

Crop regulation studies in guava (*Psidium guajava* L.) cv. L 49 under Ultra High Density Planting

ABSTRACT: A field experiment was carried out on 8 years old guava cv L 49 trees to assess the effect of pruning level and growth regulators with different combinations on vegetative growth and fruiting attributes in Ultra High Density Planting. The experiment consisted of 2 factors with 36 combinations viz., factor -1 (pruning level) P₁- pruning of 25 cm of the shoot from the tip, P₂- pruning of 50 cm of the shoot from the tip, P₃- pruning of 75 cm of the shoot from the tip, P₄ – control (without pruning). Factor -2(growth regulators) G₁, G₂- Potassium nitrate(1 ,2%) , G₃, G₄- Thiourea (0.1 ,0.2%) , G₅, G₆- Ethephon (250, 500 ppm) , G₇, G₈- Cycocel (250, 500 ppm) and G₉ – Control. Results showed that among different levels of pruning, 50cm pruning from the tip with potassium nitrate spray at 2 different concentrations was found to be the best for promoting early vegetative bud burst, fruit set and fruit yield. The increment in plant height and canopy spread in East-West and North-South were recorded more in 25 cm pruning from the tip. A greater number of shoots are visible in the P₃G₅ combination. When compared to other treatments, the P₃G₂ combination significantly increased the average index number of bud bursts and shoot length under Ultra High Density Planting.

Keywords: guava, factors, pruning, growth regulators, concentrations

INTRODUCTION

Guava (*Psidium guajava* L.) belongs to the family Myrtaceae, which has more than 80 genera and 3,000 species, distributed in the tropics and subtropics, native to tropical America stretching from Mexico to Peru. Guava is rich in ascorbic acid, calcium, iron, and phosphorus, which has led to it being referred to as the "poor man's apple" or the "apple of the tropics" (Prakash *et al.*, 2002). It contains 2-5 times more vitamin C as compared to oranges. According to an estimate, 100 g of guava fruit contains approximately 260 mg of vitamin C. Guava is the fifth most important fruit pertaining to area, production, and productivity among different fruit crops grown in India. It contributes 3.4 percent of the area and 3.9 percent of production in total fruit crops grown all over India. The other major states for guava cultivation are Uttar Pradesh, Bihar, and Karnataka. Maharashtra's most common variety is guava L-49 (Sardar). The production of 4.92 million MT of guava fruit has recently been regulated to a 315 thousand hectare area in India.

Getting an increase in guava production per unit area can be accomplished by increasing the plant population (Singh *et al.*, 1980, Mitra *et al.*, 1984). In the initial years, ultra high-density planting increases yield while simultaneously increasing net economic returns per unit area and allowing for more effective input utilization (Reddy, 2004).

MATERIAL AND METHODS

A field experiment was conducted at Horticultural College and Research Institute, Periyakulam, Theni in March 2023. Eight years old guava trees under Ultra High Density Planting with a spacing of 3 x 1.5 m were selected for a research trial. The treatment includes nine different concentrations of growth regulators (Potassium nitrate @ 1% & 2%, Thiourea @ 0.1% & 0.2%, Ethephon @ 250 ppm & 500 ppm, Cycocel @ 250 ppm & 500 ppm, and

Guava fruit is produced on the stalk of the current season and is produced by guava flowers, which appear singly or in cymes of two or three in the axil of leaves. Guava pruning is one of the most important practices that influences the vigor, productivity, and quality of the fruits. To build a strong architecture that can support a heavy crop load, early pruning is done (Lian *et al.*, 2019).

To maximize the unit area production and keep in mind its good demand, the production of genuine pruning techniques is a pre-requisite. It is always important for the fruit growers to adopt the best pruning technique. Therefore, the experiment was conducted with a goal to standardize the pruning technique for distribution to fruit growers. For the above purpose, standardize the pruning techniques needed to obtain good quality fruits. To adopt the correct pruning technique under UHDP, the level of pruning is important. Plant growth regulators like Potassium nitrate, Thiourea, Ethephon, and Cycocel play important roles in guava production by direct or indirect influences on the growth and development of guava. Pruning by different levels and application of growth regulators improve the yield and quality of the guava. In the UHDP system, the study's objective is to standardize the pruning level with the optimal growth regulators.

Control) as well as four various levels of pruning (25, 50, 75 cm of the shoot from the tip, and Control). The 36 treatment combinations in the experiment were set up in a 2-factor Factorial Randomized Block Design (f-RBD) with two replications. Five uniform plants per treatment combination were chosen. The particulars of the treatment are as follows:

Factor -1 (Pruning level)

P₁– Pruning of 25 cm of the shoot from tip

P₂– Pruning of 50 cm of the shoot from tip

P₃– Pruning of 75 cm of the shoot from tip

P₄– Control

Factor – 2 (Treatments)

G₁ - Potassium nitrate @ 1%

G₂ - Potassium nitrate @ 2%

G₃ - Thiourea @ 0.1%

G₄ - Thiourea @ 0.2%

G₅ - Ethephon @ 250 ppm

G₆ - Ethephon @ 500 ppm

G₇ - Cycocel @ 250 ppm

G₈ - Cycocel @ 500 ppm

G₉ – Control

List 1 -Treatment combinations				
P*G	P ₁	P ₂	P ₃	P ₄
G ₁	P ₁ G ₁	P ₂ G ₁	P ₃ G ₁	P ₄ G ₁
G ₂	P ₁ G ₂	P ₂ G ₂	P ₃ G ₂	P ₄ G ₂
G ₃	P ₁ G ₃	P ₂ G ₃	P ₃ G ₃	P ₄ G ₃
G ₄	P ₁ G ₄	P ₂ G ₄	P ₃ G ₄	P ₄ G ₄

RESULTS AND DISCUSSION

1. Effect of pruning level and growth regulators on growth characters

1.1. Tree height (m)

The different levels of pruning and growth regulators application significantly impacted the tree height. The maximum increment in tree height was recorded in the P₂G₃ (1.27 m) combination followed by the P₃G₉ (1.24 m) combination. While the minimum increment in tree height was recorded in the P₄G₁ (0.13 m) combination (Table 1). In the present study was observed that the vegetative growth of guava tends to adjust to modifications in the level of pruning operation. Less plant height increased when the level of the pruning was increased (Singh *et al.*, 2001, Lian *et al.*, 2019, Basu *et al.*, 2007). Intensive pruning stimulates the regeneration processes and alters the size of tree tops, particularly by reducing excessive tree height (Norton 2002).

1.2. Canopy spread (m)

East-West directions

The P₁G₂ (1.00 m) combination showed the highest increase in canopy spread under the influence of varying levels of pruning, whereas the P₄G₄ (0.10 m) combination recorded the lowest increase (Table 2). An increase in the canopy spread could be caused by an increase in shoot length. Guava responds very

G ₅	P ₁ G ₅	P ₂ G ₅	P ₃ G ₅	P ₄ G ₅
G ₆	P ₁ G ₆	P ₂ G ₆	P ₃ G ₆	P ₄ G ₆
G ₇	P ₁ G ₇	P ₂ G ₇	P ₃ G ₇	P ₄ G ₇
G ₈	P ₁ G ₈	P ₂ G ₈	P ₃ G ₈	P ₄ G ₈
G ₉	P ₁ G ₉	P ₂ G ₉	P ₃ G ₉	P ₄ G ₉

According to the instructions provided for the treatment, the guava trees were pruned and growth regulators were applied immediately after pruning. With the aid of secateurs and a pruning saw, pruning was carried out after entirely defoliating all of the leaves. N-500 g, P₂O₅ g, K₂O 500 g, and 40 Kg FYM per plant per year were applied as a standard fertilizer dose. Plant protection and other cultural activities were consistently provided as needed. Five randomly chosen plants from each replication were subjected to biometrical observations to evaluate their morphological characteristics, i.e. increment in plant height, canopy spread (in both E-W and N-S directions), canopy volume, first vegetative bud burst, bud burst activity, days taken for first flowering, fruit set, fruit yield (kg/plant).

well to pruning, topping, and hedging at various intervals (Norton 2002). Pruning removes carbon-starved, fruiting-exhausted shoots, encourages the growth of new leaves to store carbohydrates for the following flowering, and enables the sprouting of lateral buds, all of which have an impact on the plant's height, spread, volume, and other vegetative characteristics. This is consistent with research on guava (Meena *et al.*, 2016, Dhaliwal *et al.*, 2002, Kumar and Rattanpal 2010).

North – South directions

Data presented in Table (3) showed that the P₁G₂ combination (1.50 m) recorded the highest increase in North-South canopy spread whereas the P₄G₂ combination (0.10 m) recorded the lowest increase. The guava tree reacts well to canopy change in terms of spreading, hence pruning the canopy and using some growth regulators in high-density orchards may be techniques to increase production yield (Sah *et al.*, 2015).

1.3. Canopy volume (m³)

Concerning the effect of pruning level and growth regulators on canopy volume Table 4 showed that the P₁G₄ combination (44.22 m³) recorded the greatest canopy volume. The lowest canopy volume was recorded in the P₂G₁ combination (21.61 m³) (Table 4). Canopy volume was at its highest in 25% pruning of previous season growth as compared to 75% pruning of previous season growth (Singh and

Canaan 2005). Since pruning eliminates carbon-starved, fruit-exhausted branches and encourages the growth of new leaves to store carbs for the following flowering, it also permits lateral buds to sprout, which in turn affects the canopy volume and other vegetative characteristics of the plants. This is consistent with research on guava (Pilanin *et al.*, 2010).

1.4. Time taken for first vegetative bud burst (days)

The data on variations in pruning level and growth regulators showed that the P₂G₂ combination had the earliest emergence (5.01 days) and maximal (22.00 days) of vegetative bud burst in the P₄G₈ combination (Table 5). Early pruning caused new branches to sprout early. Similar findings were reported that a rise in pruning severity promotes the early bud burst (Lian *et al.*, 2019, Basu *et al.*, 2007, Dhaliwal *et al.*, 2000). Severe pruning along with potassium nitrate at 4% induced the highest average index number of bud bursts (Bhagawati *et al.*, 2015).

1.5. Number of shoots emerged from the pruned branches

The P₃G₅ combination (7.50) produced more on average number of new shoots followed by the P₃G₁ combination (7.30), according to the data in table (6). The lowest number of new shoots was recorded in the P₄G₃ combination (2.00). 75 cm pruning with ethephon at 250 ppm produce the highest number of new shoots compared to others. Pruning enhanced the guava's vegetative development similar these results (Bhagawati *et al.*, 2015, Pilanin *et al.*, 2010).

1.6. Length of newly emerged shoots (cm)

In terms of substance effect, the P₂G₄ combination had the longest average shoot length (43.50 cm), followed by the P₃G₃ and P₂G₁ combinations (Table 7). With the passage of time moderate pruning has given a favorable effect. Interaction between the concentration of growth regulators and pruning level showed that the P₂G₄ combination gave the greatest value of shoot length. On another side, the shortest shoot length was recorded in the P₃G₁ combination (23.80 cm). Shoot length in guava plants increased as a result of pruning, which encouraged vegetative development (Shaban and Haseeb 2009). When the shoots were pruned three times a year to half of their original length, the maximum gross return was achieved as well (Bisla *et al.*,1988).

2. Effect of pruning level and growth regulators on fruiting characters

2.1. Bud burst activity

Flower bud burst activity data in Table (8) showed that the highest significant average index

number was recorded in the P₃G₂ combination (4.90) followed by the P₁G₂ combination (3.60). The lowest average index number was recorded in the P₄G₈ combination (1.40). Meanwhile, 75 cm pruning with KNO₃ at 2% shows the highest average index number of the flower bud burst.

2.2. Fruit set (%)

Over the control, all interaction effects showed an increase in the fruit set. The average Fruit set percentage was more in the P₂G₁ combination (96.00 %) followed by the P₂G₂ combination (89.00%). Absolute control (P₄G₉ combination) was recorded lowest fruit set (70.00%) (Table 9). A direct relationship was observed between the concentration of chemical substances and the fruit set was recorded with the highest concentrations. Moderate pruning and the application of 4% potassium nitrate were shown to significantly boost the early fruit set (Bhagawati *et al.*, 2015). Eugelol and ethephon, when used at higher concentrations, decreased fruit set (Mehta *et al.*, 2012) [19]. Similar outcomes were also obtained in an increase in fruit set and fruit retention in guava by pruning over control (Curry and Williams 1989, Pilanin *et al.*, 2010).

2.3. Number of fruits/ Plant

The highest number of fruit per plant was recorded in the P₂G₁ combination (192.00) and the least number of fruit per plant was recorded in the P₄G₉ combination (55.80) (Table 10). The interaction between the two factors has a considerable impact on the total amount of fruit. You may control your tree's size and fruit production with the help of shoot pruning. Pruning increases the amount of fruit that a plant produces. Others made similar observations as well. Fruit yield is seen to decline as pruning severity is increased (Dalal *et al.*, 2000, Lopez *et al.*, 1982, Quijada *et al.*, 1999). Pruning, which decreased the fruiting area and on the other hand encouraged vegetative growth at the expense of reproductive growth, is the cause of the drop in fruit production per plant (Kumar and Rattanpal 2010).

2.4. Fruit yield (kg/ Plant)

Maximum yield was achieved with a P₂G₂ combination (27.10 kg) followed by a P₁G₈ combination (25.98 kg). The minimum yield was recorded in the P₄G₉ combination (8.37 kg) (Table 11). According to Dutta, foliar spraying of potassium increased the yield and quality and decreased with the pruning intensity in Sardar guava. Pruning increases the fruit weight in guava (Maji *et al.*, 2015). Using various crop regulation practices like the pruning of shoots, defoliation, or deblossoming, it is necessary to decrease fruit set during the rainy season and then increase fruit set during the winter season in order to regulate guava crop, provides support to the present finding (Boora *et al.*, 2016) . The findings of this study are consistent with 45 cm shoot pruning in May

Growth regulators	Pruning level				Mean
	P ₁	P ₂	P ₃	P ₄	
G ₁	0.83	0.63	1.19	0.13	0.70
G ₂	0.89	0.91	1.21	0.34	0.84
G ₃	0.74	1.27	1.05	0.41	0.87
G ₄	1.16	1.19	1.08	0.78	1.05
G ₅	0.38	0.88	0.92	0.70	0.72
G ₆	0.87	0.93	0.87	0.42	0.77
G ₇	0.68	1.00	0.91	0.37	0.74
G ₈	0.72	0.77	0.99	0.56	0.76
G ₉	0.71	0.90	1.24	0.58	0.86
Mean	0.78	0.94	1.05	0.48	
	Pruning		Growth regulators		Interaction (P×G)
SE(d)	0.008		0.012		0.025
CD(0.05)	0.017		0.025		0.051

Table 1. Effect of pruning level and growth regulators on increment in tree height

Growth regulators	Pruning level				Mean
	P ₁	P ₂	P ₃	P ₄	
G ₁	0.55	0.35	0.10	0.75	0.44
G ₂	1.00	0.40	0.25	0.50	0.54
G ₃	0.60	0.05	0.55	0.70	0.48
G ₄	0.70	0.15	0.30	0.10	0.31
G ₅	0.19	0.12	0.30	0.65	0.29
G ₆	0.85	0.20	0.40	0.50	0.49
G ₇	0.25	0.45	0.30	0.35	0.34
G ₈	0.65	0.11	0.45	0.85	0.52
G ₉	0.05	0.60	0.70	0.90	0.56
Mean	0.53	0.26	0.37	0.59	
	Pruning		Growth regulators		Interaction (P×G)
SE(d)	0.025		0.038		0.077
CD(0.05)	0.052		0.078		0.157

Table 2. Effect of pruning level and growth regulators on increment canopy spread (E-W)

Growth regulators	Pruning level				Mean
	P ₁	P ₂	P ₃	P ₄	
G ₁	0.20	0.91	0.55	0.55	0.55
G ₂	1.50	0.30	0.15	0.10	0.51
G ₃	0.05	0.60	0.40	0.35	0.35
G ₄	0.15	0.25	0.30	0.95	0.41
G ₅	0.35	0.20	0.50	0.30	0.34
G ₆	0.45	0.15	0.60	0.90	0.53
G ₇	0.15	0.40	0.50	0.85	0.48
G ₈	1.10	0.40	0.60	0.60	0.68
G ₉	0.25	0.65	0.75	1.30	0.74
Mean	0.47	0.43	0.48	0.66	
	Pruning		Growth regulators		Interaction (P×G)
SE(d)	0.024		0.036		0.072
CD(0.05)	0.048		0.073		0.146

Table 3. Effect of pruning level and growth regulators on increment canopy spread (N-S)

Growth regulators	Pruning level				Mean
	P ₁	P ₂	P ₃	P ₄	
G ₁	35.41	21.61	29.32	32.18	29.63
G ₂	35.29	29.88	29.23	30.43	31.21
G ₃	32.48	29.07	26.60	29.44	29.40
G ₄	44.22	31.54	28.77	36.34	35.22
G ₅	27.19	31.58	25.56	33.31	29.41
G ₆	31.58	27.16	26.60	24.54	27.47
G ₇	33.31	33.91	25.07	27.16	29.86
G ₈	33.20	29.39	26.10	32.89	30.40
G ₉	33.88	41.18	32.16	43.21	37.61
Mean	34.06	30.59	27.71	32.17	
	Pruning		Growth regulators		Interaction (PxG)
SE(d)	0.217		0.326		0.653
CD(0.05)	0.441		0.662		1.325

Table 4. Effect of pruning level and growth regulators on canopy volume

Growth regulators	Pruning level				Mean
	P ₁	P ₂	P ₃	P ₄	
G ₁	11.22	9.37	8.00	19.65	12.06
G ₂	13.50	5.01	11.48	19.22	12.30
G ₃	13.32	7.46	8.52	23.56	13.22
G ₄	12.10	7.50	9.33	18.00	11.73
G ₅	15.67	8.27	7.58	22.59	13.53
G ₆	15.15	7.00	6.34	19.66	12.04
G ₇	11.00	10.35	12.29	21.63	13.82
G ₈	10.08	9.86	11.67	22.00	13.40
G ₉	9.00	11.07	10.74	20.53	12.84
Mean	12.34	8.43	9.55	20.76	
	Pruning		Growth regulators		Interaction (PxG)
SE(d)	0.121		0.181		0.36
CD(0.05)	0.246		0.369		0.738

Table 5. Effect of pruning level and growth regulators Time taken for first vegetative bud burst

Growth regulators	Pruning level				Mean
	P ₁	P ₂	P ₃	P ₄	
G ₁	2.60	5.50	7.30	3.25	4.66
G ₂	3.10	6.50	6.30	4.50	5.10
G ₃	2.60	6.60	6.50	2.00	4.43
G ₄	3.50	6.30	7.00	3.00	4.95
G ₅	2.10	6.83	7.50	3.00	4.86
G ₆	2.50	5.83	7.16	4.25	4.94
G ₇	2.50	6.63	6.16	4.75	5.01
G ₈	2.80	7.00	6.30	3.50	4.90
G ₉	2.50	6.00	6.60	4.25	4.84
Mean	2.69	6.35	6.76	3.61	
	Pruning		Growth regulators		Interaction (PxG)
SE(d)	0.041		0.062		0.125
CD(0.05)	0.085		0.127		0.255

Table 6. Effect of pruning level and growth regulators Number of shoots emerged from the pruned branches

Growth regulators	Pruning level				Mean
	P ₁	P ₂	P ₃	P ₄	

G₁	29.50	42.10	23.80	27.00	30.60
G₂	33.30	41.80	36.20	25.00	34.08
G₃	33.30	42.10	42.40	30.60	37.10
G₄	29.30	43.50	40.80	32.10	36.43
G₅	35.50	41.50	30.40	27.50	33.73
G₆	29.60	42.10	32.80	29.50	33.50
G₇	32.10	35.80	32.80	33.10	33.45
G₈	34.30	38.00	35.60	39.10	36.75
G₉	30.80	36.50	32.80	38.80	34.73
Mean	31.97	40.38	34.18	31.41	
	Pruning		Growth regulators		Interaction (P×G)
SE(d)	0.331		0.496		0.993
CD(0.05)	0.672		1.008		2.017

Table 7. Effect of pruning level and growth regulators Length of newly emerged shoots

Growth regulators	Pruning level				Mean
	P ₁	P ₂	P ₃	P ₄	
G₁	3.03	3.00	3.30	2.90	3.06
G₂	3.60	3.20	4.90	2.00	3.43
G₃	2.33	2.42	2.77	2.16	2.42
G₄	1.93	2.15	2.31	1.49	1.97
G₅	2.01	2.20	2.43	2.50	2.29
G₆	1.60	2.28	2.40	1.77	2.01
G₇	1.73	1.76	2.41	1.57	1.87
G₈	2.03	1.80	1.82	1.40	1.76
G₉	1.93	1.95	2.10	1.60	1.90
Mean	2.24	2.31	2.72	1.93	
	Pruning		Growth regulators		Interaction (P×G)
SE(d)	0.019		0.028		0.057
CD(0.05)	0.038		0.058		0.116

Table 8. Effect of pruning level and growth regulators bud burst activity

Growth regulators	Pruning level				Mean
	P ₁	P ₂	P ₃	P ₄	
G₁	88.00	96.00	78.26	86.00	87.07
G₂	73.33	89.00	75.75	83.34	80.36
G₃	83.30	83.63	73.60	75.00	78.88
G₄	84.84	86.63	82.22	83.73	84.36
G₅	82.00	87.50	72.41	73.80	78.93
G₆	81.81	86.50	78.94	86.84	83.52
G₇	85.71	86.50	74.19	73.07	79.87
G₈	83.87	84.61	80.00	73.30	80.45
G₉	76.66	88.70	72.63	70.00	77.00
Mean	82.17	87.67	76.44	78.34	
	Pruning		Growth regulators		Interaction (P×G)
SE(d)	0.658		0.988		1.976
CD(0.05)	1.337		2.005		4.011

Table 9. Effect of pruning level and growth regulators on fruit set

Growth regulators	Pruning level				Mean
	P ₁	P ₂	P ₃	P ₄	
G₁	162.10	180.67	75.30	93.50	127.89
G₂	168.40	192.00	82.40	100.30	135.78
G₃	165.10	172.78	69.80	82.30	122.50

G₄	153.20	163.11	70.20	85.50	118.00
G₅	156.50	154.65	63.70	92.20	116.76
G₆	161.70	150.23	65.50	95.30	118.18
G₇	171.40	164.50	59.50	97.80	123.30
G₈	173.20	170.30	63.50	86.30	123.33
G₉	167.20	152.40	64.50	55.80	109.98
Mean	164.31	166.74	68.27	87.67	
	Pruning		Growth regulators		Interaction (PxG)
SE(d)	3.378		5.067		10.134
CD(0.05)	6.858		10.287		20.574

Table 10. Effect of pruning level and growth regulators on the Number of fruits/ Plant

Growth regulators	Pruning level				Mean
	P ₁	P ₂	P ₃	P ₄	
G₁	24.32	25.08	11.30	14.03	18.68
G₂	25.26	27.10	12.36	15.05	19.94
G₃	24.77	24.80	10.47	12.35	18.10
G₄	22.98	23.92	10.53	12.83	17.57
G₅	23.48	24.47	9.56	13.83	17.84
G₆	24.26	23.20	9.83	14.30	17.90
G₇	25.71	22.53	8.93	14.67	17.96
G₈	25.98	24.68	9.53	12.95	18.29
G₉	24.32	25.55	9.68	8.37	16.98
Mean	24.56	24.59	10.24	13.15	
	Pruning		Growth regulators		Interaction (PxG)
SE(d)	0.158		0.237		0.474
CD(0.05)	0.321		0.481		0.963

Table 11. Effect of pruning level and growth regulators on Fruit yield

Conclusion

In conclusion the typical flowering and fruiting behavior of the plant required to be controlled in order to produce an enormous crop load and make guava cultivation very profitable under Ultra High density planting. In terms of growth and flowering yield, all crop regulating techniques were determined to be superior to the untreated control.

Unpruned guava trees have a tendency to prolong vegetative growth and diminish the bearing area, which reduces fruit size, yield, and quality. Pruning is therefore necessary to achieve a suitable balance between vegetative and reproductive growth. According to this study's findings, 50 cm of pruning from the tip using potassium nitrate at 1% and 2% is superior for enhancing vegetative growth and production of guava trees.

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