International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(2): 2332-2335

Received: 18-01-2018
Accepted: 21-02-2018

**Shivangi Arvind**
Department of Horticulture, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

**Shant Lal**
Department of Horticulture, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

**CP Singh**
Department of Horticulture, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

**SK Guru**
Department of Plant Physiology, College of Basic Science and Humanities, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

**Rajesh Kumar**
Department of Horticulture, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

**Correspondence**
**Shivangi Arvind**
Department of Horticulture, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

# Effect of leaf to fruit ratios on the physico-chemical quality of guava (*Psidium guajava* L.) cv. pant prabhat planted under high density

**Shivangi Arvind, Shant Lal, CP Singh, SK Guru and Rajesh Kumar**

**Abstract**
An experiment was conducted during years 2016-17 and 2017-18 to determine the effect of leaf to fruit ratio on the physico-chemical quality of guava planted under high density. Plants at four spacing namely $S_1$= 1.0 m x 1.0 m, $S_2$= 1.5 m x 1.5 m, $S_3$= 2 m x 1 m and $S_4$= 2 m x 1.5 m were selected and different leaf to fruit ratio treatments of $T_1$=4:1, $T_2$=8:1, $T_3$=12:1, $T_4$=16:1 and $T_5$=Defoliation of fruiting shoots (appx. 24:1) were imposed on them while untreated trees served as $T_6$= control (appx. 32:1). The results revealed that highest mean fruit weight, fruit length, fruit volume, total soluble solids, reducing sugar and total sugar per cent was recorded in spacing $S_4$. The maximum mean fruit weight, fruit length, fruit volume, total soluble solids and total sugar per cent were recorded in moderate leaf to fruit ratio of $T_4$ and $T_3$.

**Keywords:** leaf to fruit ratio, guava, high density, quality

## Introduction
Guava is a native crop of South America but is now widely grown in almost all the tropical and sub-tropical parts of the globe. Its popularity seems to be increasing with time among consumers who are health conscious as well as farmers who wish to maximize crop productivity with minimum resources. In the present scenario where area for fruit cultivation is constantly decreasing, the concept of high density planting becomes highly relevant. Moreover, guava is the choicest crop for adoption of this practice as it bear fruits on the current season growth and is highly responsive to pruning, both factors very crucial for being planted under high density. However, for achieving the optimum quality of fruits, the proper balance between the source and the sink is quintessential especially under high density plantations, where over shading of the canopy becomes a major problem with time, leading not only to poor quality fruits but also enhancing the risk of pest and diseases in the dense canopy. However, the concept of leaf to fruit ratio is not new, but such studies have been restricted to high value crops like apple, grapes, dates etc. Moreover, it also varies with the species, cultivar and agro-ecological conditions. Orjuela and Barreto (2009) [1] estimated seven leaves (146 $cm^2$) for optimum quality of one fruit of Pineapple guava (*Acca sellowiana* Berg). In this purview, an experiment was designed with the objective of examining the effect of various leaf to fruit ratios on the physico-chemical quality of guava under high density planting system and eventually determine an optimum leaf to fruit ratio to be maintained for guava.

## Materials and methods
The present experiment was conducted at the Horticulture Research Centre, Pattharchatta, of G.B. Pant University of Agriculture and Technology, Pantnagar during the years 2016-17 and 2017-18. Seven years old grafted guava plants of cultivar Pant Prabhat planted at four spacing namely $S_1$= 1.0 m x 1.0 m, $S_2$= 1.5 m x 1.5 m, $S_3$= 2 m x 1 m and $S_4$= 2 m x 1.5 m; were selected for the study as per uniformity in growth, shape and vigour. Five treatments of different leaf to fruit ratio ranging from low ($T_1$=4:1, $T_2$=8:1), moderate ($T_3$=12:1, $T_4$=16:1) to high ($T_5$=Defoliation of fruiting shoots with an average leaf to fruit ratio of 24:1) were incorporated while untreated trees served as $T_6$= control (with an average leaf to fruit ratio of 32:1) The experiment was designed in a factorial randomized block fashion replicated thrice giving altogether twenty four treatment combinations. The selected plants were pruned almost to an equal height of about 2 m in the month of February. The treatments were imposed in the

Second week of June (after fruit set) during both years. All plants were subjected to uniform cultural practices for the entire course of investigation. After harvesting, the physico-chemical attributes of the fruit were analyzed by taking a random sample of ten fruits per treatment combination of the rainy season crop for both years of the investigation. Fruit weight was measured using a digital balance. Fruit length and width were measured using a digital vernier caliper. The volume of the fruit was measured using the water displacement method by Archimedes. The total soluble solids were estimated with the help of a hand refractometer. The estimation of sugars (both reducing and total sugars) was done using the Lane and Eynon method as described by Ranganna (1986) [2]. The statistical analysis was done using the methods described by Snedecor and Cochran (1968) [3] and Gomez and Gomez (1984) [4].

**Results and Discussion**

All the physical parameters like mean fruit weight, mean fruit length, mean fruit width and mean fruit volume were influenced by both spacing as well as leaf to fruit ratio treatments (Table1). The mean fruit weight tends to increase with increase in spacing and was found to be highest in spacing $S_4$ (2.0 m x 1.5 m) as 105.16 g and 102.89 g in both years respectively. However it was found at par with that of spacing $S_3$ (2.0 m x 1.0 m). Similar results were obtained in case of other physical parameters where highest mean fruit length (5.32 cm and 5.27 cm) and mean fruit volume (93.39 ml and 93.28 ml) were found in spacing $S_4$ and at par with that of spacing $S_3$ during both years respectively. The increase in the fruit weight and other physical parameters might be due to the fact that light penetration in wider spacing is more as compared to the narrower ones and consequently there is more production of photosynthates in the 'source' and supply of assimilates among the 'sinks' leading to the increment in fruit weight and size. The present findings are in line with that of Singh (2007) [5], Singh and Dhaliwal (2007) [6], and Kumawat *et al*. 2014[7]. The mean fruit width became significantly higher in spacing $S_4$ during the second year i.e. 2017-18. The different leaf to fruit ratios also significantly influenced the above physical parameters. The mean fruit weight, mean fruit length and mean fruit volume increased with increase in the leaf to fruit ratio. The quality of the fruits obtained directly depends on the quantity of assimilates it receives. This quantity would be more if either there is less competition among the fruits or the number of leaves present for each fruit is more. However, both low as well as high leaf to fruit ratio treatments showed significantly lesser values for these traits in both years. It means that an optimum balance between the number of leaves and fruits is crucial to enhance the quality of fruits. The maximum mean fruit weight (107.98 g and 107.86 g) was recorded in the leaf to fruit ratio of $T_4$ (16:1), which was at par with the mean fruit weight obtained from ratio $T_3$ (12:1) as 100.65 g and 101.48 g respectively for both years. Similarly, mean fruit length (5.32 cm and 5.39 cm) and mean fruit volume (99.58 ml and 100.08 ml; 91.67 ml and 91.33 ml) was also recorded as their highest with ratios $T_4$ and $T_3$ respectively in both years. The mean fruit width though showed a non-significant difference among the various leaf to fruit ratio treatments but in the second year, significantly higher fruit width was recorded with ratios $T_4$ and $T_3$ i.e. 5.90 cm and 5.78 cm respectively. On the contrary, Al-Salman *et al*. 2012[8] did not observe any significant effect on the quality of Khlass date palm with different leaf to bunch ratio. Srivastava *et al*. 2017[9] reported that irrespective of 8 apple cultivars under study; fruit weight, fruit length, fruit diameter were highest in 30 leaves/fruit. The interaction effect of the two factors of spacing and leaf to fruit ratio treatments was also studied but no significant results were obtained. Although the wider spacing $S_4$ combined with moderate leaf to fruit ratio treatments of both $T_4$ and $T_3$ gave the maximum value for all the physical parameters studied.

**Table 1:** Effect of spacing and leaf to fruit ratio treatments on the physical quality of guava fruit.

| Spacing | | Mean fruit weight (g) | | Mean fruit length (cm) | | Mean fruit width (cm) | | Mean fruit volume (ml) | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2016-17 | 2017-18 | 2016-17 | 2017-18 | 2016-17 | 2017-18 | 2016-17 | 2017-18 |
| $S_1$ (1.0 m x 1.0 m) | | 79.95 | 78.14 | 4.62 | 4.67 | 5.38 | 5.27 | 74.83 | 71.22 |
| $S_2$ (1.5 m x 1.5 m) | | 89.00 | 87.29 | 4.84 | 4.89 | 5.54 | 5.47 | 80.11 | 77.61 |
| $S_3$ (2.0 m x 1.0 m) | | 95.47 | 97.18 | 5.01 | 5.03 | 5.67 | 5.62 | 86.56 | 84.78 |
| $S_4$ (2.0 m x 1.5 m) | | 105.16 | 102.89 | 5.32 | 5.27 | 5.76 | 5.75 | 93.39 | 93.28 |
| SEm± | | 4.68 | 5.31 | 0.82 | 0.73 | 0.11 | 0.88 | 4.21 | 4.01 |
| CD at 5% | | 13.32 | 15.13 | 0.23 | 0.21 | 0.31 | 0.25 | 11.99 | 11.42 |
| Treatment | | | | | | | | | |
| $T_1$ (4:1) | | 81.49 | 82.45 | 4.72 | 4.60 | 5.43 | 5.26 | 74.67 | 76.83 |
| $T_2$ (8:1) | | 85.62 | 86.57 | 4.94 | 4.98 | 5.49 | 5.24 | 76.67 | 77.08 |
| $T_3$ (12:1) | | 100.65 | 101.48 | 5.18 | 5.27 | 5.79 | 5.78 | 91.67 | 91.33 |
| $T_4$ (16:1) | | 107.98 | 107.86 | 5.32 | 5.29 | 5.83 | 5.90 | 99.58 | 100.08 |
| $T_5$ (DFS) | | 88.22 | 89.73 | 4.68 | 4.76 | 5.41 | 5.44 | 78.83 | 78.75 |
| $T_6$ (Control) | | 90.42 | 80.15 | 4.83 | 4.89 | 5.57 | 5.56 | 80.92 | 66.25 |
| SEm± | | 5.73 | 6.51 | 0.10 | 0.89 | 0.13 | 0.11 | 5.16 | 4.91 |
| CD at 5% | | 16.31 | 18.53 | 0.28 | 0.26 | 0.38 | 0.31 | 14.69 | 13.99 |
| Interaction | | | | | | | | | |
| Spacing | Treatment | | | | | | | | |
| $S_1$ | $T_1$ | 66.33 | 68.00 | 4.49 | 4.45 | 5.17 | 4.93 | 70.67 | 70.00 |
| | $T_2$ | 78.33 | 76.00 | 4.61 | 4.69 | 5.33 | 4.95 | 71.67 | 70.67 |
| | $T_3$ | 91.55 | 88.44 | 4.99 | 5.08 | 5.70 | 5.60 | 85.00 | 79.67 |
| | $T_4$ | 94.67 | 95.50 | 5.11 | 5.07 | 5.67 | 5.77 | 85.00 | 89.00 |
| | $T_5$ | 73.33 | 76.33 | 4.01 | 4.19 | 5.19 | 5.17 | 70.00 | 64.67 |
| | $T_6$ | 75.47 | 64.55 | 4.49 | 4.56 | 5.23 | 5.20 | 66.67 | 53.33 |
| $S_2$ | $T_1$ | 75.87 | 77.50 | 4.59 | 4.49 | 5.46 | 5.33 | 71.33 | 72.33 |
| | $T_2$ | 85.83 | 86.43 | 4.77 | 4.97 | 5.43 | 5.15 | 73.33 | 73.33 |
| | $T_3$ | 97.99 | 98.00 | 5.09 | 5.20 | 5.78 | 5.63 | 90.00 | 83.33 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | $T_4$ | 101.83 | 103.52 | 5.30 | 5.13 | 5.74 | 5.88 | 95.00 | 93.33 |
| | $T_5$ | 84.17 | 88.33 | 4.43 | 4.74 | 5.36 | 5.37 | 76.00 | 78.33 |
| | $T_6$ | 88.33 | 70.00 | 4.82 | 4.79 | 5.51 | 5.49 | 75.00 | 65.00 |
| S3 | $T_1$ | 82.31 | 84.79 | 4.61 | 4.49 | 5.48 | 5.34 | 76.67 | 74.33 |
| | $T_2$ | 80.64 | 89.24 | 5.09 | 5.05 | 5.59 | 5.40 | 76.67 | 81.00 |
| | $T_3$ | 104.17 | 108.14 | 5.18 | 5.32 | 5.83 | 5.87 | 93.33 | 99.00 |
| | $T_4$ | 115.83 | 114.90 | 5.36 | 5.42 | 5.93 | 5.91 | 106.67 | 108.00 |
| | $T_5$ | 93.00 | 94.67 | 4.92 | 4.84 | 5.45 | 5.46 | 81.00 | 79.67 |
| | $T_6$ | 96.89 | 91.33 | 4.91 | 5.05 | 5.75 | 5.77 | 85.00 | 66.67 |
| S4 | $T_1$ | 101.45 | 99.50 | 5.19 | 4.97 | 5.62 | 5.44 | 80.00 | 90.67 |
| | $T_2$ | 97.67 | 94.67 | 5.27 | 5.20 | 5.63 | 5.47 | 85.00 | 83.33 |
| | $T_3$ | 108.89 | 111.33 | 5.47 | 5.49 | 5.87 | 6.01 | 98.33 | 103.33 |
| | $T_4$ | 119.58 | 117.53 | 5.52 | 5.53 | 6.01 | 6.04 | 111.67 | 110.00 |
| | $T_5$ | 102.39 | 99.59 | 5.34 | 5.27 | 5.64 | 5.76 | 88.33 | 92.33 |
| | $T_6$ | 100.98 | 94.72 | 5.11 | 5.16 | 5.79 | 5.78 | 97.00 | 80.00 |
| SEm± | | 11.46 | 13.02 | 0.20 | 0.18 | 0.27 | 0.22 | 10.32 | 9.83 |
| CD @ 5% | | 32.62 | 37.07 | 0.57 | 0.51 | 0.76 | 0.62 | 29.38 | 27.98 |

DFS = Defoliation of Fruiting shoots

The results obtained from the chemical analysis of the guava fruits are shown in the Table 2. The total soluble solids content was found to be significantly influenced by different spacing as well as leaf to fruit ratios. During both years spacing $S_4$ (9.49 and 9.60°B) and leaf to fruit ratio of $T_4$ (10.25 and 11.04°B) recorded the highest value for TSS. Srivastava *et al*. 2017[9] also reported highest TSS value from moderate leaf to fruit ratio of 30 per fruit in case of apple. Similar results were obtained with the reducing sugar content of the guava fruits where spacing $S_4$ gave its highest value (6.44 and 6.39 per cent respectively) closely followed by spacing $S_3$ (5.34 and 5.54 per cent) for both years. However, the various leaf to fruit ratio treatments could not produce a significant difference in the reducing sugar per cent of guava fruit. The non-reducing sugar per cent of guava fruit remained unaffected by both the factors taken for the study during the first year but some significant difference among the leaf to fruit ratio treatments was observed in the second year. The total sugar per cent in the guava fruits was found to be influenced by both spacing and leaf to fruit ratio treatments and was thus recorded significantly higher in spacing $S_4$ (9.65 and 9.24 per cent) and ratio $T_4$ (10.27 and 9.84 per cent) respectively in both years of investigation. The peak values of TSS and total sugars from the wider spacing could have been a result of the increased photosynthetic efficiency of the plants due to better penetration of the sunlight in their canopy. Similar results have been reported in this context by Singh (2007) [5], Singh and Dhaliwal (2007) [6], Singh *et al*. 1980[10], Bal and Dhaliwal (2003) [11], and Pratibha and Lal (2012) [12]. Lal *et al*. (2007) [13] reported non –significant effect on the quality of guava under various planting systems, however, maximum quality attributes were still reported from the square planting system accommodating least number of plants. The decline in sugar content of grape berries with low leaf to fruit ratio was reported by Etchebarne *et al*. 2010[14]. Deshmukh *et al*. (2012) [15] observed that moderate leaf to fruit ratios of 45:1 followed by 55:1 LFR were found suitable for improvement in the quality of low chill peach cv. Flordasun than the untreated control. The interaction effect of both these factors was also studied but no significant differences could be observed during both years.

**Table 2:** Effect of spacing and leaf to fruit ratio treatments on the chemical quality of guava fruit.

| **Spacing** | | **TSS (°B)** | | **Reducing Sugar (%)** | | **Non-reducing Sugar (%)** | | **Total Sugar (%)** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **2016-17** | **2017-18** | **2016-17** | **2017-18** | **2016-17** | **2017-18** | **2016-17** | **2017-18** |
| $S_1$ (1.0 m x 1.0 m) | | 7.74 | 8.23 | 4.22 | 3.95 | 3.34 | 3.43 | 7.56 | 7.38 |
| $S_2$ (1.5 m x 1.5 m) | | 8.38 | 8.82 | 4.85 | 4.79 | 3.40 | 3.45 | 8.25 | 8.24 |
| $S_3$ (2.0 m x 1.0 m) | | 8.77 | 9.15 | 5.34 | 5.54 | 3.40 | 3.31 | 8.74 | 8.85 |
| $S_4$ (2.0 m x 1.5 m) | | 9.49 | 9.60 | 6.44 | 6.39 | 3.21 | 2.85 | 9.65 | 9.24 |
| SEm± | | 0.19 | 0.26 | 0.35 | 0.26 | 0.48 | 0.35 | 0.42 | 0.25 |
| CD at 5% | | 0.54 | 0.74 | 1.00 | 0.73 | 1.36 | 0.99 | 1.19 | 0.73 |
| **Treatment** | | | | | | | | | |
| $T_1$ (4:1) | | 7.32 | 7.47 | 4.79 | 5.30 | 2.69 | 2.06 | 7.48 | 7.36 |
| $T_2$ (8:1) | | 7.96 | 8.16 | 5.30 | 5.22 | 2.70 | 2.87 | 8.00 | 8.09 |
| $T_3$ (12:1) | | 8.89 | 9.47 | 5.81 | 5.33 | 3.52 | 3.80 | 9.33 | 9.13 |
| $T_4$ (16:1) | | 10.25 | 11.04 | 5.54 | 5.80 | 4.73 | 4.01 | 10.27 | 9.81 |
| $T_5$ (DFS) | | 8.42 | 8.59 | 4.95 | 4.48 | 3.15 | 3.64 | 8.10 | 8.12 |
| $T_6$ (Control) | | 8.73 | 8.97 | 4.89 | 4.86 | 3.23 | 3.21 | 8.12 | 8.07 |
| SEm± | | 0.23 | 0.32 | 0.43 | 0.31 | 0.59 | 0.42 | 0.51 | 0.31 |
| CD at 5% | | 0.66 | 0.90 | 1.23 | 0.89 | 1.67 | 1.21 | 1.45 | 0.89 |
| **Interaction** | | | | | | | | | |
| **Spacing** | **Treatment** | | | | | | | | |
| $S_1$ | $T_1$ | 6.89 | 6.78 | 4.10 | 4.02 | 2.72 | 2.48 | 6.82 | 6.50 |
| | $T_2$ | 7.14 | 7.06 | 3.86 | 4.08 | 3.48 | 3.39 | 7.34 | 7.47 |
| | $T_3$ | 8.33 | 9.09 | 4.95 | 3.26 | 3.24 | 5.14 | 8.19 | 8.40 |
| | $T_4$ | 9.03 | 10.50 | 4.01 | 4.45 | 5.35 | 4.07 | 9.36 | 8.52 |
| | $T_5$ | 7.67 | 8.09 | 3.96 | 3.35 | 3.09 | 3.97 | 7.05 | 7.32 |
| | $T_6$ | 7.37 | 7.89 | 4.43 | 4.51 | 2.17 | 1.56 | 6.60 | 6.07 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $S_2$ | $T_1$ | 7.17 | 7.51 | 4.21 | 5.29 | 3.35 | 2.08 | 7.56 | 7.37 |
| | $T_2$ | 7.70 | 8.17 | 5.03 | 5.00 | 2.52 | 2.91 | 7.55 | 7.91 |
| | $T_3$ | 8.58 | 9.28 | 5.41 | 4.63 | 3.44 | 4.22 | 8.85 | 8.85 |
| | $T_4$ | 10.13 | 10.90 | 5.42 | 5.21 | 4.17 | 4.47 | 9.59 | 9.68 |
| | $T_5$ | 8.13 | 8.52 | 4.48 | 4.08 | 3.40 | 3.49 | 7.88 | 7.57 |
| | $T_6$ | 8.58 | 8.54 | 4.54 | 4.54 | 3.55 | 3.52 | 8.09 | 8.06 |
| S3 | $T_1$ | 7.42 | 7.69 | 5.01 | 5.90 | 2.69 | 1.75 | 7.70 | 7.65 |
| | $T_2$ | 8.13 | 8.54 | 5.25 | 5.22 | 2.64 | 3.17 | 7.89 | 8.39 |
| | $T_3$ | 8.90 | 9.53 | 5.66 | 6.30 | 3.99 | 3.19 | 9.65 | 9.49 |
| | $T_4$ | 10.27 | 11.10 | 6.34 | 6.46 | 3.90 | 3.73 | 10.24 | 10.19 |
| | $T_5$ | 8.73 | 8.67 | 5.10 | 4.70 | 3.47 | 3.78 | 8.57 | 8.48 |
| | $T_6$ | 9.17 | 9.40 | 4.71 | 4.68 | 3.67 | 4.21 | 8.38 | 8.89 |
| S4 | $T_1$ | 7.82 | 7.90 | 5.82 | 6.01 | 2.03 | 1.89 | 7.85 | 7.90 |
| | $T_2$ | 8.85 | 8.88 | 7.07 | 6.58 | 2.14 | 2.01 | 9.21 | 8.59 |
| | $T_3$ | 9.73 | 10.00 | 7.21 | 7.13 | 3.43 | 2.64 | 10.64 | 9.77 |
| | $T_4$ | 11.57 | 11.68 | 6.40 | 7.08 | 5.50 | 3.77 | 11.90 | 10.85 |
| | $T_5$ | 9.17 | 9.10 | 6.25 | 5.80 | 2.65 | 3.31 | 8.90 | 9.11 |
| | $T_6$ | 9.82 | 10.07 | 5.87 | 5.73 | 3.53 | 3.52 | 9.40 | 9.25 |
| SEm± | | 0.46 | 0.63 | 0.86 | 0.63 | 1.17 | 0.85 | 1.02 | 0.62 |
| CD @ 5% | | 1.32 | 1.80 | 2.46 | 1.79 | 3.34 | 2.42 | 2.91 | 1.78 |

DFS = Defoliation of Fruiting shoots

## Conclusion

From the above experiment it can be concluded that firstly, moderate leaf to fruit ratios i.e. $T_3$=12:1 and $T_4$=16:1; improved the quality of guava fruits as compared to both low ($T_1$ and $T_2$) as well as high ($T_5$ and $T_6$) leaf to fruit ratios. Secondly, the minimum number of leaves, required for optimum quality of guava fruits, under high density planting was found to be at least 12 for one fruit irrespective of the spacing adopted. Thirdly, the physical characters of guava fruit tend to be influenced more by the manipulation of source-sink relationship than the chemical characters. Lastly, plants at wider spacing performed better in almost all respect than their closely planted counterparts irrespective of the treatment provided.

## Acknowledgement

The present investigation was conducted under the financial assistance of Innovation in Science Pursuit for Inspired Research (INSPIRE) Programme of the Department of Science and Technology, Government of India.

## References

1. Orjuela N, Barreto E. Determination of the optimal foliar area for fruit filling in feijoa (*Acca sellowiana* Berg) in clone Quimba 41. Undergraduate thesis. Agronomy faculty. National university of Colombia, Bogota, 2009.
2. Ranganna S. Handbook of analysis and quality control for fruit and vegetable products. Tata McGraw Hill Publication, New Delhi, 1986.
3. Snedecor GW, Cochran GW. Statistical methods. Oxford and IBH Publication, New Delhi, 1968.
4. Gomez KA, Gomez AA. Statistical procedures for agricultural research (2nded). John Wiley and Sons, New York. 1984, 680.
5. Singh G. Recent development in production of guava. Proceedings of 1st International Symposium on Guava, Acta Horticulturae. ISHS. 2007; 735:161-173.
6. Singh A, Dhaliwal GS. Solar radiation interception and its effect on physical characteristics of fruits of guava cv. Sardar. Proceedings of 1st International Symposium on Guava, Acta Horticulturae. ISHS. 2007; 735:295-302.
7. Kumawat KL, Sarolia DK, Kaushik RA, Jodha AS. Effect of different spacing on newly planted guava cv. L-49 under ultra-high density planting system. African Journal of Agricultural Research. 2014; 9(51):3729-3735. Retrieved from DOI: 10.5897/AJAR2013.7679.
8. Al-Salman H, Al-Wusaibai N, Al-Husseini M, Al-Hajji HI, Al-Abdulhadi IA, Ben Abdallah A. The effect of different leaf/bunch ratios on yield and fruit physical characteristics of Khlass date palm cultivar. Indian Journal of Science and Technology. 2012; 5(3):2287-2288.
9. Srivastava KK, Sharma OC, Singh SR, Tiwari JN, Kumar D. Determining leaf: fruit ratio for high productivity in apple (*Malus pumila*) under intensive orcharding system. Current Horticulture. 2017; 5(1):43-48.
10. Singh JS, Singh HK, Chauhan KS. Effect of high and low density plantation on yield and quality of guava under semi-arid conditions. Journal of Research Haryana Agriculture University. 1980; 10(3):421-423.
11. Bal JS, Dhaliwal GS. High-density planting studies in guava. Haryana Journal of Horticultural Sciences. 2003; 32(1):19-20.
12. Pratibha, Lal S. Effect of shoot pruning and different planting systems on vegetative growth, yield and quality of guava cv. Sardar. Asian Journal of Horticulture. 2012; **7**(1):65-71.
13. Lal S, Tiwari JP, Mahajan AR. Studies on planting systems in guava (*Psidium guajava* L.) cv. Sardar. *Proceedings of 1st* International Symposium on Guava, Acta Horticulturae. ISHS. 2007; 735:263-266.
14. Etchebarne F, Ojeda H, Hunter JJ. Leaf:Fruit ratio and vine water status effects on Grenache Noir (*Vitis vinifera* L.) berry composition: water, sugar, organic acids and cations. South African Journal of Enology and Viticulture. 2010; 31(2):106-115.
15. Deshmukh NA, Patel RK, Deka BC, Jha AK, Lyngdoh P. Leaf to fruit ratio affects fruit yield and quality of low chilling peach cv. Flordasun. Indian Journal of Hill Farming. 2012; 25(1):31-34. Available online at www.kiran.nic.in.