (%)	Non-reducing sugar (%)	Ascorbic acid (mg $100g^{-1}$)	Pectin (%)	SA ratio
				Canopy height				
1.25 m(H1)	11.64a	0.21c	10.85a	4.25a	6.30a	223.67a	0.99a	51.99a
1.5 m(H2)	11.40a	0.24b	10.00c	4.14a	5.57c	203.75b	0.98ba	42.29cb
1.75 m(H3)	11.09b	0.24b	10.30b	3.85b	6.13a	204.58b	0.87bc	43.90b
Unpruned (H4)	10.58c	0.25a	9.87c	3.74c	5.82b	203.83b	0.76c	40.29c
LSD≤0.05	0.26	0.02	0.24	0.11	0.24	11.18	0.12	3.07
				Density (trees/ha)				
5000 (D1)	11.07b	0.25a	10.22b	3.96a	5.95b	207.38ba	0.81b	41.62b
3333 (D2)	11.34a	0.22b	10.52a	4.01a	6.20a	216.69ba	1.01a	48.67a
4444 (D3)	11.13ba	0.23b	10.03b	4.02a	5.70c	216.68b	0.88b	43.57b
LSD≤0.05	0.22	0.01	0.21	0.10	0.21	9.68	0.10	2.67
				Canopy height (H) × Density (D)				
H1 × D1	11.05c	0.22e	10.86b	4.03de	6.49bc	223.5b	0.92cbd	50.64b
H1 × D2	12.98a	0.19e	11.36a	4.14dc	6.93a	247.5a	1.11b	59.28a
H1 × D3	10.90c	0.23cbd	10.32ced	4.56b	5.47f	200ced	0.94cb	46.04cbd
H2 × D1	10.88c	0.23cbd	10.02fe	4.02de	5.7ef	187.5e	0.74ed	43.15ced
H2 × D2	12.05b	0.25cb	10.08fe	3.64hg	6.11dc	208.75cb	1.31a	41.43ed
H2 × D3	11.28c	0.24cbd	9.91f	4.76a	4.89g	215cb	0.89ced	42.29ed
H3 × D1	11.93b	0.25b	9.89f	3.77fg	5.81def	200ced	0.87ced	39.88e
H3 × D2	10.25dc	0.22cd	10.48cbd	4.31c	5.87def	206.25cebd	0.88ced	47.61cb
H3 × D3	11.10d	0.24cbd	10.54cb	3.48h	6.7ba	207.5cbd	0.87ced	44.20ced
H4 × D1	10.43d	0.31a	10.12fed	4.00de	5.81def	218.5cb	0.71e	32.78f
H4 × D2	10.08c	0.22cd	10.15cfed	3.95fe	5.89de	204.25cebd	0.76ced	46.35cbd
H4 × D3	11.23c	0.23cbd	9.35g	3.28i	5.77def	188.75ed	0.81ced	41.75ed
LSD≤0.05	0.45	0.03	0.40	0.19		19.36	0.20	5.32

Mean values in each column and for each canopy height, density or canopy height × density combination followed by different lower-case letters were significantly different at $P \leq 0.05$ by Turkey's HSD test.

density 5000 plants ha^{-1} for ascorbic acid and 4444 plants ha^{-1} for TSS and reducing sugars. Increase in qualitative parameters is due to abundant availability of photosynthates among fruits as observed in the present study is in agreement with Jayswal *et al*. (7) and Dubey *et al.* (6). In this context, Lal *et al.* (10) reported that prevalence of low temperature in winter season at the time of fruit ripening was the cause of high ascorbic acid content in guava which contributed to retardation of excessive loss of respiratory substances but also increased the translocation of phtosynthates from leaves to the fruits.

The study of interaction between canopy height and planting density (H × D) revealed that the best quality fruits of guava in respect of TSS (12.98°B), total sugars (11.36%), non-reducing sugar (6.93%), ascorbic acid (247.5 mg 100g^{-1}) and sugar: acid ratio (59.28) were produced under 1.25 m canopy height with planting density of 3333 plants ha^{-1}, while highest content of acid (0.31%) were noticed in the fruits from unpruned plant with 5000 plantsha^{-1} planting density. The canopy height of 1.5 m with planting density of 4444 plants ha^{-1} and 3333 plants ha^{-1} registered greater content of reducing sugars (4.76%) and pectin (1.31%), respectively. TSS content increased significantly with increase in pruning severity and spacing among plants. The finding presented were in line with those of Adhikari *et al.* (2), who summoned in a sentence that might be attributed by faster starch degradation in pruned fruits compared with control trees.

The results about pectin content of fruits observed in this study are in confirmation with Joshi *et al*. (9) who concluded that plants with wider spacing produced fruits with more pectin content that other treatments. Similar findings in regards to sugar: acid ratio was also reported by Lal *et al*. (10) and Pratibha *et al*. (12).

From the above experiment, it can be concluded that firstly, plants maintained at a height of 1.25 m from the ground level, proved effective to produce superior quality fruits in terms of different physical and chemical characteristics with highest fruit set and yield. Secondly, plants having lower density per hectare or with wider spacing proved best by virtue of producing highest number of quality fruits. So far achieving the high yield of quality fruits of Pant Prabhat during winter season, the guava trees should be planted at a density of 3333 ha^{-1} with maintaining the tree height of 1.25 m from the ground level.

ACKNOWLEDGEMENT

The present investigation was conducted under the financial assistance of JRF (Junior Research Fellowship), ICAR, Government of India.

REFERENCES

1. AOAC. 2000. Official Methods of Analysis. Association of Official Agricultural Chemists. (*15st ed*.), Washington, D.C., U.S.A.
2. Adhikari, S. and Kandel, T.P. 2015. Effect of time and level of pruning on vegetative growth, flowering, yield, and quality of guava. *International J. Fruit Sci.* **15**: 1-12.
3. Bhagawati, R., Bhagawati, K., Choudhary, V.K. 2015. Effect of Pruning Intensities on the Performance of Fruit Plants under Mid-Hill Condition of Eastern Himalayas: Case Study on Guava. *International Letters of Natural Sci.* **46**: 46-55.
4. Bhat, S.A. and Singh, R. 2014. Extraction and characterization of pectin from guava fruit peel. *International J. Res. Engg. Adv. Technol*. **2**: 1-7.
5. Dhaliwal, G.S. and Singh, G. 2004. Effect of different pruning levels on vegetative growth, flowering and fruiting in Sardar guava. *Haryana J. Hort. Sci.* **33**: 175-77.
6. Dubey, A.K., Singh, D.B. and Dubey, N. 2001. Deblossoming of summer season flowering of guava (*Psidium guajava* L.) by shoot pruning. *Prog. Hort.* **33**: 165-68.
7. Jayswal, D.K., Sharma, D.P., Sharma, T.R., Dwivedi, A.K., Gonita, A.S. and Lal, N. 2017. Effect of pruning intensity and nutrition on quality of guava fruit cv. Allahabad Safeda. *International J. Chemical Studies*, **5**: 483-86.
8. Joseph, B and Priya, M. 2011. Phytochemical and biopharmaceutical aspects of *Psidium guajava* L. Essential oil: A review. *Research J. Medicinal Plant,* **5**: 1-11.
9. Joshi, P., Lal, S., Nautiyal, P. and Pal, M. 2016. Effect of plant spacing and pruning intensity on flowering, fruiting and yield of guava (*Psidium guajava* L.) cv. Pant Prabhat. *International J. Agric. Sci.* **8**: 1064-68.
10. Lal, S., Tiwari, J.P. and Misra K.K. 2000. Effect of plant spacing and pruning intensity on fruit yield and quality of guava. *Prog. Horti.* **32**: 20-25.

11. Pratibha and Lal, S. 2012. Effect of shoot pruning and different planting systems on vegetative growth, yield and quality of guava cv. Sardar. *The Asian J. Hort.* **7**: 65-71.

12. Pratibha, Lal, S. and Goswami, A.K. 2013. Effect of pruning and planting systems on growth, flowering, fruiting and yield of guava cv. Sardar. *Indian J. Hort.* **70**: 496-500.

13. Ranganna, S. 1986. *Handbook of Analysis Quality Control for Fruit and Vegetable Products*. Tata Mc. Graw Hill Publishing Company Ltd, New Delhi.

14. Shukla, A.K., Singh, V.K., Mishra, K.K., and Sharma, N. 2018. Response of pruning techniques on yield in high density planting of guava (*Psidium guajava* L.) cv. Allahabad safeda. *J. Pharma Phytochem.* **7**: 3781-82.

15. Westwood, M.N., Degman, E.S. and Grim, J.H. 1983. Effects of long term fertilizer management practices in growth and yield of pears grown in clay adobe soil. *Oregon Agric. Exp. Station, Tech. Bullet.* **82**: 35.

Received : April, 2019; Revised : December, 2019; Accepted : February, 2020