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## Studies on floral bud development and flowering behaviour of guava (*Psidium guajava* L.)

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### Abstract

Guava (*Psidium guajava* L.) is an important and common fruit of the tropical and subtropical regions of the world and is known as the “Apple of Tropics”. The current study was carried out to investigate the floral biology of two important guava cultivars, Lucknow-49 and Lalit. The cultivar Lalit was the first to begin flowering (29th April) earlier than the cultivar L-49 (3rd May). Lalit had the longest flowering period of 51 days, while L-49 had the shortest flowering period of 43 days during the rainy season flowering. Both the cultivars came to full bloom during the first fortnight of May to mid-June. The flowers bear on the current season's growth in the axils of leaves either solitary or in cymes of two or three. The flowers are white. Floral buds passed through eight distinct stages in both cultivars. The cultivar Lalit (47 days) took more number of days than L-49 (38 days). Opening of flowers and dehiscence of anthers took place early in the morning hours in both the cultivars. The optimum time of anthesis was found from 5:30 AM to 9:30 AM with the peak period of anthesis from 5:30 to 6:30 AM in both the cultivars. The optimum time for anther dehiscence is 6:30 to 9:30 AM with the peak period of anther dehiscence from 7:30 to 9:30 AM in both the cultivars.

**Keywords:** Guava, floral bud, anthesis, duration of flowering, Lalit, L-49

### Introduction

Guava (*Psidium guajava* L.) is an important and common fruit of the tropical and subtropical regions of the world. It also occupies an important place in the horticultural wealth of our country. Guava is one of the most delicious tropical fruit crops worldwide and in India (Singh *et al* 2016)<sup>[15]</sup>. Botanically, it belongs to the order Myrtales and the family Myrtaceae, known as the “Apple of Tropics” or “poor man’s fruit”. (J S Bal and G S Dhaliwal 2004)<sup>[5]</sup>. Guava is one of the most popular fruits due to its comparatively low price, high nutrient value, good taste, and high health benefits than some other fruits (Tanwar *et al* 2014)<sup>[17]</sup>. It is one of the energetic fruits, grown in India's sub-humid, subtropical and tropical regions. However unknown, it is generally accepted that guava began spreading from Central America or southern Mexico (J S Bal 2014)<sup>[3]</sup>. It is reported to have been introduced into India by the Portuguese during the 17<sup>th</sup> century (Menzal and Paxton, 1985).

India is the number one in guava production in the world. Major guava-producing countries are India, Indonesia Mexico, China, Pakistan, Brazil, Malawi, Thailand, and Bangladesh. Worldwide production of guava is 54.73MT. In India, guava occupies an area of about 304 thousand ha with a production of 4.43 MT (Anon. 2021)<sup>[2]</sup>. In Punjab, guava was cultivated on a large scale in all districts, it occupied second place in the case of area and production after Kinnow. The districts are Patiala, Ludhiana, Sangrur, SAS Nagar, Ferozpur, Jalandhar, Mukatsar, Bathinda, Ropar and Amritsar are known for producing guava crop (Bal, 2014)<sup>[3]</sup>. In Punjab, guava covers an area of 9730 ha with a production of 219850 MT and a yield of 22596 kg per unit (Anonymous, 2021)<sup>[2]</sup>.

The information on bearing habits, floral morphology, biology, fruit drop, and fruit set is an essential pre-requisite for planning a successful hybridization program. Studies on these aspects will also be useful in understanding such problems as pollen sterility and varietal incompatibility. The flowering time, duration, anthesis, and dehiscence, etc. are useful indices of floral biology. Hence, the present studies were conducted with the following specific objectives:

1. To study the flowering behavior of important varieties of guava i.e. L-49 and Lalit.

2. To study the duration of floral bud development on different stages of important varieties of guava i.e. L-49 and Lalit.

### Material and Methods

The present investigation entitled “Studies on floral bud development and flowering behaviour of guava (*Psidium guajava* L.)” was carried out at Sri Guru Granth Sahib World University, Fatehgarh Sahib in 2022. For the present study, a total of 6 trees were taken, 3 trees of Sardar (L-49) and 3 trees of Lalit. The observations were recorded on the time and duration of flowering, time of anthesis, and time of dehiscence, in two guava cultivars Sardar (L-49) and Lalit. The details of materials to be used and methods to be employed are given as under:

#### 3.1 Experimental Site and Location

The experiment was conducted in a guava orchard at Fatehgarh Sahib. This city is located in Punjab at 30.6435 N and 76.3970 E, at a height of 246 meters above mean sea level. The state’s agro-climatic zone 3 (Central Plain Zone) encompasses this area.

#### 3.2 Planting Material

In the present investigation, six trees of guava were taken. Three trees, eight years old, of Lalit and three trees, eleven years old, of Sardar (L-49) which had good growth were selected. All the plants of both cultivars were provided with uniform recommended cultural practices.

#### 3.4 Climate and Weather

The climate of this region is classified as tropical, hot, and semi-arid which is mainly dry. Both summer and winter are severe except during the monsoon season. The temperature in this zone ranges from 7°C to 32°C. During June-July temperature exceeds from 40°C. The annual rainfall of the region is 692 mm. Monsoon rainfall contributes 79% of the annual rainfall in the region. The rainy season starts in the first week of May and lasts until the last week of September, with intermittent and occasionally heavy rainfall.

### 3. Results and Discussion

#### 3.1: Floral biology of guava cvs. Sardar (L-49) and Lalit

The data recorded to examine the floral biology of guava on time and duration of flowering, floral bud development, flowering behavior, anthesis, and dehiscence of rainy season crops are presented and discussed as follows.

##### 3.1.1 Time and duration of flowering

The perusal of data in Table 1 and Fig.1 indicates the time and duration of flowering. The beginning of flowering

during the rainy season in both cultivars occurred at different dates. The cultivar Lalit (29<sup>th</sup> April) started flowering earlier than the cultivar L-49 (3<sup>rd</sup> May) and had a flowering period of 51 days. The cultivar Lalit blooms begin at the end of April and last until the end of June. L-49 started in the first week of May and lasted until around mid-June. Lalit had the longest flowering period i.e. 51 days, whereas Sardar (L-49) had the shortest flowering period i.e. 43 days during the rainy season of flowering. Both the cultivars came to full bloom during the first fortnight of May to mid-June. The data recorded on flowering season revealed that the flowering in guava occurs in two flowering flushes i. e. during April-May and August-September. Under the sub-tropical conditions of Punjab, both the guava varieties under study were found to be flowering twice a year. In the present study, no variation was observed in the flowering season. Similar results were reported by Mitra and Sanyal (2004) that the two distinct seasons of flowering-April – May and August–September occur from which fruits ripen during rainy and winter season, respectively. The results recorded in the present study are not in agreement with the results of Singh (2000) who reported that the three flowering season in Northern India, namely summer, rainy, and autumn, with corresponding harvest periods in rainy, winter, and spring. Similarly, Ramteke *et al* (2015) [10] observed that guava tree flowers throughout the year, but the peak flowering is observed in 2 seasons, rainy crop (April - May) and winter crop (Aug - Sept). Shiva (2017) [13] also reported that the flowering season of guava depends on the climatic conditions.

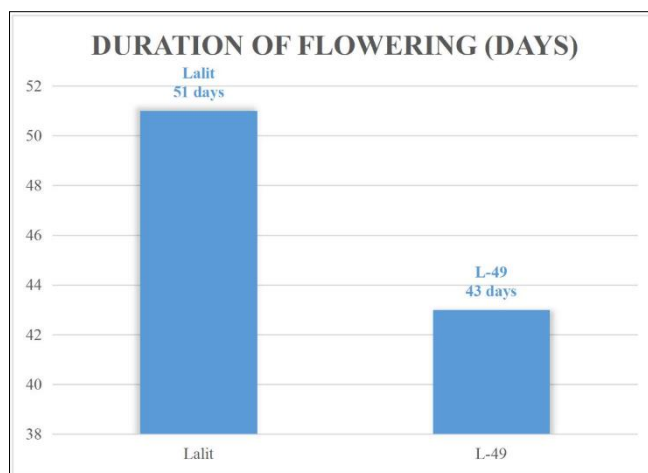
The flowering period can differ from one location to another. In northern India, guava flowers twice in a year (April-May and August - September). Similarly, Shiva (2017) [13] observed that flowering in different genotypes occurred during the 3<sup>rd</sup> and 4<sup>th</sup> week of April. They observed maximum flowering duration in Lalit and Shweta (52 days) followed by Hisar Surkha (51 days), Sasni Collection (51 days), and Arka Amulya (50 days), while, the shortest flowering duration was recorded in Hafsi Red (39 days). Sahoo *et al* (2017) [11] also reported that the duration of flowering across the rainy season (Ambe-Bahar) crop was shortest in Hisar Safeda and L-49 (44 days) followed by Banaras Round, Allahabad Safeda, and Sweta (48 days) and the longest in HRS Pride (52 days). The results of the present study are also in consonance with Kundu S and Mitra S K (1994) [7] who also reported that among different cultivars, Allahabad Safeda was first to bloom (24th April) followed by Snow White, Black guava, Lalit, Arka Amulya, and Hissar Surkha (25th April), although L-49 (Sardar) was last to flower (10th May).

**Table 1:** Time and duration of flowering in guava cultivars

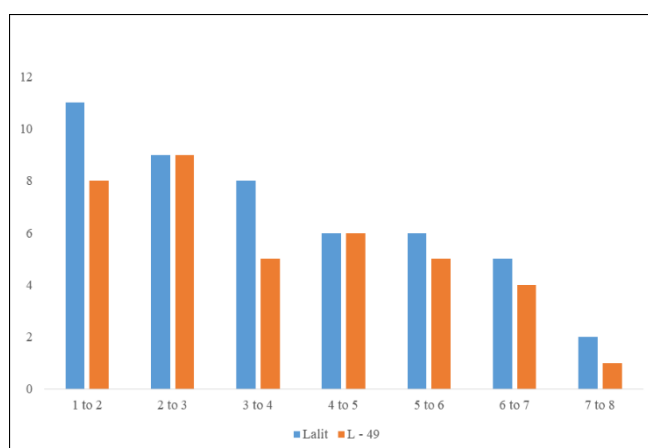
| Cultivars     | Rainy season crop   |                               | Duration of flowering (Days) |
|---------------|---------------------|-------------------------------|------------------------------|
|               | Flowering time      | Full bloom period (50% - 60%) |                              |
| Lalit         | 29 April to 19 June | 05 May to 12 June             | 51                           |
| Sardar (L-49) | 03 May to 15 June   | 12 May to 04 June             | 43                           |

**Table 2:** Number of days required for floral bud development in guava cultivars

| Cultivar        | No. of buds observed | No. of days required for passing from one stage to the other |        |        |        |        |        |        | Total no. of days |
|-----------------|----------------------|--|--------|--------|--------|--------|--------|--------|-------------------|
|                 |                      | 1 to 2   | 2 to 3 | 3 to 4 | 4 to 5 | 5 to 6 | 6 to 7 | 7 to 8 |                   |
| Lalit           | 30                   | 11   | 9      | 8      | 6      | 6      | 5      | 2      | 47                |
| Sardar (L – 49) | 30                   | 8  | 9      | 5      | 6      | 5      | 4      | 1      | 38                |
| Average         | 30.0                 | 9.5  | 9.0    | 6.5    | 6.0    | 5.5    | 4.5    | 1.5    | 42.5              |



**Fig 1:** Duration of flowering (days)



**Fig 2:** Duration of floral bud development in guava cultivars

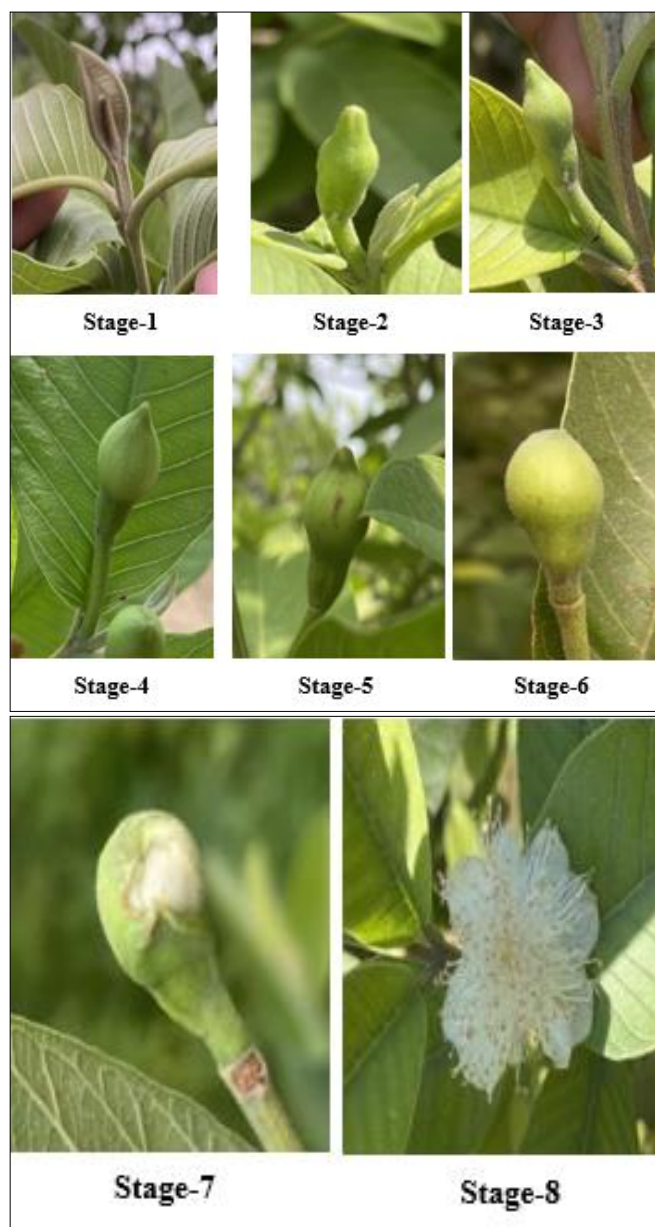
### 3.2: Floral bud development

The results reported in Tables 2 and Figure 2 revealed that there was no appreciable variation in the number of days required for flower bud development in both guava cultivars. The days required for complete bud growth were determined to be 38-47 days. The time required for passing from one stage of bud development to the next did not show appreciable cultivar variation. Flower buds passed through eight arbitrary stages of development from fully dormant to fully opened stages are presented in Table no. 2 which shows that in both the cultivars Lalit (47 days) took more days than Sardar (L-49) (38 days). In both the cultivars, the first stage to the second stage of development took more days and it was interesting to note that the number of days required for the completion of one stage to another stage reduced progressively during its development. (J S Bal 2018) [4]. Based on data (Table 2) it was observed that Lalit took 11 days to pass from the first stage to the second stage while Sardar (L-49) took 9 days. Both cultivars took 9 days to pass from the second to the third stage. However, for passing the 3<sup>rd</sup> to 4<sup>th</sup> stage Lalit took 8 days while Sardar (L-49) took 5 days. For the 4<sup>th</sup> to 5<sup>th</sup> stage both the cultivars took 6 days. Furthermore, for the 6<sup>th</sup> and 7<sup>th</sup> stages, both cultivars took 4 to 6 days. During the last stage of bud development, both cultivars took only 1 to 2 days.

The initiation of flower buds occurred simultaneously with the onset of the fresh vegetative flush. The formation of flower buds begins with the lowest visible size. Flower buds in guava were seen to go through eight arbitrary stages of development, from latent to fully open. The entire bud

development process can be divided into eight separate phases. Starting with the smallest visible flower buds, the entire development period can be divided into eight separate phases (Plate. 1). The first stage, buds varied in length from 2.08 mm to 2.38 mm in Sardar (L-49) and 2.13 mm to 2.23 mm in Lalit. These buds are protected by two thin green bracteoles. The second-stage buds measured 7.72 to 7.95 mm in Sardar (L-49) and 7.87 to 8.06 mm in Lalit, when they became conical with well-defined pedicels in 9 to 11 days. In 9 days, the buds reached the third stage, which was defined by the formation of a constriction below the middle. After another 5 to 6 days, the buds entered the fifth stage, when the top or free section began rounding and developing more rapidly than the lower or adnate part. The buds were 17.49 to 21.45 mm long in Sardar (L-49) and 18.03 to 21.23 mm long in Lalit when they reached the sixth stage, which took another 4 to 6 days. The bud's color stayed green till this stage. It took 3 to 5 days for the buds to reach the seventh stage when they were completely formed. At this stage, both cultivar's size and form were different. The buds ranged in length from 20.10 to 22.97 mm in both the cultivars. The splitting of the calyx, which occurred 13 to 26 hours before the flower opened, marked the eighth stage. The calyx detached as a cap or divided irregularly (Plate. 1). The results of the present study are quite similar to Kahlon *et al* (1987) [6] who observed that in Allahabad Safeda and Sardar (L-49), fruit buds passed through eight stages from dormant to the fully opened stage. Allahabad Safeda took 43 days while Sardar (L-49) took 40 or 38 days for the completion of all the stages during the autumn and spring

seasons, respectively. Also, Subramanyam *et al.* (1992) [16] reported that flower development took 36–45 days in *P. quadrangularis*, *P. molle*, *P. cattleianum*, and *P. friedrichsthalianum*.



**Fig 1:** Floral bud development stages in guava cultivars

### 3.3: Flowering Behavior

It was observed that the flowers are borne on the current season growth on the axils of leaves. The flowers are white. The flowers are solitary or in cymes of two or three. The flowering shoots are both terminal and lateral. Flowers appear on shoots that are two to three months old. The flowering behavior was the same in both the cultivars. Similarly, Ulemale *et al.* (2016) [18] revealed that the type of flower and color of the flower was solitary and white. The flowering habit of all genotypes was discovered to be solitary. The results of the present study are quite similar to Sharma *et al.* (2017) [12] who observed that the flowers are borne on the current season growth in the axils of leaves. The flowers are solitary or in cymes of two to three. The shoots bearing the flowers are terminal as well as lateral. The flowers appear on two to three months old shoot. Similarly, Shiva (2017) [13] observed that guava flowers are

white, hermaphrodite, solitary, or in 2–3 flowered cymes that emerge from the leaf axils. The findings of the present study are similar to that reported by Mishra (2021) in guava. He also reported that guava bears a single flower or cymes of two or three flowers on the current season's growth in the leaf axils. (Plate. 2)

### 3.4: Anthesis

The data presented in Table 3 and Figure 3 shows that the anthesis started at 5:30 AM and continued up to 11:30. The optimum time of anthesis was found from 5:30 AM to 9:30 AM with the peak period of anthesis from 5:30 to 6:30 AM in both the cultivars. It was revealed that the majority of flowers opened from 5:30 AM to 7:30 AM. None of the cultivars showed up before 5:30 AM and after 11:30 AM.

The anthesis was first started in Lalit. The maximum percentage of anthesis was recorded in Lalit (40.00%) followed by Sardar (L-49) (36.66%) from 5:30 AM to 6:30 AM. During 6:30 AM to 7:30 AM and 7:30 to 8:30 AM percentage of anthesis was 30.00 and 16.67 in Sardar (L-49) while 26.66 and 13.34 in Lalit. The minimum anthesis was observed from 8:30 AM to 9:30 AM i.e. 10.00% in Sardar (L-49) and 13.33% in Lalit. The lowest percentage of anthesis was observed during 9:30 to 11:30 AM with 0.00 to 06.67% in both the cultivars.

The results of the present study align with Singh (2004) who also studied anthesis in different genotypes of guava and found that it began at 4 a.m. and lasted until 11 a.m. All the genotypes had the best anthesis times from 5.00 AM to 9.00 AM, with the peak period from 6.00 AM to 8.00 AM. However, the least anthesis was observed between 10:00 and 11:00 AM. None of the genotypes had anthesis before 4.00 AM or after 11.00 AM.

Also, Sharma *et al.* (2013) reported that the peak period of anthesis is 5.30 AM to 6.30 AM and another dehiscence is 6.00 AM to 8.00 AM varied with cultivar and seasons of flowering. Similarly, Vishwakarma *et al.*, (2021) discovered that the time of anthesis and anther dehiscence differed between *Psidium* species. *P. chinensis* had early anthesis (05:00 to 06:30), *P. guineense* and *P. molle* had late anthesis (05:30 to 06:30), and *P. cattleianum* var. *cattleianum* and *P. cattleianum* var. *lucidum* had late anthesis (08:00 to 10: 00).

### 3.5 Dehiscence

The data is presented in Table.4, Figure.4 and Plate. 2 indicated that anther dehiscence commenced 15–20 minutes before or after anthesis i.e. at 5:30 AM, and continued up to 11:30 AM. It was observed that the optimum time for anther dehiscence is 6:30 to 9:30 AM with the peak period of anther dehiscence from 7:30 to 9:30 AM in both the cultivars. None of the cultivars showed anther dehiscence before 5:30 AM and after 11:30 AM. The maximum other dehiscence occurred between 7:30 AM to 8:30 AM in Sardar (L-49) (43.34%) followed by Lalit (36.67%). The least other dehiscence was recorded from 10:30 AM to 11:30 AM in Sardar (L-49) (00.00%) and Lalit (03.33%). The results conform to the findings of Dhaliwal and Singla (2002) who observed that anther dehiscence commenced just before the opening of a flower, i.e. at 5:30 AM, and continued up to 11:30 AM. The optimum time for anther dehiscence was from 5.30-9.30 AM, with the peak period being 6.30-8.30 AM in all the genotypes.

Similarly, Sharma *et al.* (2013) found that dehiscence occurred 15–30 minutes before flowering in various guava

cultivars, with the peak period of dehiscence occurring between 6.00 and 9.00 AM. Shiva (2017) [13] also reported that the dehiscence of anthers starts 15–20 minutes after the opening. In a majority of the cultivars, peak dehiscence time is 6.00–8.00 AM. In *P. friedrichsthalianum*, peak

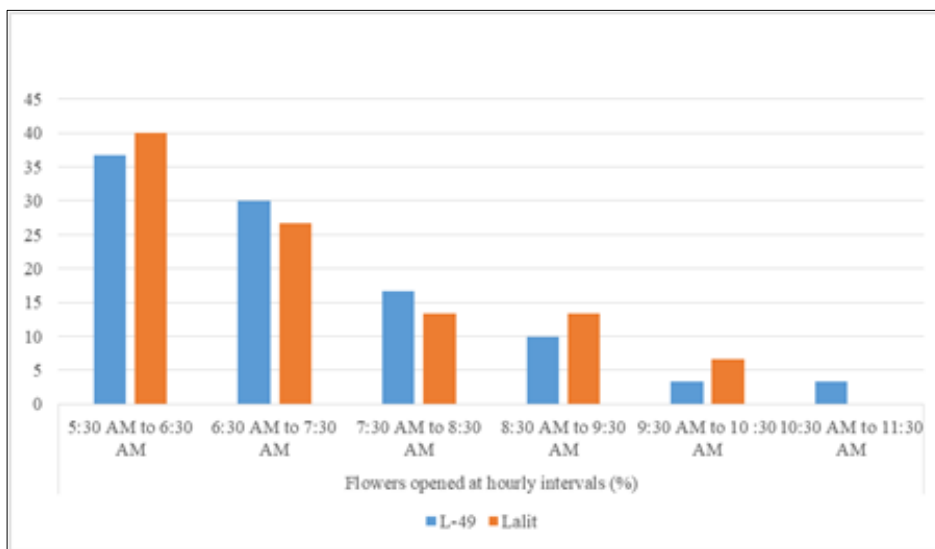
dehiscence occurs between 7.00 and 9.00 AM, while in *P. pumilum*, it is between 9.00 and 11.00 AM. anthesis timing of all the genotypes was reported to be very similar to one another.

**Table 3:** Time of anthesis in guava cultivars

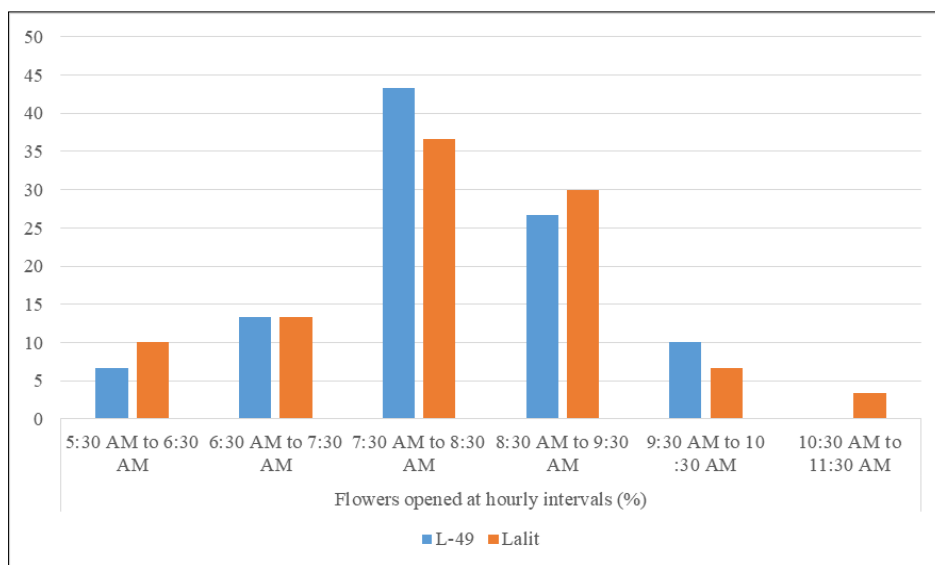
| Cultivar      | No. of buds observed | Flowers opened at hourly intervals (%) |                    |                    |                    |                    |                     |
|---------------|----------------------|--|--------------------|--------------------|--------------------|--------------------|---------------------|
|               |                      | 5:30 AM To 6:30 AM                     | 6:30 AM to 7:30 AM | 7:30 AM to 8:30 AM | 8:30 AM to 9:30 AM | 9:30 AM To 10:30AM | 10:30AM to 11:30 AM |
| Sardar (L-49) | 30                   | 36.66                                  | 30.00              | 16.67              | 10.00              | 03.33              | 03.33               |
| Lalit         | 30                   | 40.00                                  | 26.66              | 13.34              | 13.33              | 06.67              | 00.00               |
| Average       | 30                   | 38.33                                  | 28.33              | 15.05              | 11.66              | 05.00              | 03.33               |

**Table 4:** Time of dehiscence of guava cultivars

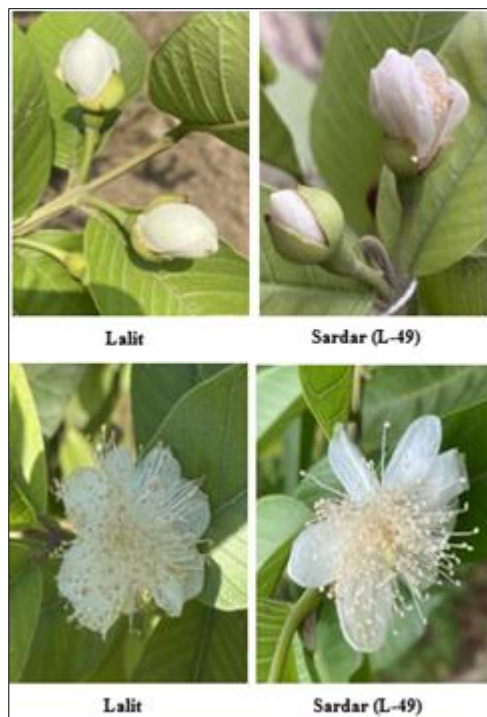
| Cultivar      | No. of buds observed | Flowers dehised at hourly intervals (%) |                    |                    |                    |                     |                      |
|---------------|----------------------|---|--------------------|--------------------|--------------------|---------------------|----------------------|
|               |                      | 5:30 AM to 6:30 AM                      | 6:30 AM to 7:30 AM | 7:30 AM to 8:30 AM | 8:30 AM to 9:30 AM | 9:30 AM to 10:30 AM | 10:30 AM to 11:30 AM |
| Sardar (L-49) | 30                   | 06.67                                   | 13.34              | 43.34              | 26.67              | 10.00               | 00.00                |
| Lalit         | 30                   | 10.00                                   | 13.34              | 36.67              | 30.00              | 06.67               | 03.33                |
| Average       | 30.00                | 08.33                                   | 13.34              | 40.00              | 28.33              | 08.33               | 03.33                |



**Fig 3:** Time of anthesis in guava cultivars



**Fig 4:** Time of anther dehiscence in guava cultivars



**Fig 5:** Anthesis and Dehiscence in guava cultivars

### Conclusion

After analyzing the floral biology parameters, in two important cultivars Lalit and Sardar (L-49), it is concluded that the cultivar Lalit was the earliest to start flowering and the maximum duration of flowering was noticed in Lalit (51 days) than Sardar (L-49) (43 days). Flower buds pass through eight arbitrary stages of development from fully dormant to fully opened stages. The optimum time for anthesis was noticed from 5.30 AM to 7.30 AM and the peak period of anthesis varied significantly in both the cultivars.

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