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# Effect of different tree spacings on microclimate and vegetative behaviour of guava cv. Shweta

**Himanshu Chawla, Naresh Kumar Arora, Karandeep Kaur and Rakesh Meena**

## Abstract
The present investigation on the effect of different tree spacings on microclimate and vegetative behaviour of guava cv. Shweta was carried out to study how the vegetative growth behaviour of guava at various planting densities was affected by changes in the canopy microclimate. With the increase in plant density from 333 (6x5 m) to 833 (4x3 m) plants per hectare area, the solar radiation interception in plant canopies was found to decrease during both the rainy and winter seasons. Similarly, by decreasing the number of plants per unit area, the average canopy temperature increased, while the relative humidity in the canopy decreased. However, the microclimatic conditions in the spacing of 6x5 m and 5x5 m did not vary to a greater extent. Growth of vegetative characters in terms of stock and scion girth, tree spread (EW and NS) and canopy volume increased with a decrease in plant density, while tree height increased with an increase in plant density. The planting density of 4x3 m and 4x4 m spacing was not observed to be encouraging because of insufficient canopy microclimatic conditions and insufficient solar radiation penetration. The plant densities of 333 and 400 plants/ha were discovered superior during both rainy and winter seasons due to optimal microclimate and maximum radiation absorption in the orchard, which promotes better vegetative growth. It may be concluded that guava planted at 5x5 m (400 trees/ acre) had significantly optimal solar radiation interception, canopy temperature and relative humidity. Which enhances better vegetative growth as compared to trees planted at recommended spacing i.e 6x5 m.

**Keywords:** Guava, Shweta, high density planting, spacing, microclimate, vegetative growth

## Introduction
Guava area and production both saw significant growth over the past ten years but guava productivity per unit area remained constant. In order to compete with the global market, some crucial measures have been discovered for improving guava production in India. Old orchards must be rejuvenated and cutting-edge plantation techniques like high-density planting (HDP) must be adapted as farmers' perspectives have changed significantly in the context of the globalization era from production to productivity and profitability, which can be attained by high density planting (Singh, 2008) [9]. The precocity and improved productivity of high-quality fruits, along with a decrease in production costs and labour requirements, have nearly completely changed the fruit industry of guava (Mali, 2015) [5]. In the current scenario of commercial agriculture, because of the rapidly increasing land and labour costs along with the urging need for rapid returns on the capital invested, this trend of high-density planting is becoming sensational worldwide. However, microclimatic factors that influence the vegetative, flowering and yield of guava fruits directly or indirectly, include solar radiation absorption, canopy temperature, and relative humidity (Brar *et al.* 2009) [1]. Guava has a larger ratio of "shade" to "sun" leaves, and leaves in deeper shade are found to be inactive for photosynthetic activity, making them an unproductive sink (Singh and Singh, 2007) [10]. Plants use light absorption and light energy conversion into chemical energy for their vegetative and reproductive growth (Brar *et al.* 2009) [1]. In order to determine the extent to which guava plant density can be increased per unit area while maintaining ideal microclimatic conditions, the current studies looked at the relationship between change in canopy microclimate and increasing plant population in a unit area and its effect on vegetative behaviour of guava.

## Materials and Methods
Investigations were carried out in the Fruit Research Farm, Department of Fruit Science, Punjab Agricultural University, Ludhiana during the year 2021-22.

The observations were recorded on five-year-old plants of guava cv. Shweta was planted in September 2016 at different planting densities *viz.* 6x5 m, 5x5 m, 5x4 m, 5x3 m, 4x4 m and 4x3 m have three replications of five plants per unit with different spacing and a total of 90 experimental trees.
Standard methods were used to record growth parameters such as stock girth, scion girth, tree height, tree spread (in the east-west and north-south directions), and tree canopy volume in the month of April and December.
Observations of solar radiation interception, relative humidity and canopy temperature were made at 15-day intervals in especially three parts of the tree canopy from March 2021 to February 2022. In order to collect observations, the upper third, middle third and lower third were divided into three portions.
The solar radiation (SR) was measured three times a day, at timings ranging from 9:00 a.m., 12:00 p.m. and 3:00 p.m., with the help of a Digital Multi-Volt Meter to record the sensor output from the Pyranometer. Pyranometer was pointed upward to measure the amount of incoming solar radiation (Cal/cm$^2$/min) at one foot above the canopy and in the middle of the upper, middle, and lower tree sections. In order to investigate the tree canopy below, the Pyranometer was inverted one foot above it. The amount of reflected short-wave radiations [Albedo (A)] was then measured. At a certain observation time, the difference between incoming radiation received in each of the three distinct sections of the tree canopy was measured and expressed as intercepted radiation.

Radiation intercepted in the upper part = $I-(I_1+A) \times 100 = X\%$

Radiation intercepted in the middle part = $I-(I_2+A) \times 100 - X\% = Y\%$

Radiation intercepted in the lower part = $I-(I_3+A) \times 100 - (X\%+Y\%) = Z\%$

Total light intercepted by the tree canopy = X+Y+Z

Where,
I = Incoming SR received one foot above top of the tree canopy, $I_1$= Incoming SR received in the upper portion of the tree canopy, $I_2$= Incoming SR received in the middle portion of the tree canopy and $I_3$= Incoming SR received in the lower portion of the tree canopy.
The dry, as well as wet bulb temperatures and the relative humidity, were recorded with the help of a Psychron (Belfort Inst. Company Model No. 556). On the same day of solar radiation. Psychrometric tables were used to calculate relative humidity from the dry and wet bulb temperatures.

## Results and Discussions

### 1. Vegetative characters

The stock and scion girth was observed to increase with an increase in plant spacing Table 1. The maximum mean value of stock girth (43.40 cm) and scion girth (41.40 cm) at the wider spacing (6x5 m), was at par with 5x5 m spacing. Tree planted at a closer spacing of 4x3 m revealed the minimum mean stock girth (33.10 cm) and scion girth (27.59 cm). It was discovered that the stock and scion girth of plants increases with an increase in plant spacing owing to lesser competition among the plants for water, nutrients, sunlight and other requirements due to the progression in spaces between the plants. Similar results coincide with Pal *et al.* (2016) [7], Brar *et al.* (2012) [3] and Kumawat *et al.* (2014) [4] observed that plant growth increased with an increase of plant spacing in terms of stock and scion girth of *P. guajava* cv. Allahabad Safeda.
The mean maximum tree height (3.42 m) was recorded at 4x3 m spacing, while the minimum plant height (2.89 m) was recorded at 6x5 m plant spacing (Table 1). This was due to enough space left for plants to spread out and this may be due to increased competition for light led to more lateral development produced. Similar results were found by Tripathi (2018) [11], Pal *et al.* (2016) [7] and Kumawat *et al.* (2014) [4] measured the highest tree height at the closest and minimum at the wider spaced plants.
In the wider spacing (6x5 m), maximum canopy spread was observed. However, the mean maximum canopy spread (4.71 m) was found at 6x5 m spacing and the least (3.69 m) was observed in plants at 4x3 m spacing (Table 1). The impact of different spacings was statistically not affected significantly in the direction of East-West. Whereas, maximum spread under the North-South direction was at 4.35 m in wider spaced plants (6x5 m), which was statistically at par with 5x5 m spacing and minimum (3.42 m) was observed in 4x3 m spacing. High-density plants have less tree spread because of space constraints, which causes more apical development at the expense of lateral growth. Nayak *et al.* (2020) (6), Pal *et al.* (2016) [7], Brar *et al.* (2012) [3] and Kumawat *et al.* (2014) [4] recorded maximum tree spread under wider spacing and minimum under closer spacing. Whereas, the highest canopy volume observed at 6x5 m was 33.43 m$^3$ and the lowest (24.33 m$^3$) was at 4x3 m spacing (Table 1). Tripathi, (2018) [11] found similar results between the various spacings; trees spaced at 5x2 m had the tallest trees (4.54 m), and those spaced at 6x6 m had the closer trees (3.18 m). Pal *et al.* (2016) [7], observed similar results that plant height decreased with an increase in plant spacing.

**Table 1** Effect of plant spacings+ on vegetative characters in 'Shweta' guava.

| Characters | Plant Spacings | | | | | | CD at 5% |
|---|---|---|---|---|---|---|---|
| | 6x5m | 5x5m | 5x4m | 5x3m | 4x4m | 4x3m | |
| Scion girth (cm) | 41.40 | 39.14 | 34.06 | 32.20 | 29.16 | 27.59 | 4.90 |
| Stock girth (cm) | 43.40 | 42.21 | 38.68 | 36.05 | 34.58 | 33.10 | 5.85 |
| Plant height (m) | 2.89 | 2.95 | 3.05 | 3.16 | 3.33 | 3.42 | NS |
| Canopy spread (m) - E-W | 5.06 | 4.25 | 4.21 | 4.18 | 4.14 | 3.96 | NS |
| Canopy spread (m) - N-S | 4.35 | 4.17 | 3.95 | 3.93 | 3.66 | 3.42 | 0.36 |
| Mean Canopy spread (m) | 4.71 | 4.21 | 4.08 | 4.06 | 3.90 | 3.69 | 0.43 |
| Canopy volume (m$^3$) | 33.43 | 27.32 | 27.15 | 26.55 | 26.46 | 24.33 | 0.61 |

## 2. Solar radiation interception

In the rainy season (March to August) crop, mean total solar radiation interception with respect to planting distance of guava plants was found greater (68.80%) in plants at a spacing of 6x5 m and the least was 37.80 percent in plants at the closest (4x3 m) spacing as shown in Fig 1. Similarly, the winter season crop (September to February) was found to be increased with an increase in plant spacing up to 6x5 m spacing with 333 plants/ha. The maximum was 62.75 percent in plants at a wider spacing of 6x5 m and the least was 29.30 percent in plants at the closest spacings (4x3 m) as shown in Fig 2. The average total radiation intercepted with respect to part of the canopy during the rainy season was found to be affected significantly in cv. Shweta of guava plants was greater (39.90%) in plants at the upper part of the canopy, followed by the middle part (9.73%) and the least interception was 5.00 percent in the lower parts of the canopy. A similar trend was found in the winter season crop. The effect of interaction between plant spacing and part of the canopy is shown in Fig 1 and 2. Solar radiation interception was found to be maximum at 6x5 m spacing with respect to the upper part than the middle part and the lower. The minimum solar radiation interception was recorded in closer spacing (4x3 m) with a similar trend as above during both the cropping seasons (rainy and winter). The results of the current study also coincide with Brar *et al.* (2012) [3] observed it was discovered that wider plant spacing was preferable due to the maximum absorption of solar radiation. Brar *et al.* (2009) [1] found that during both the rainy and the winter crop seasons, there was a considerable decrease in the amount of solar radiation that plant canopies absorbed. Brar *et al.* (2013) [2] studied that in guava cv. L-49 there was a higher incidence of solar radiation in wider spaced plants at 6x4 m spacing compared to high density plants.

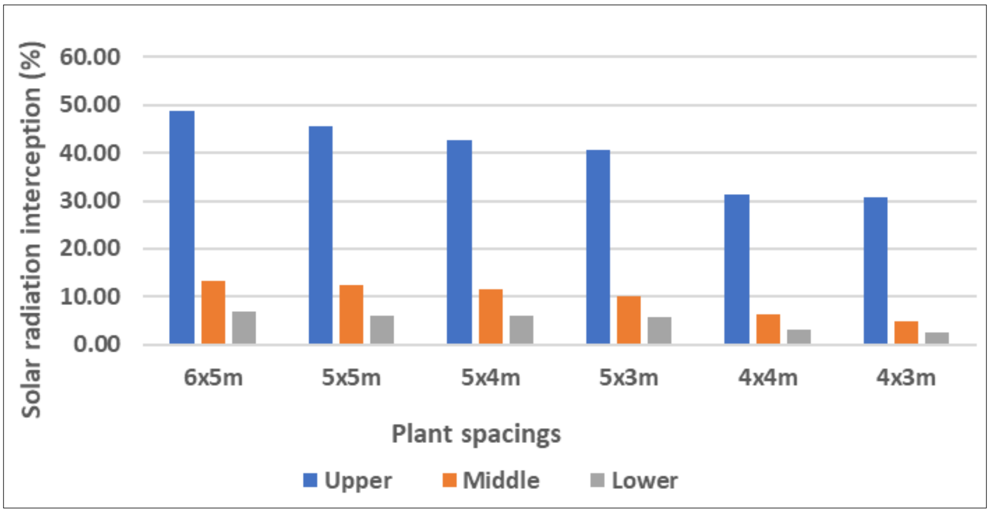


**Fig 1:** Effect of plant spacing on solar radiation interception during the rainy season (March-August) in different parts of 'Shweta' guava trees

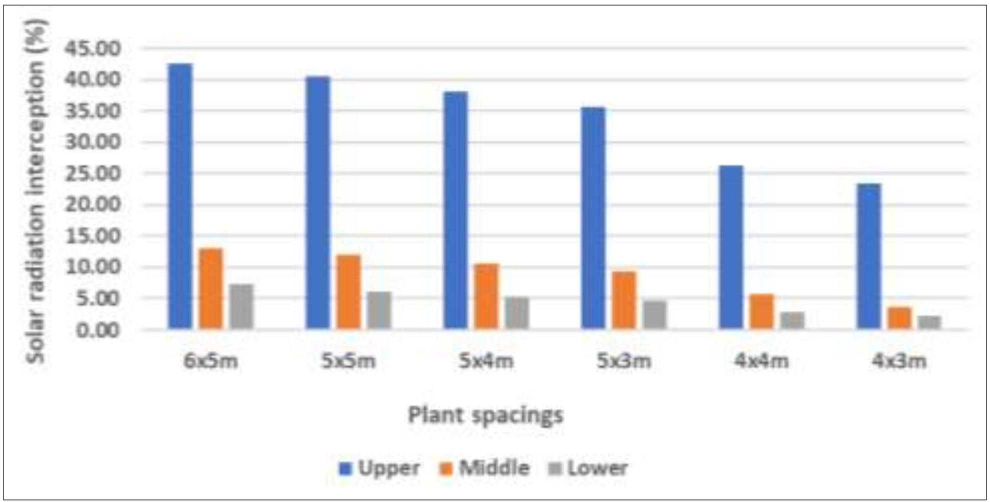


**Fig 2:** Effect of plant spacing on solar radiation interception during the winter season (September- February) in different parts of 'Shweta' guava trees

## 3. Canopy temperature

The effect of mean canopy temperature with respect to planting distance in the rainy season (March to August) crop was measured greater (32.4 °C) at wider spacings of 6x5 m and the minimum mean canopy temperature was 29.2 °C in plants at the closest (4x3 m) spacing as in Fig 3. Whereas, in the winter season (September to February) the average canopy temperature was 26.3 °C in plants at wider spacings of 6x5 m and the minimum (23.5 °C) in plants at the closest spacing (4x3 m) as shown in Fig 4. The average canopy temperature in rainy season crop with respect to part of the canopy was measured as greater in the upper portion (31.8 °C) of the canopy and the minimum was 29.5 °C at the lower part of the canopy. A similar trend was observed in the winter season crops. The effect of interaction between plant spacing and part of the canopy was found to be maximum at wider (6x5 m) with respect to the upper part than the middle part and lower part of the canopy and minimum was noticed at 4x3 m spacing with a similar trend during both the cropping seasons. Similar results were observed by Tripathi, (2018) [11] examined that during the rainy and winter seasons, increasing the plant spacing resulted in a considerable increase in the mean canopy temperature. In the rainy and winter season crops, the highest mean canopy temperature was noted in plants spaced at 6x6 m and the lowest mean canopy temperature was noted in trees at 5x2 m. The Winter season (September to February) mean canopy temperature was lower than the rainy season mean canopy temperature (April to September). The upper region of the tree canopy had a much higher mean canopy temperature than the middle and lower canopy portions.

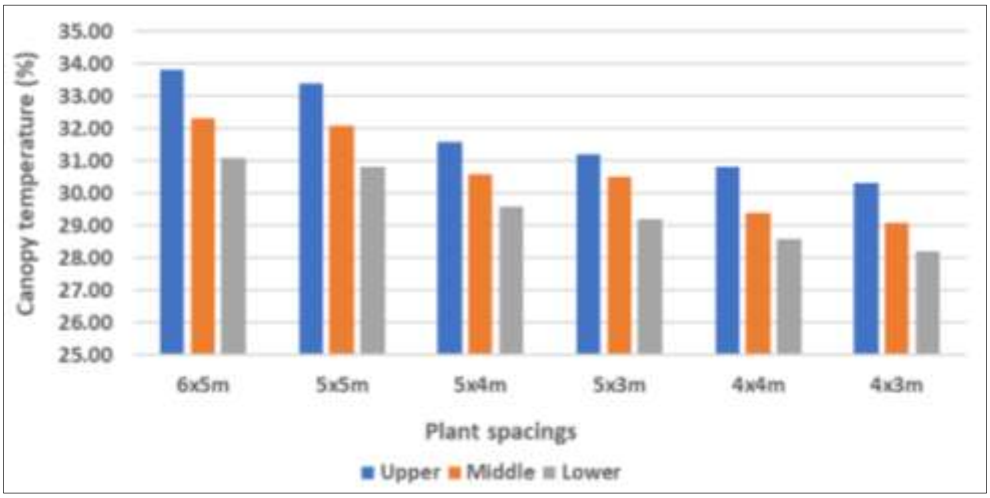


**Fig 3:** Effect of plant spacing on canopy temperature during rainy season crop (March-September) in different parts of 'Shweta' guava trees.

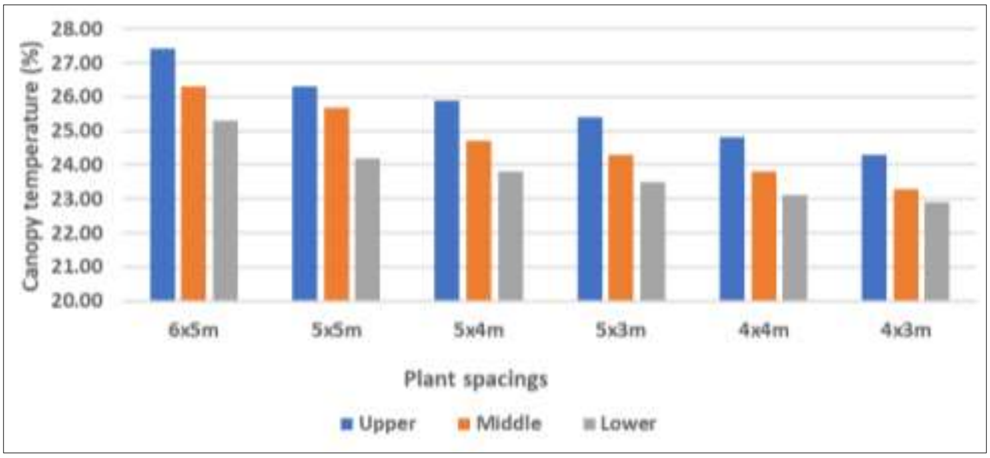


**Fig 4:** Effect of plant spacing on canopy temperature during winter season (October- February) in different parts of 'Shweta' guava trees.

### 4. Relative humidity

The mean relative humidity with respect to planting distance in the rainy season (March to August) crop was measured greater (59.4%) at a closer spacing of 4x3 m and the minimum was 50.6 percent in plants at wider (6x5 m) spacing as in Fig 5. During the winter season (September to February), the maximum mean relative humidity was 69.6 percent in plants at the closer spacing of 4x3 m and the minimum was 59.7 percent in plants at wider (6x5 m) spacing. The average relative humidity in rainy season crop was measured greater in the lower portion of the canopy was 56.3 percent. While, minimum (54.3%) mean of relative humidity was found at upper portion of the tree. In winter, the similar trend was observed as in the rainy season crop. The effect of interaction between plant spacing was found to be maximum at 4x3 m with respect to the lower part followed by the middle part and the upper part of the canopy. Whereas, the minimum was noticed at 6x5 m spacing in the lower, followed by middle and upper parts of the canopy during rainy and winter season crops. The results of the current study coincide with that of Tripathi, (2018) [11] with a decrease in planting density, the relative humidity decreased. Lower relative humidity was observed in the upper and middle branches of the tree canopy than in the lower branches. It is possible that high temperatures, greater solar radiation absorption and enhanced air movement caused the relative humidity to decrease as plant density decreased. Brar *et al.* (2009) [1] discovered that by reducing the density of plants per unit area, the mean canopy relative humidity in the canopy decreased. Similarly, Singh and Dhaliwal, (2007) [8] and Brar *et al.* (2013) [2] revealed that the closest spacing produced the highest average relative humidity.

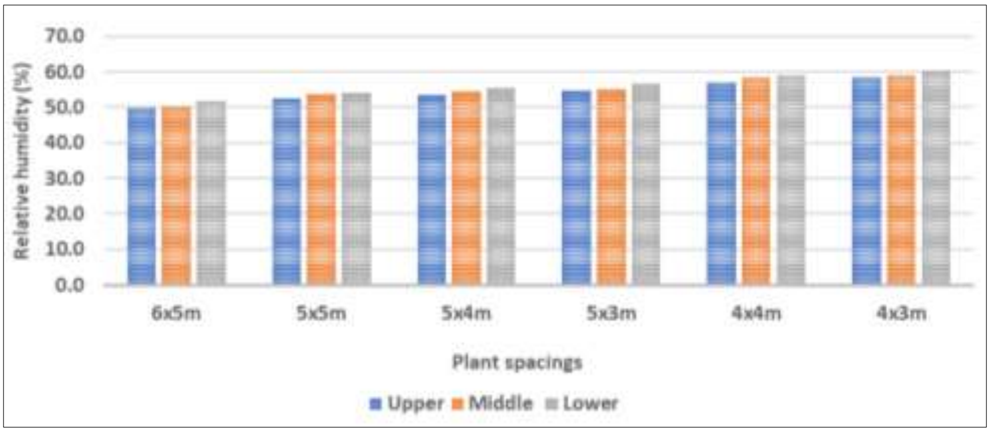


**Fig 5**. Effect of plant spacing on relative humidity during rainy season crop (March- September) in different parts of 'Shweta' guava trees

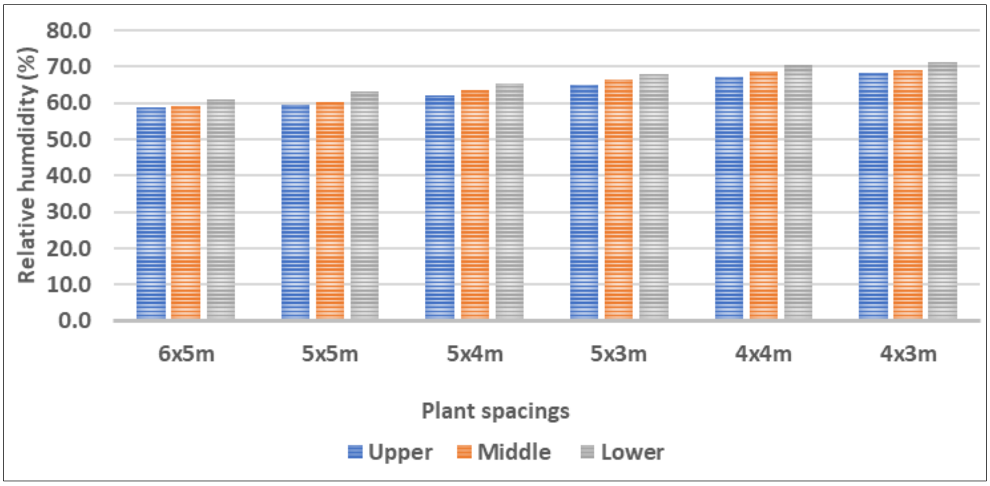


**Fig 6.** Effect of plant spacing on relative humidity during winter season (October- February) in different parts of 'Shweta' guava trees

## Conclusion

It may be concluded that guava planted at 5x5 m (400 trees/ acre) had significantly optimal solar radiation interception, canopy temperature and relative humidity. Which enhances more vegetative growth with respect to stock and scion girth, tree spread (EW and NS directions), canopy volume and tree height as compared to trees planted at recommended spacing i.e 6x5 m.

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