International Journal of Bio-resource and Stress Management https://ojs.pphouse.org/index.php/IJBSM

Crossref

IJBSM August 2025, 16(8): 01-07

Article AR6255

Research Article

Natural Resource Management

DOI: HTTPS://DOI.ORG/10.23910/1.2025.6255

# Effect of Branch Bending on Fruit Production and Quality of Different Varieties of Guava (*Psidium guajava* L.)

**Rajnish Kumar[1], Divya Tiwari[1], Dhyanananda Kumari[1], Neha Sinha[1], Ajeet Kumar[2], C. S. Azad[3], Subrat Kishori Behera[4] and Randhir Kumar[1]**

[1]Dept. of Horticulture (Fruit and Fruit Technology), [2]Dept. of Soil Science, [3]Dept. of Plant Pathology, [4]Dept. of SMCA, Nalanda College of Horticulture, Noorsarai, Nalanda, Bihar Agricultural University, Sabour, Bhagalpur, Bihar (813 210), India

Open Access

**Corresponding** dtiwari1912@gmail.com

0000-0001-5220-5938

## ABSTRACT

The present investigation was carried out from January to August, 2024 in a guava orchard at Nalanda College of Horticulture, Noorsarai (Nalanda), Bihar, to evaluate the effects of branch bending and pruning on vegetative growth, flowering, fruit yield, and quality of different guava varieties. The experiment followed a Factorial Randomized Block Design with twelve treatment combinations and three replications, involving three guava varieties-Lucknow-49 ($V_1$), Lalit ($V_2$), and Allahabad Safeda ($V_3$)-subjected to four pruning and bending treatments: $B_0$ (control), $B_1$ (bending of lateral branches and partial removal of older leaves), $B_2$ (One leaf pair pinching with complete removal of old leaves), and $B_3$ (Removal of leaves, keeping 10 to 12 pairs of leaves intact at the terminal portion of each branch). Results revealed that $B_1$ treatment significantly enhanced early shoot emergence (12.49 days), vegetative growth, and reproductive parameters, with $V_2$ (Lalit) showing the shortest shoots. Flower initiation and fruit set occurred earliest in $B_1$ (42.39 and 60.59 days, respectively), while $V_1$ (Lucknow-49) exhibited early fruit maturity. $B_1$ treatment yielded the highest fruit set (68.67%) and retention (74.67%), with the $V_3B_1$ combination producing the heaviest fruits (117.72 g) and highest pulp-seed ratio (41.18). $B_1$ also led to the highest fruit count (117.78 fruits plant$^{-1}$), yield (12.54 kg plant$^{-1}$), and productivity (90.90 q ha$^{-1}$ with $V_1B_1$). Biochemical analysis confirmed superior fruit quality under $B_1$, with maximum total soluble solids (10.64°Brix), total sugars (6.57%), and ascorbic acid (178.31 mg 100 g$^{-1}$ pulp), and also superior quality with Lalit ($V_2$) highlighting its overall efficacy.

**KEYWORDS:** Branch bending, crop regulation, fruit quality, fruit yield, guava

***Citation* (VANCOUVER):** Kumar et al., Effect of Branch Bending on Fruit Production and Quality of Different Varieties of Guava (*Psidium guajava* L.). *International Journal of Bio-resource and Stress Management,* 2025; 16(8), 01-07. HTTPS://DOI.ORG/10.23910/1.2025.6255.



***Data Availability Statement:*** Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

***Conflict of interests:*** The authors have declared that no conflict of interest exists.

RECEIVED on 27th March 2025 RECEIVED in revised form on 19th July 2025 ACCEPTED in final form on 05th August 2025 PUBLISHED on 18th August 2025

## 1. INTRODUCTION

Guava (*Psidium guajava* L.), commonly known as the "Apple of the Tropics" or the "poor man's apple," is one of the most economically and nutritionally important fruit crops cultivated extensively in tropical and subtropical regions belonging to the family Myrtaceae. Guava possesses a diploid chromosome number of 2n=22 (Saini et al., 2018). The plant is believed to have originated in tropical America, spanning from Mexico to Peru, and was introduced to India by the Portuguese in the $17^{th}$ century (Singh, 1995).

Guava flowers and fruits year-round under suitable climatic conditions. According to Shukla et al. (2008), Guava exhibits three primary flowering seasons in India: Ambe Bahar (February-March), producing fruit in July-August; Mrig Bahar (June-July), with harvest time during October-December; and Hasth Bahar (October-November), yielding fruits between February-April. In Bihar, the crop generally flowers twice annually, once in spring (March-April) and another during the rainy season (July-August).

Guava holds a prominent position among fruit crops, ranking fourth after mango, citrus, and banana in terms of cultivation area and production (Samant and Kishore, 2019; Singh et al., 2015). It exhibits remarkable adaptability to a variety of soil types and climatic conditions, making it ideal for both smallholder and commercial farming systems (Pasha et al., 2019; Pio et al., 2018). Major guava-producing countries include India, Thailand, Brazil, China, Egypt, South Africa, and the USA (Parvez et al., 2018). In India, guava is cultivated over an area of 351.90 th ha, yielding 5364 th mt. In Bihar alone, the crop spans 30.59 th ha with a production of 435.69 th mt (Anonymous, 2023a).

Nutritionally, guava is a powerhouse, especially valued for its high vitamin C content (299 mg $(100 g)^{-1}$ pulp), ranking third after barbados cherry and aonla (Gupta, 2014). It is also a good source of vitamin A, thiamine (vitamin $B_1$), riboflavin (vitamin $B_2$), iron, phosphorus, calcium, and dietary fiber (Cogill, 2015). Guava contains two to five times more vitamin C than oranges and is second only to fig in fiber content among fruits (Kumar and Kumar, 2013; Muthukumar and Selvakumar, 2017). Its high pectin content makes it suitable for processing into products such as jams, jellies, syrups, beverages, marmalades, and chutneys (Kanwal et al., 2016; Singh et al., 2018; Kumari et al., 2020).

Despite its wide cultivation, productivity in Bihar remains suboptimal due to poor crop management and inadequate canopy regulation. A major concern among growers is low fruit set and quality, which can be mitigated through canopy management practices like branch bending. This technique is known to reduce shoot vigour by altering the orientation of branches, thereby improving light penetration, flower induction, and fruit quality (Nandi et al., 2017). Studies on guava cv. Sardar and other fruit crops such as tangerine and wax apple have confirmed that bending branches at specific angles enhances flowering and fruiting (Tamang et al., 2021; Azizu et al., 2016; Khandaker et al., 2016).

Branch bending induces physiological changes by increasing wood tension and reducing phloem flow, thereby slowing the translocation of photosynthates and raising the carbon-to-nitrogen (C:N) ratio in the bent shoots. This condition promotes the development of floral buds and improves fruit set (Sarkar et al., 2005; Ito et al., 1999; Samant et al., 2016). In contrast, vertical shoots typically exhibit vegetative growth with reduced flowering.

Considering the flowering behavior and productivity challenges in Bihar, the present study is aimed at evaluating the effect of branch bending on the yield and quality attributes of different guava cultivars. This research will contribute valuable insights toward improving guava production through effective canopy management practices.

## 2. MATERIALS AND METHODS

The experiment was conducted during January to August, 2024 at Research Farm, Nalanda College of Horticulture, Noorsarai, Nalanda (Bihar). The experimental site was situated at 67 m above mean sea level, latitude 25°32'26'' N and longitude 85°50'35'' E. The soil was well-drained sandy loam with high fertility and a flat surface. The region come under the subtropical semi-arid climatic zone with an average annual rainfall of approximately 1035 mm. The experimental site experienced three distinct seasons: summer (March to June), rainy season (mid-June to October), and winter (November to February), with temperatures ranging from a minimum of 7.6°C in January to a maximum of 38.6°C in May.

The experiment was laid out in a Factorial Randomized Block Design (FRBD) with 12 treatment combinations and three replications, using eight-year-old guava plants of three varieties: Lucknow-49, Lalit, and Allahabad Safeda, spaced at 4×4 $m^2$. The treatment combinations included branch bending and pruning- $B_0$: (Without bending and pruning), $B_1$: Bending of lateral branches and partial removal of older leaves, $B_2$: One leaf pair pinching with complete removal of old leaves, $B_3$: Removal of leaves, keeping 10–12 pairs intact at the terminal portion. Each treatment was applied in combination with the three varieties: $V_1$ (Lucknow-49), $V_2$ (Lalit), and $V_3$ (Allahabad Safeda), resulting in 12 combinations ($T_1$ to $T_{12}$).

### 2.1. *Treatment application and observations*

Bending and pruning treatments were imposed on the plants during the 1st week of February 2024. Bending was executed by gently defoliating the shoots and bending the branches with ropes until the emergence of new flushes. Observations were recorded for vegetative parameters viz. days to shoot emergence and shoot length at 15 days interval, length of shoot at flowering, reproductive traits i.e. days to first flower initiation, 50% flowering, fruit set, pea stage, marble stage and yield parameters like per cent fruit set and retention as well as yield $ha^{-1}$. Physical attributes (fruit size, diameter, volume, seed index, pulp-seed ratio) and biochemical properties (TSS, reducing, non-reducing, total sugars, ascorbic acid and acidity) were also measured to evaluate the effect of branch bending and pruning on guava varieties.

### 2.2. *Physico-chemical analysis*

Four representative fruit samples from each replication were used for chemical analysis for total soluble solids (°Brix), were measured using a hand refractometer calibrated at 20°C, and the results were expressed in degrees Brix (°B). Titratable acidity was determined by titrating fresh fruit juice against 0.1 N sodium hydroxide using phenolphthalein as an indicator, and the values were expressed as percent citric acid equivalents, following the Anonymous (2023b) method. Total and reducing sugars were estimated using the Lane and Eynon volumetric method with Fehling's A and B solutions, employing methylene blue as an internal indicator. Non-reducing sugars were obtained by subtracting the reducing sugars from the total sugars. The vitamin C content was analyzed using the method described by Ranganna (1986), with metaphosphoric acid ($HPO_3$) used as an extractant, and results expressed in mg 100 $g^{-1}$ of fresh weight. The data were analyzed using ANOVA for Factorial Randomized Block Design (FRBD) to determine the significance of treatment effects at a $p$=0.05 level of probability.

## 3. RESULTS AND DISCUSSION

### 3.1. *Vegetative growth parameters*

The observations on vegetative growth parameters have been presented in Table 1 which revealed that the various guava varieties, bending and pruning treatments were significantly influenced the days taken to shoot emergence and shoot length at 15 days intervals. Allahabad Safeda ($V_3$) showed the minimum days taken to shoot emergence (17.15 days) as compared to Lalit ($V_2$) with 19.63 days, while $B_1$ (bending of lateral branches with partial removal of older leaves) resulted in the earliest shoot emergence (12.49 days). The findings of this study are consistent with those reported by Devy et al. (2023), who observed that branch bending reduces auxin levels in the shoot tissue, which in turn promotes higher cytokinin activity in the lateral shoots of Mandarin citrus. Similar outcomes were noted in the work of Azizu et al. (2016) on the "Borneo Prima" orange cultivar and Zhang et al. (2017) in apples, where branch bending led to an increase in the emergence of new shoots. At 15, 30, and 45 days of shoot emergence, Lalit ($V_2$) recorded the shortest shoot length at 45 days (5.80 cm) among the

Table 1: Effect of varieties, bending and pruning and their interaction on vegetative growth parameters in guava

| Treatment | Number of days to shoot emergence (day) | Length of shoot at 15 days (cm) | Length of shoot at 30 days (cm) | Length of shoot at 45 days (cm) | Length of shoot at flowering (cm) |
|---|---|---|---|---|---|
| Varieties (V) | | | | | |
| $V_1$ | 17.93 | 1.26 | 4.01 | 6.20 | 7.71 |
| $V_2$ | 19.63 | 1.24 | 3.99 | 5.80 | 7.30 |
| $V_3$ | 17.15 | 1.29 | 4.04 | 6.55 | 8.05 |
| SEm± | 0.49 | 0.01 | 0.01 | 0.05 | 0.05 |
| CD (5%) | 1.45 | 0.03 | 0.03 | 0.14 | 0.14 |
| Bending and pruning (B) | | | | | |
| $B_0$ | 22.24 | 1.25 | 4.00 | 6.16 | 7.66 |
| $B_1$ | 12.49 | 1.12 | 3.86 | 5.48 | 6.98 |
| $B_2$ | 17.80 | 1.37 | 4.13 | 6.74 | 8.25 |
| $B_3$ | 20.40 | 1.31 | 4.06 | 6.36 | 7.86 |
| SEm± | 0.57 | 0.01 | 0.01 | 0.06 | 0.06 |
| CD (5%) | 1.68 | 0.04 | 0.04 | 0.17 | 0.16 |
| Interaction (V×B) | | | | | |
| $V_1B_0$ | 21.52 | 1.20 | 3.95 | 6.10 | 7.60 |
| $V_1B_1$ | 13.05 | 1.13 | 3.87 | 5.67 | 7.17 |
| $V_1B_2$ | 17.36 | 1.36 | 4.12 | 6.80 | 8.33 |
| $V_1B_3$ | 19.77 | 1.25 | 4.00 | 6.25 | 7.75 |
| $V_2B_0$ | 23.62 | 1.30 | 4.05 | 5.85 | 7.35 |
| $V_2B_1$ | 13.45 | 1.02 | 3.77 | 4.76 | 6.26 |
| $V_2B_2$ | 19.37 | 1.37 | 4.13 | 6.51 | 8.01 |
| $V_2B_3$ | 22.06 | 1.33 | 4.08 | 6.10 | 7.60 |
| $V_3B_0$ | 21.59 | 1.24 | 3.99 | 6.52 | 8.02 |
| $V_3B_1$ | 10.95 | 1.20 | 3.95 | 6.01 | 7.51 |
| $V_3B_2$ | 16.67 | 1.38 | 4.13 | 6.90 | 8.41 |
| $V_3B_3$ | 19.37 | 1.35 | 4.10 | 6.75 | 8.25 |
| SEm± | 0.98 | 0.02 | 0.02 | 0.10 | 0.10 |
| CD | NS | 0.06 | 0.07 | 0.29 | 0.28 |

$V_1$: Lucknow-49; $V_2$: Lalit; $V_3$: Allahabad Safeda; $B_0$: Without bending and pruning; $B_1$: Bending of lateral branches and partial removal of older leaves; $B_2$: One leaf pair pinching with complete removal of old leaves; $B_3$: Removal of leaves; keeping 10 to 12 pairs of leaves intact at the terminal portion of each branch; CD: CD ($p$=0.05) varieties while $B_1$ showed the minimum shoot length at 45 days (5.48 cm) among bending and pruning treatments. The interaction effect of varieties along with bending and pruning treatment showed significant difference among length of shoot at 45 days wherein combination treatment of $V_2B_1$ (Lalit+Bending of lateral branches and partial removal of older leaves) produced the minimum shoot length (4.76 cm) while the treatment combination of $V_3B_2$ (Lucknow-49+One leaf pair pinching with complete removal of old leaves) produced the maximum shoot length (6.90 cm) at 45 days after shoot emergence. The findings align with those of Samant et al. (2016), who reported that bending and selective pruning treatments reduce apical dominance and internode elongation, leading to more compact growth reflecting a desirable compact growth pattern.

### 3.2. *Flowering and fruiting characteristics*

Significant variation was observed in flowering and fruiting characteristics among the varieties and treatments result presented in Table 2. Lucknow-49 ($V_1$) took minimum days for flowering (42.43 days), 50% flowering (53.28 days), fruit set (61.54 days), fruit at pea stage (69.48 days), fruit at marble stage (111.54 days) and fruit at the harvesting stage (173.06 days) while Lalit ($V_2$) took maximum days for flowering (55.37 days), indicating that bending could effectively induce early flowering by altering the hormonal distribution and promoting better nutrient mobilization towards reproductive organs (Nandi et al., 2017). It was also suggested that branch bending enhanced the sink strength and source capacity by permitting increased light penetration within the plant canopy and sustaining higher amounts of endogenous cytokinin, which in turn could have hastened the growing process of floral bud and decreased the time of flowering (Azizu et al., 2016; Han et al., 2008).

The $B_1$ treatment significantly reduced the time to flower initiation (42.39 days) and also shortened the duration to days to 50% flower (53.10 days), fruit set (60.59 days) and development stages, leading to earlier harvest maturity (171.41 days). Interaction treatments showed that the combination of $V_1$ (Lucknow-49) and $B_1$ resulted in the earliest flower initiation (37.81 days), fruit set (56.34 days), pea stage (64.27 days) and at the marble stage (106.34 days). This finding aligns with research by Tamang et al. (2021), which suggests that bending treatments enhance carbohydrate translocation to developing fruits, expediting the transition from flowering to fruit set. According to Bagchi et.al. (2008), proline biosynthesis might be stimulated an episode of stress, therefore profuse flower bud initiation occurs in the stressed plants which terminates in the higher yield.

### 3.3. *Yield parameters*

Yield parameters, data presented in Table 3 which included fruit set (%), fruit retention (%), number of fruits plant$^{-1}$, yield plant$^{-1}$, and yield ha$^{-1}$ showed significant improvement with bending and pruning treatments.

Table 2: Effect of varieties, bending, pruning and their interaction on flowering and fruiting parameters in guava

| Treatment | Days to first flower initiation | Days to 50% flower | Days to fruit set | Days to fruit at pea stage | Days to fruit at marble stage | Days to fruit at harvesting stage |
|---|---|---|---|---|---|---|
| Varieties (V) | | | | | | |
| $V_1$ | 42.43 | 53.28 | 61.54 | 69.48 | 111.54 | 173.06 |
| $V_2$ | 55.37 | 65.64 | 73.66 | 81.84 | 123.66 | 177.01 |
| $V_3$ | 46.29 | 56.89 | 64.74 | 73.17 | 114.74 | 182.00 |
| SEm± | 0.72 | 0.74 | 0.93 | 0.97 | 0.93 | 1.07 |
| CD | 2.12 | 2.19 | 2.74 | 2.86 | 2.74 | 3.17 |
| Bending and pruning (B) | | | | | | |
| $B_0$ | 53.88 | 64.48 | 73.08 | 81.01 | 123.08 | 183.45 |
| $B_1$ | 42.39 | 53.10 | 60.59 | 69.19 | 110.59 | 171.41 |
| $B_2$ | 46.77 | 57.37 | 65.08 | 73.13 | 115.08 | 175.24 |
| $B_3$ | 49.08 | 59.46 | 67.84 | 75.99 | 117.84 | 179.33 |
| SEm± | 0.83 | 0.86 | 1.07 | 1.12 | 1.07 | 1.24 |
| CD | 2.45 | 2.52 | 3.16 | 3.30 | 3.16 | 3.66 |
| Interaction (V×B) | | | | | | |
| $V_1B_0$ | 48.90 | 60.50 | 68.77 | 75.70 | 118.77 | 179.03 |
| $V_1B_1$ | 37.81 | 48.74 | 56.34 | 64.27 | 106.34 | 168.61 |
| $V_1B_2$ | 40.23 | 50.50 | 59.10 | 67.37 | 109.10 | 170.70 |
| $V_1B_3$ | 42.77 | 53.37 | 61.97 | 70.57 | 111.97 | 173.90 |
| $V_2B_0$ | 61.14 | 71.07 | 80.34 | 89.27 | 130.34 | 183.94 |
| $V_2B_1$ | 49.17 | 59.44 | 67.04 | 75.64 | 117.04 | 169.97 |
| $V_2B_2$ | 54.21 | 64.81 | 71.74 | 79.67 | 121.74 | 173.67 |
| $V_2B_3$ | 56.97 | 67.24 | 75.51 | 82.77 | 125.51 | 180.44 |
| $V_3B_0$ | 51.59 | 61.86 | 70.12 | 78.06 | 120.12 | 187.39 |
| $V_3B_1$ | 40.19 | 51.12 | 58.39 | 67.66 | 108.39 | 175.66 |
| $V_3B_2$ | 45.87 | 56.80 | 64.40 | 72.34 | 114.40 | 181.34 |
| $V_3B_3$ | 47.50 | 57.77 | 66.03 | 74.63 | 116.03 | 183.63 |
| SEm± | 1.44 | 1.48 | 1.86 | 1.94 | 1.86 | 2.15 |
| CD | NS | NS | NS | NS | NS | NS |

$V_1$: Lucknow-49; $V_2$: Lalit; $V_3$: Allahabad Safeda; $B_0$: Without bending and pruning; $B_1$: Bending of lateral branches and partial removal of older leaves; $B_2$: One leaf pair pinching with complete removal of old leaves; $B_3$: Removal of leaves; keeping 10 to 12 pairs of leaves intact at the terminal portion of each branch; CD: CD ($p$=0.05)

Fruit set (%) and fruit retention (%) was recorded highest in Lucknow-49 (67.09 % and 73.09%, respectively) under $B_1$ treatment, indicating that branch bending positively influenced both flowering (68.67%) and fruit set (74.67%).

Among the varieties, Lucknow-49 had the highest number of fruits plant$^{-1}$ (124.34) and yield ha$^{-1}$ (75.25 q ha$^{-1}$).

Table 3: Effect of varieties, bending and pruning and their interaction on yield parameters in guava

| Treatment | Fruit set (%) | Fruit retention (%) | No. of fruit plant$^{-1}$ | Yield plant$^{-1}$ (kg) | Yield ha$^{-1}$ (q) |
|---|---|---|---|---|---|
| Varieties (V) | | | | | |
| $V_1$ | 67.09 | 73.09 | 124.34 | 12.04 | 75.25 |
| $V_2$ | 61.34 | 67.34 | 89.25 | 7.83 | 48.94 |
| $V_3$ | 63.01 | 69.01 | 107.50 | 11.58 | 72.38 |
| SEm± | 0.48 | 0.48 | 1.03 | 0.13 | 0.83 |
| CD | 1.40 | 1.40 | 3.03 | 0.39 | 2.45 |
| Bending and Pruning (B) | | | | | |
| $B_0$ | 58.78 | 64.78 | 97.23 | 8.85 | 55.31 |
| $B_1$ | 68.67 | 74.67 | 117.78 | 12.48 | 78.00 |
| $B_2$ | 65.45 | 71.45 | 108.56 | 10.70 | 66.88 |
| $B_3$ | 62.34 | 68.34 | 104.56 | 9.84 | 61.50 |
| SEm± | 0.55 | 0.55 | 1.19 | 0.15 | 0.96 |
| CD | 1.62 | 1.62 | 3.50 | 0.45 | 2.83 |
| Interaction (V×B) | | | | | |
| $V_1B_0$ | 62.67 | 68.67 | 110.34 | 9.92 | 62.00 |
| $V_1B_1$ | 71.33 | 77.33 | 138.67 | 14.55 | 90.94 |
| $V_1B_2$ | 68.00 | 74.00 | 127.33 | 12.47 | 77.94 |
| $V_1B_3$ | 66.34 | 72.34 | 121.00 | 11.46 | 71.63 |
| $V_2B_0$ | 55.67 | 61.67 | 82.00 | 6.79 | 42.44 |
| $V_2B_1$ | 66.67 | 72.67 | 97.33 | 9.27 | 57.94 |
| $V_2B_2$ | 63.34 | 69.34 | 90.34 | 7.98 | 49.88 |
| $V_2B_3$ | 59.67 | 65.67 | 87.34 | 7.37 | 46.06 |
| $V_3B_0$ | 58.00 | 64.00 | 99.34 | 9.97 | 62.31 |
| $V_3B_1$ | 68.01 | 74.01 | 117.34 | 13.81 | 86.31 |
| $V_3B_2$ | 65.00 | 71.00 | 108.00 | 11.82 | 73.88 |
| $V_3B_3$ | 61.01 | 67.01 | 105.33 | 10.88 | 68.00 |
| SEm± | 0.95 | 0.95 | 2.05 | 0.27 | 1.66 |
| CD | NS | NS | NS | 0.78 | 4.90 |

$V_1$: Lucknow-49; $V_2$: Lalit; $V_3$: Allahabad Safeda; $B_0$: Without bending and pruning; $B_1$: Bending of lateral branches and partial removal of older leaves; $B_2$: One leaf pair pinching with complete removal of old leaves; $B_3$: Removal of leaves; keeping 10 to 12 pairs of leaves intact at the terminal portion of each branch; CD: CD ($p$=0.05)

Table 4: Effect of varieties, bending and pruning and their interaction on physical properties of fruits in guava

| Treat-ment | Fruit size | | Wei-ght (g) | Fruit volume (cc) | Seed index (g) | Seed pulp ratio |
|---|---|---|---|---|---|---|
| | Polar length (cm) | Fruit diameter (cm) | | | | |
| Varieties (V) | | | | | | |
| $V_1$ | 5.55 | 4.78 | 96.85 | 93.13 | 2.07 | 24.34 |
| $V_2$ | 4.41 | 4.83 | 87.69 | 84.32 | 2.24 | 20.24 |
| $V_3$ | 4.83 | 5.40 | 107.70 | 103.56 | 1.60 | 35.52 |
| SEm± | 0.037 | 0.036 | 0.668 | 0.642 | 0.002 | 0.233 |
| CD | 0.110 | 0.108 | 1.972 | 1.896 | 0.006 | 0.686 |
| Bending and pruning (B) | | | | | | |
| $B_0$ | 4.54 | 4.75 | 91.01 | 87.51 | 2.08 | 23.45 |
| $B_1$ | 5.41 | 5.50 | 105.96 | 101.89 | 1.87 | 30.73 |
| $B_2$ | 4.95 | 4.89 | 98.58 | 94.79 | 1.94 | 27.26 |
| $B_3$ | 4.83 | 4.87 | 94.11 | 90.49 | 1.99 | 25.36 |
| SEm± | 0.043 | 0.042 | 0.772 | 0.741 | 0.002 | 0.268 |
| CD | 0.128 | 0.124 | 2.278 | 2.189 | 0.007 | 0.793 |
| Interaction (V×B) | | | | | | |
| $V_1B_0$ | 5.20 | 4.47 | 89.91 | 86.46 | 2.16 | 21.46 |
| $V_1B_1$ | 6.03 | 5.55 | 104.91 | 100.87 | 1.97 | 27.76 |
| $V_1B_2$ | 5.63 | 4.40 | 97.91 | 94.14 | 2.05 | 24.78 |
| $V_1B_3$ | 5.34 | 4.70 | 94.69 | 91.05 | 2.10 | 23.36 |
| $V_2B_0$ | 4.22 | 4.60 | 82.81 | 79.63 | 2.40 | 17.63 |
| $V_2B_1$ | 4.62 | 5.00 | 95.26 | 91.60 | 2.12 | 23.25 |
| $V_2B_2$ | 4.43 | 4.90 | 88.37 | 84.97 | 2.19 | 20.85 |
| $V_2B_3$ | 4.38 | 4.80 | 84.33 | 81.09 | 2.26 | 19.21 |
| $V_3B_0$ | 4.20 | 5.17 | 100.32 | 96.46 | 1.68 | 31.25 |
| $V_3B_1$ | 5.57 | 5.95 | 117.72 | 113.19 | 1.51 | 41.18 |
| $V_3B_2$ | 4.80 | 5.38 | 109.47 | 105.26 | 1.59 | 36.16 |
| $V_3B_3$ | 4.77 | 5.10 | 103.30 | 99.33 | 1.62 | 33.50 |
| SEm± | 0.075 | 0.073 | 1.336 | 1.284 | 0.004 | 0.465 |
| CD | 0.221 | 0.215 | NS | NS | 0.012 | 1.373 |

$V_1$: Lucknow-49; $V_2$: Lalit; $V_3$: Allahabad Safeda; $B_0$: Without bending and pruning; $B_1$: Bending of lateral branches and partial removal of older leaves; $B_2$: One leaf pair pinching with complete removal of old leaves; $B_3$: Removal of leaves; keeping 10 to 12 pairs of leaves intact at the terminal portion of each branch; CD: CD ($p$=0.05)

However, under the bending and pruning treatments, the $B_1$ treatment recorded the highest number of fruits plant$^{-1}$ (117.78) and yield ha$^{-1}$ (78.00 q ha$^{-1}$).

The interaction treatment of Lucknow-49 along with $B_1$

Table 5: Effect of varieties, bending and pruning and their interaction on biochemical parameters of fruits in guava

| Treatment | TSS (°Brix) | Total sugar (%) | Reducing sugar (%) | Non-reducing sugar (%) | Acidity (%) | Ascorbic acid (mg (100 g)$^{-1}$ pulp) |
|---|---|---|---|---|---|---|
| Varieties (V) | | | | | | |
| $V_1$ | 9.98 | 6.38 | 3.99 | 2.39 | 0.38 | 169.92 |
| $V_2$ | 10.60 | 6.58 | 4.24 | 2.33 | 0.36 | 173.57 |
| $V_3$ | 9.68 | 5.93 | 3.54 | 2.40 | 0.40 | 167.54 |
| SEm± | 0.07 | 0.05 | 0.03 | 0.06 | 0.004 | 1.13 |
| CD | 0.22 | 0.14 | 0.08 | NS | 0.01 | 3.34 |
| Bending and pruning (B) | | | | | | |
| $B_0$ | 9.50 | 5.99 | 3.59 | 2.40 | 0.40 | 161.75 |
| $B_1$ | 10.64 | 6.57 | 4.20 | 2.37 | 0.35 | 178.31 |
| $B_2$ | 10.24 | 6.36 | 3.97 | 2.38 | 0.38 | 173.35 |
| $B_3$ | 9.97 | 6.27 | 3.93 | 2.34 | 0.39 | 167.98 |
| SEm± | 0.08 | 0.05 | 0.03 | 0.07 | 0.004 | 1.31 |
| CD | 0.25 | 0.16 | 0.09 | NS | 0.01 | 3.85 |
| Interaction (V×B) | | | | | | |
| $V_1B_0$ | 9.50 | 6.11 | 3.72 | 2.38 | 0.40 | 160.35 |
| $V_1B_1$ | 10.50 | 6.68 | 4.33 | 2.35 | 0.35 | 178.24 |
| $V_1B_2$ | 10.11 | 6.41 | 4.01 | 2.39 | 0.38 | 174.63 |
| $V_1B_3$ | 9.81 | 6.32 | 3.89 | 2.43 | 0.39 | 166.46 |
| $V_2B_0$ | 9.81 | 6.30 | 3.89 | 2.41 | 0.39 | 165.63 |
| $V_2B_1$ | 11.30 | 6.80 | 4.41 | 2.39 | 0.33 | 181.23 |
| $V_2B_2$ | 10.80 | 6.62 | 4.23 | 2.36 | 0.35 | 175.57 |
| $V_2B_3$ | 10.50 | 6.60 | 4.43 | 2.17 | 0.36 | 171.86 |
| $V_3B_0$ | 9.20 | 5.57 | 3.15 | 2.41 | 0.42 | 159.25 |
| $V_3B_1$ | 10.10 | 6.22 | 3.85 | 2.37 | 0.37 | 175.46 |
| $V_3B_2$ | 9.81 | 6.05 | 3.66 | 2.39 | 0.40 | 169.84 |
| $V_3B_3$ | 9.61 | 5.89 | 3.48 | 2.41 | 0.41 | 165.62 |
| SEm± | 0.15 | 0.09 | 0.05 | 0.13 | 0.01 | 2.26 |
| CD | NS | NS | 0.15 | NS | NS | NS |

$V_1$: Lucknow-49; $V_2$: Lalit; $V_3$: Allahabad Safeda; $B_0$: Without bending and pruning; $B_1$: Bending of lateral branches and partial removal of older leaves; $B_2$: One leaf pair pinching with complete removal of old leaves; $B_3$: Removal of leaves; keeping 10 to 12 pairs of leaves intact at the terminal portion of each branch; CD: CD ($p$=0.05)

achieved the maximum yield (90.94 q ha$^{-1}$), highlighting the superior response of this variety to branch bending in terms of yield enhancement. Similar outcomes were also reported by Tamang et al. (2021), who demonstrated that bending and pruning increased flowering and fruit set, contributing to higher yields.

### 3.4. *Physical parameters*

The data on physical parameters such as fruit size (polar length and diameter), fruit weight, fruit volume and seed index were significantly influenced by varieties, bending and pruning treatments have been presented in Table 4. The keen observation of the data revealed that the maximum weight (107.70 g) was recorded in Allahabad Safeda. The maximum fruit length (5.41 cm) and fruit weight (105.96 g) were recorded in $B_1$ treatment. Similar findings were reported by Patel et al. (2017), who noted that branch bending increases fruit size and quality by enhancing photosynthetic efficiency and assimilate translocation. The lowest seed index (1.60 g) and highest seed-pulp ratio (35.52) were also recorded in Allahabad Safeda whereas lowest seed index (1.87 g) and highest pulp seed ratio (30.73) was recorded in $B_1$ treatment.. In the interaction highest fruit polar length (6.03 cm) and diameter (5.55 cm) was found in $V_1B_1$ (Lucknow-49+Bending of lateral branches and partial removal of older leaves). The results were demonstrating that bending improved the physical quality of guava fruits. These findings aligned with Meena et al. (2016), who noted that bending techniques improved fruit quality by enhancing the pulp-to-seed ratio.

### 3.5. *Biochemical analysis*

Biochemical parameters finding presented in table 5 including total soluble solids (TSS), total sugar, reducing sugar, and ascorbic acid content, were significantly influenced by the treatments. Lalit had the highest TSS (10.60°Brix), total sugar content (6.58%), and ascorbic acid (173.57 mg 100 g$^{-1}$ pulp) while $B_1$ treatment consistently enhanced these qualities, with the highest TSS (10.64°Brix), total sugar (6.57%) and ascorbic acid content (178.31 mg 100 g$^{-1}$ pulp). The lowest acidity was observed in Lalit and under $B_1$ treatment, indicating improved fruit quality, an outcome supported by Sarkar et al. (2005), who noted the increase in biochemical quality with bending treatments.

## 4. CONCLUSION

Branch bending, especially bending of lateral branches with partial removal of older leaves ($B_1$), significantly improves guava growth, yield, and fruit quality. Lucknow-49 showed the best response with early flowering and highest yield, while Lalit produced superior quality fruits. The $V_1B_1$ treatment emerged as the most effective. Overall, branch bending was a promising, sustainable technique for guava canopy management, offering a practical, cost-effective strategy to enhance productivity and fruit quality across different guava cultivars.

## 5. REFERENCES

Anonymous, 2023a. National Horticulture Board (NHB) Database. Available from: https://nhb.gov.in/. Accessed on: 20th June, 2024.

Anonymous, 2023b. Official Methods of Analysis (22th Edn.). Association of Official Analytical Chemists, Washington, D.C., USA. Available from: https://www.aoac.org/official-methods-of-analysis/. Accessed on: 02nd May, 2024.

Azizu, M.N., Poerwanto, R., Suhartanto, M., Suketi, K., 2016. Bending and fertilization in transition period of Mandarin Citrus cv. Borneo Prima in swamp land Paser Regency East Kalimantan. Jurnal Hortikultura 26, 81–88.

Bagchi, T.B., Sukul, P., Ghosh, B., 2008. Biochemical changes during off-season flowering in guava (*Psidium guajava* L.) induced by bending and pruning. Journal of Tropical Agriculture 46(1–2), 64–66

Cogill, B., 2015. Contributions of indigenous vegetables and fruits to dietary diversity and quality. Acta Horticulturae 1102, 213–228.

Devy, N.F., Hardiyanto, Sugiyatno, A., Mufidah, L., 2023. Manipulation of flowering and fruiting induction through branch bending and fertilizer application in mandarin citrus cv. Batu 55. In: IOP Conference Series: Earth and Environmental Science, 1287.

Gupta, S.N., 2014. Instant horticulture. Jain Brothers, New Delhi, pp. 206.

Han, M.Y., Li, Y.W., Fan, C.H., Zhao, C.P., 2008. Effects of branch bending angle on physiological characteristics and fruit quality of Fuji apple. Acta Horticulturae Sinica 35, 1345–1350.

Kanwal, N., Randhawa, M.A., Iqbal, Z., 2016. A review of production, losses and processing technologies of guava. Asian Journal of Agriculture and Food Sciences 4(2), 96–101.

Khandaker, M.M., Idris, N.S., Siti, Z.I., Majrashi, A., Alebedi, A., Mat, N., 2016. Causes and prevention of fruit drop of Syzygium samarangense (Wax Apple): a review. Advances in Environmental Biology 10(11), 112–124.

Kumari, P., Mankar, A., Karuna, K., Homa, F., Meiramkulova, K., Siddiqui, M.W., 2020. Mineral composition, pigments, and postharvest quality of guava cultivars commercially grown in India. Journal of Agriculture and Food Research 2, 100061.

Meena, K.R., Maji, S., Kumar, S., Verma, S., 2016. Influence of shoot pruning for crop regulation and improving fruit yield of guava. The Bioscan 11(2), 1355–1359.

Muthukumar, P., Selvakumar, R., 2017. Glaustas Horticulture. New Vishal Publications, New Delhi, pp. 143.

Nandi, P., Roy, D., Ghosh, B., Kundu, S., 2017. Effect of bending of shoots on flowering, yield and quality of guava cultivar Khaja. Journal Applied and Natural Science 9(3), 1365–1368.

Parvez, G.M., Shakib, U., Khokon, M., Sanzia, M., 2018. A short review on a nutritional fruit: guava. Toxicology Research 1(1), 1–8.

Pasha, M.K., Uddin, S.B., 2019. Minor edible fruits of Bangladesh. Bangladesh Journal of Plant Taxonomy 26(2), 299–313.

Pio, R., Souza, F.B.M.D., Kalcsits, L., Bisi, R.B., Farias, D.D.H., 2018. Advances in the production of temperate fruits in the tropics. Acta Scientiarum Agronomy 41, e39549.

Ranganna, S., 1986. Handbook of analysis and quality control for fruit and vegetable products (2nd Edn.). Tata McGraw-Hill Publishing Company Ltd., New Delhi, India.

Saini, H., Baloda, S., Saini, P., 2018. Effect of pruning on productivity of guava under high density plantation-A review. Current Journal of Applied Science and Technology, 1–12.

Samant, D., Kishore, K., 2019. Standardization of pruning for high density Sardar guava orchards under hot and humid climate of Eastern India. Indian Journal of Horticulture 76, 70–74.

Samant, D., Kishore, K., Singh, H.S., 2016. Branch bending for crop regulation in guava under hot and humid climate of eastern India. Journal of the Indian Society of Coastal Agricultural Research 34(1), 92–96.

Sarkar, A., Ghosh, B., Kundu, S., Sukul, P., 2005. Effect of shoot pruning and bending on yield and fruit quality in guava cv. L-49. Environment and Ecology 23(S3), 621–623.

Shukla, A.K., Kaushik, R.A., Pandey, D., Sarolia, D.K., 2008. In: Guava. Maharana Pratap University of Agriculture and Technology, Udaipur, pp. 1–34.

Singh, N., Sharma, D.P., Kumari, S., Kalsi, K., 2018. Techniques for crop regulation in guava–a review. International Journal of Farm Sciences 8(2), 131–135.

Singh, S.P., 1995. Commercial fruits. Kalyani Publishers, New Delhi, 148p.

Singh, V.K., Ravishankar, H., Singh, A., Soni, M.K., 2015. Pruning in guava (*Psidium guajava*) and appraisal of consequent flowering phenology using modified BBCH scale. Indian Journal of Agricultural Sciences 85, 1472–1476.

Tamang, P., Saha, T., Debnath, S., 2021. Effect of branch bending time on induction of shoot and flower bud, productivity and quality of guava var. Sardar (L-49). Journal of Crop and Weed 17(3), 83–90.

Zhang, M., Ma, F., Shu, H., Han, M., 2017. Branch bending affected floral bud development and nutrient accumulation in shoot terminals of 'Fuji' and 'Gala' apples. Acta Physiologiae Plantarum 39, 156.