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Response of Shoot Pruning on Growth, Flowering and Fruiting Characteristics of Guava under Sub-Himalayan Terai Region of West Bengal

G.M. Santhoshkumar, Nilesh Bhowmick*, Aditi Chakraborty, Amarendra Nath Dey[1], Arunava Ghosh[2] and Puspendu Dutta[3]

Department of Pomology and Post-Harvest Technology, [1]Department of Forestry, [2]Department of Agricultural Statistics, [3]Department of Seed Science and Technology,
Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal-736 165, India
**E-mail: nilesh@ubkv.ac.in*

***Abstract*:** Guava is one of the important fruit crops grown worldwide. Shoot pruning improves the emergence of new flush and its role on flowering and fruiting characteristics was evaluated on this experiment. The effect on shoot pruning height and removal of top leaf bud by pinching was assessed on growth, flowering and fruiting characteristics of guava cv. L-49. The experiment was conducted at Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal.There were two factors heading back and pinching. Heading back at the level of 90, 120 and 150cm was done in January and pinching of one leaf pair was performed during the last week of June, 2018.The heading back at the level of 120 cm and no pinching were most effective for number of flowering bud (179.33), number of flowers (139.83), number of fruit set (95.33), total number of fruits (64.66), ascorbic acid (190.35 mg/100g), titratable acidity (0.28%) and heading back at the level of 120 cm and one pinching were effective in increasing number of primary shoots (39.50), flowering percentage (80.18%), fruit weight (172.00g).

Keywords: Heading back, Leaf pair pinching, Phenology, Canopy

Guava (*Psidium guajava* L.) is native to tropical America, extending from Mexico to Peru. The area under guava in India is about 262,000 hectares producing 3,648 million tonnes with a productivity of 13.9 MT/ha (Anonymous 2017).In North Indian conditions, two distinct flowering occurs in a year, first in April-May for rainy season crop and the second in August-September for winter season crop (Mitra et al 2008).Pruning is one of horticultural practices followed in the temperate and subtropical fruit crops to bring a balance between vegetative and reproductive growth of the plant. Untrained and unpruned guava trees become huge and unmanageable after a few years of growth. The bearing area is reduced and the interior of plants become entirely without fruits. Proper canopy management is therefore essential to avoid competition for light under high density planting and to achieve higher productivity. Pruning found to have pronounced effect on improving vigor of old orchards and increasing performance of fruit yield and quality (Bhagawati et al 2015). Pruning of guava is one of the most important practices that influence the vigour, productivity and quality of the fruits. Pruning at an early stage is done to develop a strong framework and capable for bearing a heavy crop load. The main advantages of pruning on bearing trees include the formation of new shoots, avoid overcrowding of branches, removal of criss-cross branches, diseased branches as well as water sprouts and root suckers. Guava bears on current season's growth and flowers appear in the axils of the new leaves, thus, it responds well to pruning. Pruning can be used as the better means to enhance the fruiting potential of guava and increasing the production. The pruning of apical shoots improved the growth and yield of guava fruit trees (Ali et al 2014).The different intensities of pruning improved vegetative growth and crop yield in grapes and other crops (Porika et al 2015, Malviya and Sharma 2016). The old and senile orcharding becomes economically non-viable and non-remunerative which leads to decline both in quality and quantity of fruits. For overcoming the problem of unproductive and uneconomic orchards existing in abundance, large scale uprooting and replacement with new plantations. Therefore, the present study was undertaken to record the performance of guava at differential pruning height and the effect of pinching on growth, flowering and fruiting characteristics of guava.

MATERIAL AND METHODS

The present experiment was carried out at Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India during 2018-19. Guava cv. L-49 was planted at distance of 4m X 4m and selected for evaluating the effect of height of heading back and pinching of shoots using two

factor randomized block design with two factors such as heading back and pinching with eight treatment combinations and three replications. Heading back at 90, 120 and 150 cm was performed during January 2018 and pinching of one leaf pair was performed during the last week of June, 2018. The parameters were subjected to two factor Randomized block design (RBD) and analyzed statistically as per method by Gomez and Gomez (1984) using Proc Glm of Statistical Analysis System (SAS) Software (Version 9.3). The details of treatment combinations are

$T_1 = H_0P_0$ (no heading back and no pinching),
$T_2 = H_0P_1$ (no heading back and one pinching in last June),
$T_3 = H_1P_0$ (90 cm heading back and no pinching),
$T_4 = H_1P_1$ (90 cm heading back and one pinching in last June),
$T_5 = H_2P_0$ (120cm heading back and no pinching),
$T_6 = H_2P_1$ (120cm heading back and one pinching in last June),
$T_7 = H_3P_0$ (150cm heading back and no pinching),
$T_8 = H_3P_1$ (150cm heading back and one pinching in last June) were followed during the experimentation.

The recommended dose of fertilizer (N: P:K) was applied at the ratio of 260:320:260 g/plant. Different growth parameters like days taken to emergence of vegetative buds, total number of primary shoots, length of the primary shoot (cm), fresh weight and dry weight of primary shoot (g), and carbohydrate content were recorded.

Tree volume (m^3): The tree volume (m^3) was calculated by following the formula given by Roose et al(1986) as $V=4/6\ \pi r^2 h$, Where, h=height of tree (m) and E-W= East-West; N-S= North-South.

$$r = \frac{\text{Sum of East-West and North-South directions}}{4}$$

Flowering characteristics: The flowering characteristics were observed on the basis of all the plants of specific replication such as days taken to emergence of first flower bud after pruning, number of flowering buds,

Flowering percentage: It was calculated by following formula-

$$\text{Flowering percentage (\%)} = \frac{\text{Number of flowers}}{\text{Number of flower buds}} \times 100$$

Fruiting characteristics: Number of fruit set, total number of fruits, fruit weight (g), fruit diameter (cm), fruit set percentage (%). The fruit set percentage was recorded and mean values presented as per cent fruit set. Fruit set percentage was calculated by following formula-

$$\text{Fruit set (\%)} = \frac{\text{Total number of fruits}}{\text{Total number of flowers}} \times 100$$

Fruit quality parameters like total soluble solids (TSS), total sugar (%), reducing sugar (%), ascorbic acid (mg/100g) and titratable acidity (%) was determined under each treatment.

RESULTS AND DISCUSSION

Growth parameters: Effect of heading back and pinching: Emergence of vegetative buds: The heading back showed variation among the different heights; whereas, pinching levels has more statistical variation (Table 1). The maximum delay (45.00 days) on vegetative buds' emergence was in H_2P_1(120cm heading back and one pinching in last June) and the lowest time required was in (33.66 days) in H_0P_0 (No heading back and no pinching) and (35.83 days) in H_0P_1(No heading back and one pinching in last June). As no heading back was performed in H_0P_0 and H_0P_1 the bud emergence time was comparatively lower than other treatment details. Suleman et al (2006) reported that among the three pruning levels in guava cv. Lucknow-49, 60 cm pruning intensity resulted in minimum days for sprouting of new shoots.

Number of primary shoots showed significant variation among the individual main factors and treatment combinations. The number of primary shoots was maximum (39.50) with $T_6(H_2P_1)$, which was statistically at par with H_3P_0

Table 1. Effect of heading back and pinching on growth parameters

Treatments/ Combination	Days taken to emergence of vegetative buds	Number of primary shoots	Number of primary shoots/ m^3	Length of the primary shoot (cm)		
				3MAP	6MAP	9MAP
T_1 H_0P_0	33.66^{e}	13.33^{f}	0.25^{d}	7.06^{c}	20.23^{bc}	29.04^{b}
T_2 H_0P_1	35.83^{de}	16.83^{e}	0.28^{d}	5.86^{c}	13.79^{b}	19.79^{b}
T_3 H_1P_0	40.00^{bc}	17.83^{e}	0.40^{cd}	10.78^{ab}	34.49^{a}	55.76^{a}
T_4 H_1P_1	40.83^{bc}	23.33^{d}	0.53^{bcd}	8.13^{bc}	39.86^{a}	63.56^{a}
T_5 H_2P_0	42.16^{abc}	27.33^{c}	0.62^{bcd}	6.56^{c}	29.85^{ab}	50.95^{a}
T_6 H_2P_1	45.00^{a}	39.50^{a}	0.73^{bc}	7.20b^{c}	31.31^{ab}	54.02^{a}
T_7 H_3P_0	42.83^{ab}	36.66^{ab}	1.17^{a}	7.58b^{c}	37.61^{a}	63.96^{a}
T_8 H_3P_1	38.50^{cd}	35.83^{b}	0.90^{ab}	11.75^{a}	34.95^{a}	56.00^{a}

**Means with the same letter are not significantly different

(36.66).whereas, it was minimum (13.33) with H_0P_0 (control). Similar trends were also recorded for number of primary shoots per unit of tree volume. The number of primary shoots/ m^3 was in lowest (0.25) with T_1 (H_0P_0) which was statistically at par (0.28) with T_2 (H_0 P_1). The maximum (1.17) number of primary shoots/ m^3 was in severe heading back T_7(H_3 P_0) was statistically at par with T_8(H_3 P_1).The result indicates heading back (severe pruning) and pinching had strong effects on bud emergence and number of primary shoot development compared to no heading back and no pinching. Increase in number of sprouts per shoot by heading back may be due to overcome of apical dominance and supply of more food materials as also suggested by Lakhpathi et al (2013). The early emergence of vegetative bud sprout, numbers of shoots and shoot length of guava trees were observed by other workers (Jadhav et al 2002, Salah 2005).

The heading back at different heights has significant effects, whereas, pinching has no effect on length of emerged pruning shoot at different month after pruning. However, the treatment combinations show significant variation for this parameter. The length of primary shoot was higher in different stages in H_3 P_0,H_3 P_1 and H_1 P_1 treatment combinations. The highest newly emerged shoot length per tree canopy volume was recorded with severe heading back (H_3 P_0).No pruning with or without pinching gave poor performance on extension of new primary shoots. The increase in shoot length may be attributed to the reserve food material in the main scaffolds or branches due to which new growth was put forth just after the heading back as suggested by Mohammed et al (2006).

The tree volume significantly varied for height of pruning on other hand pinching has no effect. Tree volume was in highest (58.18 m^3) with T_2(H_0 P_1) and lowest tree volume at T_7 (severe pruning). It is observed that severe pruning with or without leaf pinching has negative impact on tree volume. Thakre et al (2016) found minimum annual increase in tree volume with one leaf pair pruning of fruited shoots. Hiremath et al (2017) observed that minimum plant height, plant spread and stem girth were noted in pruned plants. Pinching numbers and interaction of heading back levels and pinching numbers were found in altering trees volume of guava. Similar results were observed by Kumar and Rattanpal

Table 2. Effect of heading back and pinching on length of primary shoot, tree volume and, fresh and dry weight of new shoots

Treatments/ Combination	Length of the primary shoot		Tree volume (m^3)	Fresh weight (g)	Dry weight (g)
	12 MAP	12 MAP/m^3			
T_1 H_0P_0	43.06^{d}	0.85^{cd}	53.47^{ab}	9.08^{c}	4.66^{bc}
T_2 H_0P_1	34.75^{d}	0.60^{d}	58.18^{a}	9.83^{bc}	4.91^{abc}
T_3 H_1P_0	96.40^{bc}	1.92^{bc}	45.69^{ab}	11.83^{abc}	5.33^{abc}
T_4 H_1P_1	113.93^{a}	2.71^{ab}	44.63^{ab}	16.50^{a}	6.66^{ab}
T_5 H_2P_0	90.67^{c}	2.03^{bc}	45.49^{ab}	10.16^{bc}	4.33^{c}
T_6 H_2P_1	102.15^{abc}	1.88^{bcd}	55.24^{ab}	14.00^{bc}	6.33^{abc}
T_7 H_3P_0	108.97^{ab}	3.37^{a}	36.62^{b}	13.83^{ab}	6.91^{a}
T_8 H_3P_1	90.31^{c}	2.26^{ab}	39.78^{ab}	11.17^{bc}	5.58^{abc}

**Means with the same letter are not significantly different

Table 3. Effect of heading back and pinching on flowering characters

Treatments/ Combination	Days taken to emergence of first flower bud after pruning	Number of flowering buds	Number of flowering bud/ m^3	Number of flowers	Number of flowers/ m^3	Flowering percentage
T_1 H_0P_0	89.33^{d}	148.00^{b}	2.90^{b}	113.83^{ab}	2.21^{ab}	76.86^{a} (61.32)
T_2 H_0P_1	84.83^{e}	144.50^{b}	2.50^{b}	115.33^{ab}	1.99^{b}	79.83^{a} (63.41)
T_3 H_1P_0	95.00^{c}	164.50^{ab}	3.64^{ab}	132.67^{ab}	2.90^{ab}	80.17^{a} (63.71)
T_4 H_1P_1	97.00^{b}	158.00^{ab}	3.57^{ab}	124.17^{ab}	2.77^{ab}	77.91^{a} (62.08)
T_5 H_2P_0	98.50^{b}	179.33^{a}	4.04^{ab}	139.83^{a}	3.15^{ab}	77.90^{a} (62.01)
T_6 H_2P_1	99.83^{a}	155.17^{ab}	2.86^{b}	125.00^{ab}	2.45^{ab}	80.18^{a} (63.74)
T_7 H_3P_0	98.50^{ab}	145.83^{b}	4.60^{a}	107.67^{ab}	3.40^{a}	73.86^{a} (59.26)
T_8 H_3P_1	94.66^{c}	140.50^{b}	3.56^{ab}	102.50^{b}	2.60^{ab}	72.96^{a} (58.69)

**Means with the same letter are not significantly different, values in a parenthesis are arc sine value

(2010) where they found maximum tree volume in control trees and was minimum under pruning treatment by removal of half vegetative growth in guava. Singh et al (2012) showed that pruning decreased the tree canopy volume in guava. Fresh and dry weight of newly emerged primary shoots were comparatively more than the non-pruned guava plants significant variation among the fresh weight (16.50 g) and dry weight (6.91 g) was in$H_1 P_1$and $H_3 P_0$treatment combinations, respectively.

Flowering characteristics: The highest duration was in H_2P_1(99.83 days) followed by H_3P_0. The lowest days taken to emergence of flower bud was inH_0P_1, followed by H_0P_0. The flower bud emergence was delayed in heavy pruning, but the number of flower buds produced was comparatively higher in pruning treatment compared to unpruned plants. The maximum number of flowering buds (179.33) was in T_5, followed by H_1P_0,H_1P_1 and H_2P_1. The number of flower bud per unit volume was higher in T_7($H_3 P_0$), and maximum number of flowers was in H_2P_0(139.83). However, the minimum number of flowers was in H_3P_1. All the treatment combinations showed significant variation on number of flowers/m^3. Data pertaining to the number of flowers/ m^3 was lowest (1.99) with $H_0 P_1$ (control). The highest number of flowers / m^3 (3.40) was in $H_3 P_0$. Pilania et al (2010) noticed that 25% pruning of previous season growth in guava produced maximum number of flowers/ shoot and maximum fruit diameter under 75% pruning of previous season growth followed by 50% pruning and minimum in control. The pinching has no significant effect over flowering. Heading back and pinching operation combination has non-significant for flowering percentages. However, the maximum flowering percentage (80.18%) was in $H_2 P_1$, followed by $H_1 P_0$. The interaction between heading back and numbers of pinching was found non-significant. The increase in flowering intensity with pinching as compared to the un-pinched trees indicates that pinching resulted in production of new growing points on the pinched trees reported by Saini et al(2016).Highest number of flower buds per shoot was in light pruning of guava (Bhagawati et al 2015) and maximum flowering intensity was in 60 cm pruning (Mohammed et al2006), whereas, number of flowers per shoot on severely pruned trees of guava was more than mild pruned trees (Jadhav et al 2002).

Fruiting characteristics: Heading back and pinching individually has no significant variation on number of fruit set and fruit set per unit tree volume initially. However, maximum initial fruit set was in $H_2 P_0$ treatment combination. Maximum number of fruit set per unit tree volume was in severe pruning (H_3P_0), all the other heading back treatment combinations

Table 4. Effect of heading back and pinching on fruiting characters

Treatments/Combination	Fruit set	Fruit set/ m^3	Fruit set percentage	Number of fruits	Number of fruits/ m^3
T_1 H_0P_0	69.83^{ab}	1.37^{b}	61.55^{b} (51.69)	39.00^{b}	0.74^{b}
T_2 H_0P_1	81.17^{ab}	1.40^{b}	70.16^{b} (56.97)	38.50^{b}	0.65^{b}
T_3 H_1P_0	83.17^{ab}	1.80^{ab}	61.69^{b} (51.79)	41.66^{b}	0.87^{b}
T_4 H_1P_1	83.37^{ab}	1.84^{ab}	66.46^{ab} (54.63)	48.16^{ab}	1.07^{ab}
T_5 H_2P_0	95.33^{a}	2.15^{ab}	68.19^{ab} (55.68)	64.66^{a}	1.46^{a}
T_6 H_2P_1	84.00^{ab}	1.52^{ab}	66.95^{ab} (54.92)	48.33^{ab}	0.87^{b}
T_7 H_3P_0	74.17^{ab}	2.34^{a}	68.90^{ab} (56.12)	48.66^{ab}	1.47^{a}
T_8 H_3P_1	66.17^{b}	1.68^{ab}	64.41^{ab} (53.40)	41.66^{b}	1.05^{ab}

**Means with the same letter are not significantly different, values in a parenthesis are arc sine value

Table 5. Effect of heading back and pinching on fruit weight and diameter and quality parameters

Treatments/ Combination	Fruit weight (g)	Fruit diameter (cm)	TSS (^{0}B)	Reducing sugar (%)	Total sugar (%)	Ascorbic acid (mg/100g)	Acidity (%)
T_1 H_0P_0	168.67^{ab}	5.78^{c}	8.56^{b}	2.43^{bc}	6.67^{e}	149.26^{f}	0.18^{de}
T_2 H_0P_1	127.92^{c}	5.74^{c}	8.36^{b}	2.57^{ab}	6.59^{e}	151.19^{f}	0.16^{e}
T_3 H_1P_0	137.67^{abc}	6.48^{ab}	9.83^{a}	2.15^{c}	8.13^{b}	176.00^{c}	0.22^{bc}
T_4 H_1P_1	129.93^{bc}	5.79^{c}	9.76^{a}	2.83^{a}	8.30^{a}	181.19^{b}	0.19^{d}
T_5 H_2P_0	122.42^{c}	4.87^{d}	9.60^{a}	2.56^{ab}	7.50^{c}	190.35^{a}	0.28^{a}
T_6 H_2P_1	172.00^{a}	5.86^{bc}	9.16^{ab}	2.25^{c}	7.14^{d}	170.94^{d}	0.22^{b}
T_7 H_3P_0	133.50^{abc}	6.65^{a}	8.90^{ab}	2.79^{a}	7.09^{d}	166.41^{e}	0.27^{a}
T_8 H_3P_1	108.17^{c}	6.53^{a}	9.06^{ab}	2.35^{bc}	7.10^{d}	165.32^{e}	0.20^{cd}

**Means with the same letter are not significantly different

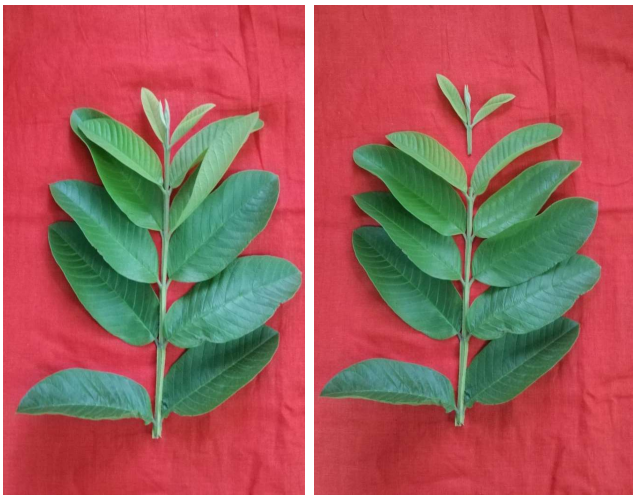

Fig. 1. Comparision of unpruned shoot and one leaf pair pinching of guava shoot

was statistically at par with T_7 (H_3P_0). The highest number of initial fruit set per unit area of tree volume observed on pruning treatments may be associated with development of a greater number of laterals, restoration of food reserve of plants is also suggested by Pratibha and Lal (2012).The heading back and pinching treatment individually has no effect on initial fruit set percentage of guava cv. L-49. The higher fruit set percentage was in T_2 (H_0P_1) compared to other treatment, indicating pinching has effect on fruit set percentage. The lowest initial fruit set percentage was in no heading back and no pinching treatment. Low initial fruit set percentage of T_1 (H_0P_0) may be due to a smaller number of developments of primary shoots, pruning and pinching compared to unpruned trees facilitate more production of new growing points as suggested by Brar et al (2007). However, contradictory report was also found by Dubey et al (2001) to found maximum fruit set in control over the pruned plants. Pruning of 25 percent of the shoot length of guava in mid-April was found to be the best treatment among for plant growth parameters, whereas, pruning of 50 percent of the shoot length in mid-May was best for obtaining maximum fruit yield in guava cv. L-49 for winter crop (Lian et al 2019).

The pinching has individually no effect on number of fruits per tree and number of fruits produced per unit area of tree. However, heading back or pruning has significant impact on production of number of fruits. Highest number of fruits was in T_5 (H_2P_0) that was statistically at par with T_7 (H_3P_0), T_6 (H_2P_1) and T_4 (H_1P_1). The beneficial effect of pruning and pinching in terms of production of new shoot may be related with the higher number of fruits compared to non-pruned plants. Individually pinching and heading back has no role on fruit weight. However, maximum fruit weight may be due to more canopy volume of T_1 (H_0P_0). Higher fruit weight in H_2P_1, may be is due to the in-vigour outing tree health due to the pruning. However,T_1 (H_0P_0) recorded higher fruit weight may be due to more canopy volume of T_1 plants following no pruning operation resulting in a smaller number of fruits having more weight. The pinching has no role on fruit diameter. Maximum fruit diameter was in T_7(H_3P_0) followed by T_8 (H_3P_1) and T_3(H_1P_0). The effect of differential pruning height and pinching had non-significant influence on TSS. Interaction effects of treatment combination were varying significantly. The maximum TSS (9.83 ºB) was in T_3 followed by T_4 and T_5. However, minimum (8.36ºB) was in T_2 followed by T_1.

Total sugar showed significant variation among the different treatment combinations. The highest total sugar percentage (8.30%) was in T_4, followed by T_3. The lowest total sugar percentage (6.59%) was in T_2 which was followed by T_1. The higher reducing sugar (2.83%) was in T_4 which was on par with T_7. However, lowest (2.15%) was in T_3. The maximum ascorbic acid (190.35 mg/100 g) was in T_5 followed by T_4. However, minimum (149.26 mg/100 g) was in T_1 followed by T_2. Acidity of fruit differed significantly among the differential pruning and pinching treatment. The higher percent of acidity (0.28%) was in T_5 which was on par with T_7. However, the lowest percent of acidity (0.16%) was in T_2 (control) which was on par with T_1 (control). More canopy volume of T_1plants following no pruning operation resulting in a smaller number of fruits, there was chances of development of less acidity compared to pruned plants.

CONCLUSIONS

The heading back at the level of 120 cm and no pinching were most effective in flowering and fruiting characteristics over unpruned trees. Hence, it is concluded that to standardize the heading back and pinching of guava cv. L-49 is a commercial cultivar of guava in West Bengal, India for getting higher fruit yield as well as superior quality of fruits.

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