Int.J.Curr.Microbiol.App.Sci (2019) *8*(2): 98-106

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 8 Number 02 (2019)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2019.802.012

Effect of Spacing and Pruning on Flowering Characters of Guava (*Psidium guajava* L.) cv. Hisar Safeda

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Keywords

Spacing, Pruning, Flowering, Guava, Bud density

Article Info

Accepted:
04 January 2018
Available Online:
10 February 2019

A B S T R A C T

Effect of spacing and pruning on flowering behavior of guava was studied at Horticulture research block, CCS Haryana Agricultural University Hisar in both rainy and winter season during the year 2016-17. Experiment was laid out with nine different spacings *i.e.* 6×2 m, 6×3 m, 6× 4 m, 6×5 m, 5×2 m, 5× 3 m, 5× 4 m, 5× 5 m and 6×6 m and two pruning levels viz. no pruning and 50% shoot pruning of last season growth. Shortest duration of flowering was found with pruned and widest (6×6 m) spacings. Date of full bloom varied from 21st May 2016 to 28th May 2016 for rainy season crop and 14th Aug 2016 to 19th Aug 2016 for winter crop. Flower bud density found more in widest (6×6 m) spacing of upper canopy part of unpruned tree during rainy season, whereas maximum flower bud density was recorded in widest spacing of upper canopy part of pruned trees.

Introduction

Guava (*Psidium guajava* L.) is undoubtedly the most important tropical and subtropical fruit crop of the world. It belongs to the family Myrtaceae which comprises 150 species of trees and shrubs many of which have edible fruits. Guava is believed to be originated in tropical America. In India it has been cultivated since early in 17th century. It can be considered as the 'Apple of Tropics' for its high vitamin C and mineral content and also known as 'Poor Man's Fruit'. Guava fruits are used both for fresh consumption and processing. High density planting (HDP) has been attempted in various tropical, sub-tropical and temperate fruit crops. As tree density increases, inter- plant competition is quite obvious which is likely to be reflected in the pattern of plant growth, yield potential of the tree and fruit quality. Dense orchards frequently become uneconomical comparatively earlier than the standard orchards because the tree size although reduced by competition, cannot be controlled sufficiently to prevent light competition, internal shading and barrenness to overcome this problem. Pruning is done in guava to manage the tree canopy under high density planting.

Guava bears on current season's growth and flowers appear in the axils of new leaves, therefore, it responds well to pruning. Pruning of guava is one of the most important practices that influence the vigour, productivity and quality of the fruits under high density planting. Pruning is usually practiced in the summer (April–May) before flower initiation. Studies have reported that the time and level of pruning influence growth, flowering, quality and yield of guava (Chandra and Govind, 1995). The rainy season crop gives maximum production of guava, however the fruits are of poor quality and severely infected by fruit fly. On the other hand winter season fruits are more nutritious and superior in quality but the yield is low. Summer pruning plays an important role in crop regulation of guava, it reduces the rainy season yield and increases the winter season yield. Jadhav *et al.,* (2002) recommended a light annual pruning after fruit harvest to encourage growth of new shoots in which flowers and fruits are borne. Similarly, Lal *et al.,* (2000) reported significant reduction of flowering and fruiting in the rainy season with pruning of shoots in summer. Although available studies have reported on enhanced yield by pruning, there is still a lack of knowledge on optimum timing and level of guava pruning. To fill this gap of knowledge, we designed a field experiment to understand the effect of time and level of pruning on growth, flowering, yield, and quality of guava. The aim of this study is to develop a standard pruning level and timing management for higher yield and quality in the winter season.

Materials and Methods

The investigation was carried out during the year 2016-2017 at experimental orchard of Department of Horticulture, CCS Haryana Agricultural University, Hisar. Hisar has a typical semi-arid climate with hot and dry summer and extremely cold winter. The mean monthly maximum and minimum temperature show a wide range of fluctuations both during summer and winter months. The experiment was laid out in randomized block design (RBD) allocating two levels of pruning *viz* 50% shoot pruning of last season growth and no pruning and nine different spacing with three replications, comprising 18 treatment combinations. Trees for the study were uniformly grown seven year old, spaced at a distance of 6×2 m, 6×3 m, 6× 4 m, 6×5 m, 5×2 m, 5× 3 m, 5× 4 m, 5× 5 m and 6×6 m. They were kept under uniform condition of orchard management during the study period with all agronomic practices carried out as per package and practices.

Duration of flowering

The period between emergence of first and last flower was considered as duration of flowering.

Date of full bloom

The opening of 70 % to 80 % of flowering was an indicative of tree in full bloom stage.

Flower bud density

Two tertiary shoots (one meter) of medium vigour each in the upper, middle and lower part of the canopy for each plant were randomly selected and tagged. Numbers of flowers on each shoot were counted and average was worked out.

The statistical method described by Panse and Sukatme (1967) was followed for the analysis and interpretation of the experimental results. In order to evaluate comparative performance of the various treatments, the data were analyzed by the technique of analysis of variance described by Fisher (1958).

Results and Discussion

Duration of flowering

Data recorded and presented in table 1 on duration of flowering of guava was not significantly affected by spacing treatments during the rainy season. However, it was significantly affected by the pruning treatments. Duration of flowering recorded in un-pruned and pruned trees were 32.8 days and 31.8 days, respectively. The interaction between different spacing and pruning treatments was statistically found non significant.

Duration of flowering was significantly different among the spacing and pruning treatments during the winter season. Duration of flowering significantly decreased with increasing the spacing. Among the treatments duration of flowering was recorded significantly maximum (44.2 days) in trees spaced at 5×2 m than all other trees spaced at 5×3 m, 5×5 m, 6×2 m, 6×3 m, 5×4 m, 6×4 m and 6×5 m and minimum (40.3 days) was recorded in trees spaced at 6×6 m. Duration of flowering was also significantly affected by the pruning treatments. Longest duration of flowering (43.1 days) was recorded in un-pruned trees and minimum (41.1 days) in pruned trees.

The interaction between spacing and pruning treatments showed statistically non-significant effect for duration of flowering. Longest duration of flowering was recorded in un-pruned trees as compared to pruned trees. Shortest duration of flowering was observed in widest spacing and pruned trees which might be due to more exposure of sun light, more availability of nutrients and aeration that promotes early initiation of flowering and end of flowering. Similar result has been observed by Singh *et al.,* (2010) in mango that pruning intensity at moderate level in high density planting took lowest number of days to 50 per cent of flowering, highest number of panicles per branch and longest blooming period. This result is conformity with earlier reported by Adhikari and Kandel (2015).

Date of full bloom

Date of full bloom was recorded different for all the spacing and pruning treatments during both the seasons (Table 2). Date of full bloom varied from 21st May 2016 to 28th May 2016 for rainy season crop. Full bloom was shortly earlier in un-pruned trees as compared to pruned trees. However during winter season the full bloom occurred between 14th Aug 2016 and 19th Aug 2016.

End of flowering

The data indicated in table 3 showed that the date of end of flowering varied from 21st May 2016 to 7th June 2016 during rainy season. End of flowering occurred early (21th May 2016) in 6×6 m spacing of un-pruned trees as compared to all other spacing and pruned trees and late end of flowering (7th June 2016) was recorded in 5×2 m spacing of pruned trees. However, during winter season the end of flowering occurred between 4th Oct 2016 and 13th Oct 2016. Early end of flowering (4th Oct 2016) was noticed in pruned trees spaced at 6×6 m and late end of flowering (13th Oct 2016) was recorded in un-pruned trees spaced at 5×2 m.

Flower bud density

The data pertaining to flower bud density presented in table 4 revealed that the flower bud density significantly affected by the plant spacing. Flower bud density was recorded significantly higher (22.5 flowers/m) in wider spacing (6×6 m) as compared to all other spacing. Whereas minimum (12.9 flowers/m) flower bud density was recorded in closer

spacing (5×2 m). Flower bud density was also significantly affected by pruning treatments. Flower bud density 20.1 flowers/m was recorded in pruned trees whereas, 15.7 flowers/m flower bud density was observed in un-pruned trees. Flower bud density significantly affected by the different parts of tree canopy. The upper part of the tree canopy exhibited significantly higher flower bud density (21.2 flowers/m) than the middle and lower canopy part. The interaction between spacing and pruning was also found significant. Maximum (25.5 flowers/m) flower bud density was recorded in wider spacing (6×6 m) of un-pruned trees as compared to all other spacing of pruned and un-pruned trees and minimum (10.9 flowers/m) flower bud density was observed in closer spacing (5×2 m) of pruned trees. Interaction effect between spacing and canopy for flower bud density was found significant. Maximum flower bud density (25.5 flowers/m) was noticed in upper canopy part of wider spacing (6×6 m) trees as compared to other spacing of different canopy part. While minimum flower bud density (10.4 flowers/m) was recorded in closer spacing (5×2 m) of lower canopy part. Interaction effect between pruning and canopy for flower bud density was also found significant. Flower bud density was found significantly higher (23.5 flowers/m) in upper canopy part of un-pruned trees as compared to middle and lower canopy part of non pruned and pruned trees. Whereas minimum flower bud density (12.8 flowers/m) was recorded in lower canopy part of pruned trees. The interaction among the spacing, pruning and canopy was also statistically found significant. Highest flower bud density (28.5 flowers/m) was recorded in upper canopy part of wider spacing (6×6 m) of un-pruned trees as compared other spacing of pruned and un-pruned different parts of tree canopy whereas it was minimum (8.9 flowers/m) in lower canopy part of closer spacing (5×2 m) trees.

The data in table 5 shows that the flower bud density was significantly affected by the plant spacing and pruning treatments during the winter season. Tree spaced at 6×6 m recorded significantly higher (14.6 flowers/m) flower bud density than tree spaced at 6×5 m, 6×4 m, 5×5 m,5×4 m, 6×3 m, 5×3 m, 6×2 m spacing and minimum (7.5 flowers/m) at 5×2 m. The effect of pruning was also found significant. Flower bud density 12.9 flowers/m recorded from pruned trees, whereas 9.6 flowers/m flower bud density observed in un-pruned trees. Flower bud density also significantly affected by the different parts of tree canopy. The flower bud density was recorded significantly higher (14.0 flowers/m) in upper parts of the tree canopy as compared to all other middle and lower canopy parts. Similarly, flower bud density was observed significantly higher (11.0 flowers/m) in middle part of canopy as compared (8.8 flowers/m) to lower canopy part. The interaction between spacing and pruning was also found significant. Highest (16.6 flowers/m) flower bud density was recorded in wider spacing (6×6 m) of pruned trees as compared to all other spacing of pruned and un-pruned trees and lowest (6.6 flowers/m) flower bud density was observed in closer spacing (5×2 m) of un-pruned trees. The interaction between spacing and canopy was statistically found significant. Maximum flower bud density (17.6 flowers/m) was observed in upper canopy part of wider spacing (6×6 m) trees as compared to all other spacing of different canopy part. Whereas, minimum flower bud density (5.6 flowers/m) was recorded in closer spacing (5×2 m) of lower canopy part. Interaction effect between pruning and canopy for flower bud density was also found significant. Flower bud density was noticed significantly higher (15.8 flowers/m) in upper canopy part of pruned trees as compared to all other canopy part of non pruned and pruned trees. Whereas, lowest flower bud density (7.5 flowers/m) was

recorded in lower canopy part of un-pruned trees. The interaction among the spacing, pruning and canopy was also statistically found significant. Highest flower bud density (28.5 flowers/m) was recorded in upper canopy part of wider spacing of un-pruned trees as compared other spacing of pruned and un-pruned different parts of tree canopy. The interaction among the spacing, pruning and canopy was showed non-significant effect for flower bud density. Flower bud density was significantly increased with increasing spacing during both rainy and winter seasons.

Table.1 Effect of spacing and pruning on the duration of flowering (days) in guava cv. Hisar Safeda

Spacing (m)	Rainy season			Winter season		
	Pruning			Pruning		
	Non pruned	Pruned	Mean	Non pruned	Pruned	Mean
6 x 2	33.0	31.3	32.2	43.7	41.5	42.6
6 x 3	32.0	31.7	31.8	42.7	41.0	41.8
6 x 4	32.3	32.7	32.5	42.0	41.3	41.7
6 x 5	32.7	31.0	31.8	42.0	40.0	41.1
5 x 2	34.0	32.0	33.0	45.7	42.7	44.2
5 x 3	33.7	31.7	32.7	44.0	41.3	42.7
5 x 4	32.0	32.0	31.8	42.7	41.7	41.7
5 x 5	32.7	31.8	32.0	43.3	42.0	42.7
6 x 6	32.7	32.0	31.8	41.7	39.0	40.3
Mean	32.8	31.8		43.1	41.1	
	CD (0.05)			**CD (0.05)**		
	Spacing	NS		**Spacing**	1.1	
	Pruning	0.06		**Pruning**	0.05	
	Spacing x Pruning	NS		**Spacing x Pruning**	NS	

Table.2 Effect of spacing and pruning on the full bloom of guava cv. Hisar Safeda

Spacing (m)	Date of full bloom			
	Rainy season		Winter season	
	Pruning		Pruning	
	Non pruned	Pruned	Non pruned	Pruned
6 x 2	24-5-2016	28-5-2016	19-8-2016	17-8-2016
6 x 3	23-5-2016	27-5-2016	17-8-2016	16-8-2016
6 x 4	22-5-2016	27-5-2016	17-8-2016	15-8-2016
6 x 5	22-5-2016	25-5-2016	16-8-2016	14-8-2016
5 x 2	26-5-2016	28-5-2016	19-8-2016	17-8-2016
5 x 3	24-5-2016	28-5-2016	18-8-2016	16-82016
5 x 4	24-5-2016	27-5-2017	17-8-2016	15-8-2016
5 x 5	23-5-2016	27-5-2017	16-8-2016	15-8-2016
6 x 6	21-5-2016	25-5-2017	15-8-2016	14-8-2016

Table.3 Effect of spacing and pruning on end of flowering in guava cv. Hisar safeda

Spacing (m)	Rainy season		Winter season	
	Pruning		Pruning	
	Non pruned	Pruned	Non pruned	Pruned
6 x 2	30-5-2016	6-6-2016	12-10-2016	8-10-2016
6 x 3	29-5-2016	5-6-2016	11-10-2016	7-10-2016
6 x 4	22-5-2016	4-6-2016	10-10-2016	6-10-2016
6 x 5	22-5-2016	3-6-2016	9-10-2016	5-10-2016
5 x 2	1-6-2016	7-6-2016	13-10-2016	9-10-2016
5 x 3	30-5-2016	6-6-2016	12-10-2016	7-10- 2016
5 x 4	24-5-2016	4-6-2016	10-10-2016	7-10-2016
5 x 5	23-5-2016	3-6-2016	10-10-2016	5-10-2016
6 x 6	21-5-2016	2-6-2016	9-10-2016	4-10-2016

Table.4 Effect of spacing, pruning and the part of tree canopy on the flower bud density (Number of flower bud/meter shoot length) during the rainy season in guava cv. Hisar Safeda

Spacing x Pruning x Canopy (S x P x C)						
Pruning →	Non pruned (Np)			Pruned (P)		
Canopy → / Spacing(m) ↓	Upper	Middle	Lower	Upper	Middle	Lower
6 x 2	20.6	17.1	13.9	15.9	13.0	10.7
6 x 3	22.9	19.4	16.0	18.9	14.7	12.6
6 x 4	23.9	20.4	17.5	20.3	15.7	13.3
6 x 5	25.6	22.2	19.4	22.2	17.1	14.6
5 x 2	18.3	14.3	12.0	13.6	10.2	8.9
5 x 3	22.2	18.5	14.9	17.1	13.9	11.0
5 x 4	24.2	20.2	16.1	19.7	15.6	12.8
5 x 5	25.0	21.9	18.8	20.6	17.8	14.2
6 x 6	28.5	25.4	22.6	22.5	19.1	16.9

Spacing x Pruning (S x P)			
Pruning → / Spacing(m) ↓	Non Pruned	Pruned	Mean (S)
6 x 2	17.2	13.2	15.2
6 x 3	19.4	15.4	17.4
6 x 4	20.6	16.4	18.5
6 x 5	22.4	17.9	20.2
5 x 2	14.9	10.9	12.9
5 x 3	18.5	14.0	16.3
5 x 4	20.1	16.0	18.1
5 x 5	21.9	17.5	19.7
6 x 6	25.5	19.5	22.5
Mean	20.1	15.7	

Spacing x Canopy (S x C)				
Canopy → / Spacing(m) ↓	Upper	Middle	Lower	Mean (S)
6 x 2	18.3	15.1	12.3	15.2
6 x 3	20.9	17.0	14.3	17.4
6 x 4	22.1	18.0	15.4	18.5
6 x 5	23.9	19.6	17.0	20.2
5 x 2	16.0	12.2	10.4	12.9
5 x 3	19.7	16.2	12.9	16.3
5 x 4	21.9	17.9	14.5	18.1
5 x 5	22.8	19.8	16.5	19.7
6 x 6	25.5	22.3	19.7	22.5
Mean	21.2	17.6	14.8	

Pruning x Canopy (P x C)				
Canopy → / Pruning ↓	Upper	Middle	Lower	Mean
Non pruned	23.5	19.9	16.9	20.1
Pruned	19.0	15.3	12.8	15.7
Mean	21.2	17.6	14.8	

CD (0.05)		
Spacing		0.3
Pruning		0.2
Canopy		0.2
Spacing x Pruning		0.5
Spacing x Canopy		0.6
Pruning x Canopy	Spacing	0.3
x Pruning x Canopy		0.8

Table.5 Effect of spacing, pruning and the part of tree canopy on the flower bud density (Number of flower bud/meter shoot length) during the winter season in guava cv. Hisar Safeda

Spacing x Pruning x Canopy (S x P x C)						
Pruning →	**Non pruned (Np)**			**Pruned (P)**		
Canopy → Spacing(m)↓	**Upper**	**Middle**	**Lower**	**Upper**	**Middle**	**Lower**
6 x 2	9.7	6.1	5.2	13.3	10.3	7.9
6 x 3	11.0	8.5	6.6	15.2	12.5	9.3
6 x 4	12.7	9.5	7.8	17.1	13.9	11.8
6 x 5	15.2	11.8	9.9	18.8	15.4	11.9
5 x 2	8.8	6.2	4.9	10.4	8.5	6.4
5 x 3	10.9	8.7	6.9	14.6	11.2	8.1
5 x 4	12.5	8.9	7.2	16.1	12.4	10.7
5 x 5	13.6	10.9	8.9	16.9	13.6	10.8
6 x 6	15.4	12.6	10.2	19.8	16.9	13.2

Spacing x Pruning (S x P)			
Pruning → Spacing(m)↓	**Non Pruned**	**Pruned**	**Mean (S)**
6 x 2	7.0	10.5	8.8
6 x 3	8.7	12.3	10.5
6 x 4	10.0	14.2	12.2
6 x 5	12.3	15.3	13.8
5 x 2	6.6	8.4	7.5
5 x 3	8.8	11.3	10.1
5 x 4	9.5	13.0	11.3
5 x 5	11.1	13.8	12.4
6 x 6	12.7	16.6	14.7
Mean	9.6	12.9	

Spacing x Canopy (S x C)				
Canopy → Spacing(m)↓	**Upper**	**Middle**	**Lower**	**Mean (S)**
6 x 2	11.5	8.2	6.6	8.8
6 x 3	13.1	10.5	7.9	10.5
6 x 4	14.9	11.7	9.8	12.1
6 x 5	17.0	13.6	10.9	13.8
5 x 2	9.6	7.4	5.6	7.5
5 x 3	12.7	10.0	7.5	10.1
5 x 4	14.3	10.6	8.9	11.3
5 x 5	15.2	12.3	9.8	12.4
6 x 6	17.6	14.7	11.7	14.7
Mean	14.0	11.0	8.8	

Pruning x Canopy (P x C)				
Canopy → Pruning↓	**Upper**	**Middle**	**Lower**	**Mean**
Non pruned	12.2	9.3	7.5	9.6
Pruned	15.8	12.7	10.0	12.9
Mean	14.0	11.0	8.8	

CD (0.05)	
Spacing	0.4
Pruning	0.2
Canopy	0.2
Spacing x Pruning	0.5
Spacing x Canopy	0.7
Pruning x Canopy	0.3
Spacing x Pruning x Canopy	NS

Maximum flower bud density was recorded in widest spacing (6×6 m) trees as than closest (5×2 m) spacing. This might be due to more canopy volume, light penetration and aeration that promote more number of flowering in plants. The results corroborate the findings of Mika *et al.*, (1981) in apple and Ristevski (1982) in pear.

Maximum flower bud density was recorded in un-pruned trees during rainy season, while higher flower bud density was noticed in

pruned trees during winter season. This might be due to that April pruning reduced flower bearing shoots in rainy season and promote new shoot growth, which increases the flowering percentage in winter season. Similar results have been observed by pruning from April to June increased the flowering percentage of guava trees as compared to February and March pruning (Singh *et al*., 2001). Jadhav *et al*., (2002) observed in guava and that maximum flower per shoot was found during winter season with 60 cm pruning treatment. Mohammed *et al.*, (2006) revealed in guava that the 60 cm pruning gave maximum number of flowers and fruits per shoot during winter season. The results are in concord with that of Pilania *et al.*, (2010), Mehta *et al.*, (2012) and Prabhakar *et al.*, (2016) in guava.

Part of canopy also significantly affected the flower bud density in plant during rainy and winter season. Flower bud density was found significantly higher in upper part of canopy in comparison to middle and lower part of canopy. This might be due to more solar radiation intercepted by the upper part of tree canopy. Whereas, minimum flower bud density found in lower part of canopy might be due to reduced radiation penetration in lower part of tree.

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How to cite this article:

Anjali Tripathi, S.K. Sehrawat and Jeet Ram Sharma. 2019. Effect of Spacing and Pruning on Flowering Characters of Guava (*Psidium guajava* L.) cv. Hisar Safeda. *Int.J.Curr.Microbiol.App.Sci.* 8(02): 98-106. doi: https://doi.org/10.20546/ijcmas.2019.802.012