The Bioscan 12(1): 395-398, 2017 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

EFFECT OF PRUNING HEIGHT AND PLANTING DISTANCE ON GROWTH AND YIELD OF GUAVA (*PSIDIUM GUAJAVA* L.) CV. PANT PRABHAT

KARISHMA KOHLI*, RAJESH KUMAR, ANKIT KUMAR AND MUKESH CHANDRA DUBEY
Department of Horticulture, College of Agriculture,
Govind Ballabh Pant University of Agriculture and Technology, Pantnagar - 263145, INDIA
e-mail: karishmakohli1991@gmail.com

KEYWORDS
Guava
Growth
Planting distance
Pruning height.

Received on :
26.10.2016

Accepted on :
23.02.2017

***Corresponding author**

ABSTRACT
Present investigation was carried out to study the effect of different pruning height 1.0m (P_1), 1.25m (P_2), 1.5m (P_3) from the ground level with control 2.0m (P_0) standard height unpruned trees and planting distance *viz*. 1.0m × 1.0m (D_1), 2.0m ×1.0m (D_2), 2.0m ×1.5m (D_3) and 1.5m ×1.5m (D_4) on growth and yield of guava. The vegetative growth parameters in terms of tree spread (1.13m), canopy volume (1.16m^3), tree girth (22.68cm), cross sectional trunk area (40.53cm^2) and leaf area (90.30cm^2) were higher in the plants planted at 2.0m ×1.5m and pruned at a height of 1.5m (P_3D_3). Highest fruit set (74.82%) and the fruit yield (3.95kg) were also observed in P_3D_3. Closer spacing (1.0m × 1.0m) and more pruning intensity (1.0m pruning height from the ground level) P_1D_1 reduced the fruit set (43.75%). Leaf area (90.30cm^2) and chlorophyll content (0.032mg/g) were found maximum in 1.5m pruning height from the ground level with wider 2.0m ×1.5m planting (P_3D_3). Overall, Pruning height 1.5m and wider spacing of 2.0m ×1.5m (P_3D_3) may be adopted by the guava growers for getting better growth and productivity.

INTRODUCTION

Guava valued for its highly nutritive index and rich in antioxidant properties. Guava is low in calories and fats but carry several vital vitamins, minerals, and antioxidant poly-phenolic and flavonoid compounds that play a pivotal role in the prevention of cancers, aging, infections, *etc*. Guava fruit is an excellent source of antioxidant vitamin-C. 100 g fresh fruit provides 228 mg of this vitamin, more than three times the required DRI (daily-recommended intake). The available land area for cultivation is shrinking due to rapid urbanization, fragmentation because of the land holdings and industrialization. Hence, there is need to improve the existing planting system and to manipulate tree growth by using canopy management, tree growth patterns, tree shape and maintaining high fruit production of desired size and quality (Singh, 2001). Under such circumstances the concept of high density planting has become significant to increase fruit yield and productivity (Goswami *et al.,* 2001). Guava crop is highly suitable for high density planting because pruning give positive response in guava as it bears on current season growth. The principle objective to underlying modern planting system is to promote the light distribution within tree canopy through optimized total light interception by reducing individual tree size and arrangement (Tustin *et al.,* 1998). Pruning is the practice which performed in an appropriate manner to provide the plant such a shape and size so as to yield the desired crops. So the pruning approach should be aimed to regulate the tree size without loss of fruit quality and yield per unit area. Earlier studies reported pruning severity and planting distance positively affect the plant growth and yield (Jadav *et al*., 2009 and Joshi *et al*., 2014). Different shoot pruning levels and planting systems improved the number of fruits per tree, fruit yield and fruit quality of guava (Pratibha *et al*., 2012). One of the ways used for efficient and profitable land use is to work on the tree height and planting distance. Its basic function is to maintain the exploitation zone of the plant with regard to light, water, and nutrients so that the highest total yield potential can be reach in smallest possible area. Therefore, the present study was undertaken to find out the suitable pruning height, planting distance and their interaction effect on growth and yield of guava.

MATERIALS AND METHODS

A field experiment was conducted during the year 2015 at Horticultural Research Centre, Patharchatta, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar (Uttarakhand). The climatic condition of experimental site was humid-subtropical. Soil is dark coloured, imperfectly drained with moderate organic matter content developed in loamy alluvial sediments averaging 0.6 to 1.0 m thick over loamy sand, sand or gravel. The plants of cv. Pant Prabhat spaced at four different planting distances and pruned at varying heights. The numbers of treatments were 16 and each replicated four times. The treatments consists of two factors *viz* three pruning heights, 1.0m (P_1), 1.25m (P_2) and 1.5m (P_3) from ground level and four different planting distance

1.0m × 1.0m (D_1), 2.0m × 1.0m (D_2), 2.0m × 1.5m (D_3) and 1.5m × 1.5m (D_4) including control 2m standard height (P_0) unproved trees. All the pruning heights were measured from the ground level. The data was analyzed statistically using two factorial randomized block design at 5% level of significance. Tree spread was calculated as per the following formula:

Tree spread = [tree spread (E + W) + (N + S)] /2

Canopy volume and tree girth was calculated as per Westwood *et al*. (1963). Cross sectional trunk area (cm^2) was calculated by the method given by Glenn and Rogers (1964) and expressed in cm^2. Leaf area was measured with the help of leaf area meter (LI- COR portable leaf area meter LI-3000A) and mean leaf area was presented in cm^2. Total chlorophyll on fresh weight basis was measured by the method as described by (Hiscox and Isrealstam, 1979) and recorded in mg/g. The fruit set was observed as number of fruits/branch and data was expressed as % of fruit. Total numbers of fruits on each tree were counted and multiplied by the mean fruit weight at the time of harvest and expressed as fruits yield per tree in Kg. Yield efficiency (kg/m^3) it was calculated by dividing the yield in kg per hectare by tree volume.

RESULTS AND DISCUSSION

Effect of planting distance

The data presented in Table 1 clearly show that different planting distances significantly affect the tree spread, canopy volume and tree girth. Maximum (1.05m, 0.93m^3 and 18.62cm) tree spread, canopy volume and tree girth were found in D_3 (2.0m × 1.5m) planting distance and minimum (0.73m, 0.49m^3 and 17.78cm) in planting distance D_1 (1.0m × 1.0m). Similar findings have also been reported by Kumar and Rattanpal (2010). These results are supported with the finding of Pandey *et al*. (2015), Ughade *et al*. (2015) growth characters were influence by the different planting density. Maximum cross sectional trunk area (26.66cm^2) was found in D_3 (2.0 m× 1.5m) planting distance and minimum cross sectional trunk area (20.49cm^2) was observed at planting distance D_1 (1.0m × 1.0m). Similar findings have also been reported by Meland (2005). Different planting distances had no significant effect on leaf area. Maximum leaf area (72.62cm^2) was found in planting distance D_3 (2.0m × 1.5m) and minimum (68.46cm^2) leaf area was observed at planting distance D_2 (2.0m × 1.0m). Similar findings have also reported by Kumawat *et al*. (2014) and Osman (2014). Maximum (0.026mg/g) chlorophyll content in leaves was observed in planting distance D_3 (2.0m × 1.5m) and minimum (0.023mg/g) chlorophyll content in leaves was observed in planting distance D_1 (1.0m× 1.0m^2). Similarly, Murthy *et al*. (2013) and Kumawat *et al*. (2014) reported that wider plant spacing has significant effect on chlorophyll content.

There was no significant effect of planting distance on fruit set. The maximum (66.35%) fruit set was found in planting distance D_3 (2.0m × 1.5m) and minimum (51.35%) fruit set was observed in planting distance D_2 (2.0m × 1.0m). The findings are in conformity with the results reported by Monga *et al*. (2011) who reported that the widely spaced trees produced significantly more fruits than the closely spaced trees. Maximum (2.49kg) fruit yield per tree was reported in planting distance D_3 (2.0m × 1.5m) and minimum (1.02kg) fruit yield per tree was observed in planting distance D_1 (1.0m × 1.0m). Similar results have also been made by Lal *et al*. (2000), Jadav *et al*. (2009) and Praitbha *et al*. (2013). Maximum (3.62 kg/m^3) yield efficiency was found in planting distance D_4 (1.5 × 1.5m) and minimum (2.43kg/m^3) yield efficiency was observed in planting distance D_2 (2.0m × 1.0m). Dalal *et al*. (2013) and Kumar and Rattanpal (2010) also reported that the maximum productive efficiency was found with low density and minimum with high density.

Effect of prunng height

The data presented in Table 1 clearly show that different pruning heights significantly affect the tree spread and canopy volume. The maximum (1.07m and 0.95m^3) tree spread and canopy volume were observed at pruning height P_3 (1.5m) while the minimum (0.71m and 0.36m^3) were observed at pruning height P_1 (1.0m). The maximum tree girth (20.04cm) was observed at pruning height P_3 (1.5m) while the minimum tree girth (15.75cm) was found at pruning height P_1 (1.0m). The maximum cross sectional trunk area (27.93cm^2) was observed at pruning height P_3 (1.5m) while the minimum cross sectional trunk area (22.11cm^2) was observed at pruning height P_1 (1.0m). Similar findings have also been reported by Meland (2005) and Pratibha *et al*. (2013) they reported that growth characters significantly influenced by the shoot pruning. The maximum leaf area (78.17m^2) was observed at pruning height P_3 (1.5m) while the minimum leaf area (65.94cm^2) was observed

Table 1: Effect of Pruning height and planting distance on growth and yield parameters

Treatments	Tree spread (m)	Canopy volume (m^3)	Tree girth (cm)	CSTA (cm^2)	Leaf area (cm^2)	Chlorophyll content (mg/g)	Fruit set (%)	Yield /tree (kg)	Yield efficiency (kg/m^3)
Pruning heights of the three									
P_0 (control-2.0m)	0.94	0.94	17.76	24.04	72.86	0.025	54.50	2.31	3.55
P_1 (1.0m)	0.71	0.36	15.75	22.11	65.94	0.023	60.78	0.58	3.36
P_2 (1.25m)	0.99	0.73	19.64	23.13	69.02	0.025	58.43	1.54	2.28
P_3 (1.5m)	1.07	0.95	20.04	27.93	78.17	0.027	62.82	2.42	2.24
Planting distance									
D_1(1.0m×1.0m)	0.73	0.49	17.78	20.49	72.54	0.023	53.86	1.02	2.75
D_2(2.0m ×1.0m)	0.96	0.76	18.43	24.56	68.46	0.025	51.34	1.49	2.43
D_3(2.0m ×1.5m)	1.05	0.93	18.62	26.66	72.62	0.026	66.35	2.49	2.64
D_4(1.5m ×1.5m)	0.97	0.78	18.56	25.50	72.37	0.025	62.98	1.19	3.62
SE (m)	0.03	0.068	0.547	1.210	4.291	0.001	3.278	0.840	0.406
CD at 5%	0.096	0.195	1.562	3.459	NS	0.002	9.369	2.400	1.160

Table 2: Interaction effect of pruning height and planting distance on growth and yield parameters

Treatments	Tree spread (m)	Canopy volume (m^3)	Tree girth (cm)	CSTA (cm^2)	Leaf area (cm^2)	Chlorophyll content (mg/g)	Fruit set (%)	Yield per tree (kg)	Yield efficiency (kg/m^3)
P_0D_1	0.87	0.81	16.64	22.07	76.72	0.024	54.50	1.12	1.48
P_0D_2	0.96	0.99	18.21	24.55	74.17	0.024	53.82	2.32	2.51
P_0D_3	0.98	0.95	16.32	21.05	60.53	0.026	51.40	3.17	3.43
P_0D_4	0.94	0.99	19.86	28.48	80.03	0.025	60.17	2.85	6.80
P_1D_1	0.43	0.12	14.13	16.60	72.63	0.016	43.75	0.54	5.11
P_1D_2	0.88	0.50	14.99	26.10	66.53	0.027	55.62	0.55	2.91
P_1D_3	0.84	0.53	17.19	20.02	65.49	0.023	70.32	0.60	1.77
P_1D_4	0.69	0.28	16.72	22.75	59.12	0.026	73.45	0.64	3.64
P_2D_1	0.67	0.41	18.60	19.55	70.79	0.026	63.65	0.79	2.13
P_2D_2	0.89	0.60	22.53	23.83	58.97	0.026	47.32	1.44	2.57
P_2D_3	1.27	1.08	18.44	25.03	74.17	0.022	68.87	2.22	2.91
P_2D_4	1.13	0.84	19.62	27.07	72.14	0.026	53.87	1.72	1.53
P_3D_1	0.97	0.63	20.88	23.73	70.13	0.027	63.45	1.63	2.29
P_3D_2	1.09	0.95	18.72	23.77	74.16	0.024	48.61	1.67	1.75
P_3D_3	1.13	1.16	22.68	40.53	90.30	0.032	74.82	3.95	2.44
P_3D_4	1.10	1.01	18.05	23.68	78.20	0.024	64.42	2.43	2.50
SE (m)	0.067	0.136	1.093	2.421	8.582	0.002	6.557	0.267	0.812
CD at %	0.191	NS	3.124	6.918	NS	0.004	NS	0.764	2.320

at pruning height P_1 (1.0m). Similar, results have been reported by Goda *et al*. (2014) who reported that pruning treatments significant encouraged leaf area as compare to those plants trained without pruning. The maximum (0.027mg/g) chlorophyll content in leaves was found at pruning height P_3 (1.5m) while the minimum (0.023mg/g) chlorophyll content in leaves was observed at P_1 (pruning height 1.0m). These results are not accordance with the finding of Goda *et al*. (2014) who found that shoot pruning had no effect on chlorophyll content of tomato leaves. The maximum fruit set (62.82%) was observed at pruning height P_3 (1.5m) and the minimum (54.50%) fruit set was observed at pruning height P_0 (2.0m). Similar findings reported by Joshi *et al*. (2014) and Pratibha *et al*. (2013). The maximum (2.42kg) fruit yield per tree was reported at pruning height P_3 (1.5m) while the minimum (0.58kg) fruit yield per tree was observed at pruning height P_1 (1.0m). These results are supported with the finding of Murali *et al*. (2015) fruit yield influenced by the pruning. The maximum (3.55 kg/m^3) yield efficiency was observed at pruning height P_0 (2.0m) while the minimum (2.24 kg/m^3) yield efficiency was observed at pruning height P_3 (1.5m).

Interaction effect of planting distance and pruning height

The interaction between pruning height and planting distance (Table 2) also had significant effect on tree spread. The maximum (1.27m) tree spread was observed in the treatment combination P_2D_3 (Pruning height 1.25m and planting distance 2.0m × 1.5m) while it was minimum (0.43m) in the treatment combination P_1D_1 (Pruning height 1.0m and planting distance 1.0m × 1.0m). The maximum canopy volume ($1.16m^3$) was recorded in the treatment combination P_3D_3 (pruning height 1.5m and planting distance 2.0m × 1.5m) while it was minimum ($0.12m^3$) in the treatment combination P_1D_1 (pruning height 1.0m and planting distance 1.0m × $1.0m^2$). The maximum tree girth (22.68cm) was recorded in the treatment combination P_3D_3 (pruning height 1.5m and planting distance 2.0m × 1.5m) while it was minimum (14.13cm) in the treatment combination P_1D_1 (pruning height 1.0m and planting distance 1.0m × 1.0m). The maximum cross sectional trunk area ($40.53cm^2$) was recorded in the treatment combination P_3D_3 (pruning height 1.5m and planting distance 2.0m × 1.5m) while it was minimum (16.60) in the treatment combination P_1D_1 (pruning height 1.0m and planting distance 1.0m × 1.0m). The maximum leaf area ($90.30cm^2$) was recorded in the treatment combination P_3D_3 (pruning height 1.5m and planting distance 2.0m × 1.5m) while it was minimum (58.97 cm^2) in the treatment combination P_2D_2 (pruning height 1.25m and planting distance 2.0m × 1.0m). The interaction between pruning height and planting distance (Table 2) also had significant effect on chlorophyll content in leaves. The maximum (0.032mg/g) chlorophyll content in leaves was recorded in the treatment combination P_3D_3 ((pruning height 1.5m and planting distance 2.0m × 1.5m) while it was minimum (0.016mg/g) in the treatment combination P_1D_1 (pruning height 1.0m and planting distance 1.0m × 1.0m). The maximum (74.82%) fruit set was recorded in the treatment combination P_3D_3 (pruning height 1.5m and planting distance 2.0m × 1.5m) while it was minimum (43.75%) in the treatment combination P_3D_3 (pruning height 1.5m and planting distance 2.0m × 1.5m). Similar findings reported by Joshi *et al*. (2014) and Pratibha *et al*. (2013). The maximum (3.95kg) fruit yield per tree was recorded in the treatment combination P_3D_3 (pruning height 1.5m and planting distance 2.0m × 1.5m) while it was minimum (0.54kg) in the treatment combination P_1D_2 (pruning height 1.0m and planting distance 2.0m × 1.0m). Similar results have also been made by Lal *et al*. (2000), Jadav *et al*. (2009) and Praitbha *et al*. (2013). The maximum yield efficiency (6.80 kg/m^3) was recorded in the treatment combination P_0D_4 (pruning height 2.0m and planting distance 1.5m × 1.5m) while it was minimum (1.48 kg/m^3) in the treatment combination P_0D_1 (pruning height 2m and planting distance 1.0m × 1.0m). Pruning height P_3 (1.5m) from the ground level and planting distance D_3 (2.0m × 1.5m) and there combination (P_3D_3) may be recommended for getting higher fruit yield of guava per unit area with much differences in quality

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