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Variability Studies in Half Sib Progenies of Guava (*Psidium guajava* L.) var. Arka Kiran for Growth, Yield and Quality Attributes

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Abstract

India is known for growing fruit crops that are widely valued in the market. In particular, red pulp varieties of guava tend to have a presence of seeds which limits their overall popularity, among consumers. Therefore, the aim of the current research is to find genotypes having deep red or pink coloured pulp and low seed number. The 48 progenies showed range of variability in terms of plant growth, yield traits and quality traits. Progenies *viz*., PG 15-9 (2.10 m), PG 1-7 and PG 35-1 (2.16 m) have showed low tree height. Fruit yield was highly significant in PG 24-6 (22.45 kg tree^{-1}). Number of seeds fruit^{-1} of progenies underlined varied between 111.22 and 630.95. Compared with PG 1-7 with its parent Arka Kiran whose fruits were of almost equal weight, PG 1-7 proved to be having less number of seeds (341.52 seeds fruit^{-1}) compared to Arka Kiran (428.98 seeds fruit^{-1}). With regards to biochemical constituents of fruit, maximum TSS and total sugar content were seen in progeny, PG 1-7 (12.6 °Brix; 6.72%). Among progenies, maximum ascorbic acid content was seen in PG 28-1 (220.42 mg/ 100 g), followed by PG 1-7 (203.73 mg/ 100 g). In short, on the basis of examination of numerous physico-chemical traits of half-sibling progenies of guava var. Arka Kiran, progeny PG 1-7 proved to be the superior one in terms of maximal intensity of colour of fruit pulp, fruit quality, seed traits and yield, in addition to its organoleptic qualities.

Keywords: Biochemical parameters, Evaluation, Morpho-physiological attributes, Organoleptic qualities, Variability

Introduction

Guava (*Psidium guajava* L.), regarded as being amongst the most significant tropical fruits of the globe, holds tremendous potential to accelerate social and economic progress of backward tropical regions (Hossen, 2012). Guava is a significant horticultural crop in India, ranks fourth in both area and productivity, followed by banana, mango and citrus. *Psidium guajava* is cultivated on 0.28 million hectares and produced 4.03 million tonnes annum^{-1}. Guava cultivation in Tamil Nadu spans across 11,097 hectares and produces a yield of 41,504 metric tons (Anonymous, 2023). Commonly recognized as the '*Apple of the Tropics*', guava is a very acceptable fruit that is valued as a vitamin C source, containing 100-300 mg/ 100 g of pulp.

Guava is endowed with medicinal qualities, *i.e.*, antioxidants and liver and allergy and infection-fighting qualities (Dakappa *et al.*, 2013). The fruit is popular due to its harvests at a price point with easy handling for transportation and consumer appeal. Additionally, guava cultivation is cost effective making it economically significant, in subtropical regions worldwide (Rodriguez *et al.*, 2010).

In cultivated guava genotypes, selective cross-pollination of the species results in considerable genetic diversity (Alves and Freitas, 2007). The application of heterogeneous parent seeds led to the creation of seedlings responsible for enhancing genetic diversity within guava. Guava is now widely popular in the global market both for its nutritious content and also for the variety of products that are processed from it, such as jam, jelly and juice. While there may be around 400 guava varieties available worldwide, there are only a small number that are widely grown and cultivated in many regions of the world. From the point of

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view of tree habit, tree size, fruit size, fruit shape, nutrient content, ripening season and yield, much variation is present within cultivated varieties (Azam *et al.*, 2020). Selection of open-pollinated progenies offers a new platform for novel genetic fusions, expanding the crop's genetic base and ensuring future selection gains. The proper representation of the genetic diversity of the guava germplasm, along with the establishment of the diversity levels and the identification of the potential lines, with breeding and conservation values is possible through the analysis of morpho-agronomic or physiological parameters (Nimisha *et al.*, 2013). The guava F_1 hybrid 'Arka Kiran' was produced by the Indian Institute of Horticultural Research in Bengaluru, exhibiting the capacity to produce medium-sized round fruits with deep red, firm pulp and a high lycopene concentration of 7.14 mg/ 100 g. A correlation was identified between flesh color and seed size (Negi and Rajan, 2005); specifically, red-fleshed fruit is consistently linked to a higher seed count and larger seed size, which hinders its export potential and broader acceptability (Ankad *et al.*, 2024). The purpose of this study was to examine the genetic variability, choose parents for better and higher production and evaluate morphological variances through phenotypic study.

Material and Methods

The research 'variability studies in half sib progenies of guava (*Psidium guajava* L.) var. Arka Kiran for growth, yield and quality traits' was performed at Dept. of Fruit Science, Horticulture College and Research Institute, TNAU, Coimbatore, at coordinates of 11.0168° N, 76.9558° E, during the years 2021-2022. For the present study, 337 half-sibling progenies of guava variety Arka Kiran were examined, which were planted in the College Orchard of the Dept. of Fruit Science at the Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, during the years 2013-2014.

The progenies were assessed for their morphological traits following the DUS guidelines on guava developed by PPV&FRA (2016). From the 337 half-sibling progenies, 48 were selected in 2021-2022 based on their fruiting and flowering performances and these selections are designated as PG selections.

The plant height was measured from the base of the trunk to the apex using a meter scale and recorded in meters (m). The tree's spread was taken in East-West and North-South orientations using a measuring tape and also noted in meters (m). The girth of the plants was taken at the collar area using a measuring tape and noted in centimetres (cm). The total number of primary and secondary branches plant^{-1} were recorded and expressed in numbers.

The length of the new shoots produced in each season was measured from the base to the apex using a metre scale and the average was calculated. The number of leaves produced in each season from individual new shoot was counted and the average was calculated. Randomly three leaves were selected from each progeny; the leaf length and leaf blade width was measured using a scale and expressed in centimetres. Total leaf area was estimated by using the formula:

Total leaf area (cm^2) = Length of leaf (cm) × Breadth of leaf (cm) × 0.72 (factor)

During harvesting, all fruits plant^{-1} were counted from each progeny and the total of each replication was put as number of fruits plant^{-1} at last. Three mature fruits were taken at random from each progeny and were weighed using weighing balance. Average weight was then calculated and reported in grams (g). Weight of fruits collected in each progeny was finally added up and fruit yield reported as kg plant^{-1}. Three fruits were randomly taken from each progeny and length and width of the fruit calculated using Vernier caliper and reported in centimetres (cm). Three fruits were randomly taken from each progeny and circumference of each fruit was measured in its center using a thread and reported in centimetres (cm). Fresh fruits' skin and pulp were stripped off, pulp being measured on electric balance and reported in grams (g). Fruits of each progeny were sliced horizontally and pulp thickness measured on a scale, then reported in centimetres (cm).

Three mature fruits were selected randomly from each progeny, thereafter selected fruits were sliced into four halves and the seeds were manually taken from the pulp and counted. Total fruit yield was calculated by counting all fruits plant^{-1} for each progeny during harvest. Three mature fruits were taken at random from each progeny and were weighed using weighing balance. Guava seeds were extracted, dried and kept at a consistent moisture level for analysis and seed hardiness was quantified utilizing a digital seed hardiness instrument and is expressed in Kgf. The following formula was used to determine the pulp-to-seed ratio:

$$\text{Pulp to seed ration} = \frac{\text{Weight of pulp (g)}}{\text{Weight of seed (g)}}$$

Soluble solids were measured on a digital refractometer with a 0-32° Brix range. One filtered single drop of juice was applied to the prism of the refractometer and the measurement at which the shadow of the sample coincided, with the scale was recorded in terms of °Brix. One hundred seeds were taken from the fruits of every progeny and seed weight was observed using an electronic weighing machine and recorded in grams (g). Three mature fruits were selected randomly from every progeny, thereafter selected fruits were sliced into four parts and the seeds were retrieved, weighed using an electronic weighing machine and recorded in grams (g). The ratio of sugar to acid in guava fruit pulp was determined using the formula.

$$\text{Sugar / Acid ratio} = \frac{\text{Total sugar in the fruit pulp (\%)}}{\text{Titrable acidity of fruit pulp (\% citric acid)}}$$

The overall pectin content was assessed according to the methodology proposed by Ranganna (1977) and presented as a percentage (%). The determination of reducing sugar was conducted following the methodology proposed by Somogyi (1952) and is represented as a percentage (%). It was estimated by subtracting the decreasing sugar values

from total sugar for each sample individually and expressed as a percentage (%). Total sugars were estimated using Somogyi's (1952) method and reported as a percentage. To analyze lycopene pigment, the fruit skin was excised and the juice was filtered through muslin fabric. The filtered juice was combined with 20 ml of acetone and agitated for 30 minutes, after which 40 ml of petroleum ether was introduced and absorbance was recorded at 503 nm to quantify the lycopene concentration, according to the procedure outlined by Ranganna (1977) and measured in mg per 100 g.

A panel of 10 judges conducted an organoleptic study of fully developed fruits from selected progenies. The evaluation was performed based on a 9-point hedonic scale prepared on the basis of principles of organoleptic evaluation (Ranganna, 1977).

Results and Discussion

Table 1 indicates that out of 48 progenies studied, a total of 22 progenies and parent Arka Kiran recorded erect type of attitude, 20 progenies showed spreading type of attitude and 6 progenies recorded drooping type attitude. Singh *et al.* (2013) found that the genotypes Apple Colour, Punjab Pink, 6-4, 7-8 and 12-11 had drooping to spreading plant habits, while the majority of the genotypes exhibited erect to spreading-type branches.

Table 1: Morphological characterization of half sib progenies of guava var. Arka Kiran using guava descriptors (PPV&FRA, 2016)

Sl. No.	Half sib progenies	Tree	Young shoot	Young leaf	Fully developed leaf	Fully developed leaf			Fruit	
		Attitude of Branches	Colour of stem	Anthocyanin coloration	Twisting	Leaf shape	Shape of leaf base	Shape of leaf tip	Longitudinal grooves	Diameter of calyx cavity in relation to that of fruit
1.	PG 1-2	Erect	Green with red streaks	Present	Absent	Round	Rounded	Acute	Absent	Small
2.	PG 1-3	Spreading	Green with red streaks	Present	Absent	Round	Rounded	Obtuse	Absent	Small
3.	PG 1-7	Erect	Green	Present	Absent	Trullate	Rounded	Acute	Present	Small
4.	PG 2-7	Spreading	Green with red streaks	Present	Absent	Round	Obtuse	Rounded	Absent	Small
5.	PG 2-8	Drooping	Green with red streaks	Present	Absent	Trullate	Obtuse	Rounded	Absent	Small
6.	PG 3-2	Erect	Green with red streaks	Present	Absent	Trullate	Rounded	Obtuse	Absent	Small
7.	PG 3-7	Spreading	Green	Absent	Absent	Trullate	Rounded	Obtuse	Absent	Small
8.	PG 4-2	Erect	Green	Absent	Absent	Round	Rounded	Obtuse	Absent	Small
9.	PG 5-5	Spreading	Green	Absent	Absent	Round	Obtuse	Rounded	Absent	Small
10.	PG 5-8	Erect	Green with red streaks	Present	Absent	Oblong	Cordate	Obtuse	Absent	Small
11.	PG 6-9	Spreading	Green	Absent	Absent	Round	Obtuse	Acute	Absent	Small
12.	PG 7-3	Spreading	Green	Absent	Absent	Oblong	Obtuse	Obtuse	Absent	Small
13.	PG 7-4	Erect	Green	Absent	Absent	Oblong	Obtuse	Obtuse	Absent	Small
14.	PG 8-5	Erect	Green with red streaks	Absent	Absent	Round	Cordate	Acute	Absent	Small

Table 1: Continue...

Sl. No.	Half sib pro-genies	Tree	Young shoot	Young leaf	Fully deve-loped leaf	Fully developed leaf			Fruit	
		Attitude of Branches	Colour of stem	Anthocyanin coloration	Twisting	Leaf shape	Shape of leaf base	Shape of leaf tip	Longi-tudinal grooves	Diameter of calyx cavity in relation to that of fruit
15.	PG 8-6	Drooping	Green with red streaks	Present	Absent	Trullate	Rounded	Obtuse	Absent	Small
16.	PG 8-7	Erect	Green with red streaks	Present	Absent	Oblong	Obtuse	Obtuse	Absent	Small
17.	PG 8-10	Erect	Green with red streaks	Present	Absent	Round	Obtuse	Obtuse	Absent	Small
18.	PG 9-5	Spreading	Green with red streaks	Present	Absent	Round	Obtuse	Acute	Absent	Small
19.	PG 9-7	Erect	Green with red streaks	Present	Present	Round	Obtuse	Obtuse	Absent	Small
20.	PG 11-4	Drooping	Green with red streaks	Present	Absent	Round	Obtuse	Obtuse	Absent	Small
21.	PG 11-5	Erect	Green with red streaks	Absent	Absent	Oblong	Rounded	Obtuse	Absent	Small
22.	PG 13-3	Spreading	Green	Present	Absent	Trullate	Rounded	Acute	Absent	Small
23.	PG 13-5	Spreading	Green with red streaks	Present	Absent	Round	Obtuse	Rounded	Absent	Small
24.	PG 15-2	Erect	Green with red streaks	Present	Absent	Oblong	Rounded	Rounded	Absent	Small
25.	PG 15-9	Spreading	Green with red streaks	Present	Absent	Oblong	Rounded	Rounded	Absent	Small
26.	PG 16-1	Erect	Green with red streaks	Present	Absent	Trullate	Rounded	Rounded	Absent	Small
27.	PG 17-1	Spreading	Green	Absent	Absent	Round	Rounded	Acute	Absent	Small
28.	PG 19-2	Erect	Green with red streaks	Present	Absent	Round	Obtuse	Rounded	Absent	Small
29.	PG 22-7	Erect	Green	Absent	Absent	Round	Cordate	Acute	Absent	Small
30.	PG 23-10	Spreading	Green with red streaks	Absent	Absent	Oblong	Rounded	Obtuse	Absent	Small
31.	PG 24-1	Drooping	Green	Absent	Absent	Oblong	Rounded	Rounded	Absent	Small

Table 1: Continue...

Sl. No.	Half sib pro-genies	Tree	Young shoot	Young leaf	Fully deve-loped leaf	Fully developed leaf			Fruit	
		Attitude of Branches	Colour of stem	Antho-cyanin coloration	Twisting	Leaf shape	Shape of leaf base	Shape of leaf tip	Longi-tudinal grooves	Diameter of calyx cavity in relation to that of fruit
32.	PG 24-6	Erect	Green	Absent	Absent	Trullate	Rounded	Acute	Absent	Small
33.	PG 25-1	Spreading	Green	Present	Absent	Trullate	Rounded	Acute	Absent	Small
34.	PG 25-6	Spreading	Green with red streaks	Present	Absent	Round	Rounded	Rounded	Absent	Small
35.	PG 27-2	Spreading	Green	Present	Absent	Round	Rounded	obtuse	Absent	Small
36.	PG 28-1	Erect	Green	Absent	Absent	Oblong	Rounded	Obtuse	Absent	Small
37.	PG 30-1	Spreading	Green with red streaks	Present	Absent	Round	Obtuse	Rounded	Absent	Small
38.	PG 30-2	Erect	Green with red streaks	Present	Absent	Trullate	Rounded	Obtuse	Present	Small
39.	PG 31-2	Drooping	Green	Absent	Absent	Oblong	Obtuse	Acute	Absent	Small
40.	PG 32-1	Erect	Green with red streaks	Present	Absent	Trullate	Rounded	Rounded	Absent	Small
41.	PG 32-3	Spreading	Green with red streaks	Present	Absent	Round	Obtuse	Acute	Absent	Small
42.	PG 33-1	Spreading	Green with red streaks	Present	Absent	Oblong	Cordate	Rounded	Absent	Small
43.	PG 34-1	Erect	Green with red streaks	Present	Absent	Oblong	Rounded	Rounded	Absent	Small
44.	PG 34-2	Spreading	Green with red streaks	Present	Absent	Round	Rounded	Obtuse	Absent	Small
45.	PG 35-1	Spreading	Green with red streaks	Present	Absent	Trullate	Rounded	Rounded	Absent	Small
46.	PG 36-1	Erect	Green with red streaks	Present	Absent	Trullate	Rounded	Rounded	Absent	Small
47.	PG 37-4	Drooping	Green with red streaks	Present	Present	Oblong	Cordate	Acute	Absent	Small
48.	PG 38-4	Erect	Green with red streaks	Present	Absent	Oblong	Rounded	Obtuse	Absent	Small
Check	Arka Kiran	Erect	Dark red	Present	Absent	Trullate	Rounded	Acute	Absent	Large

Out of 48 progenies studied, a total of 16 progenies recorded green colour of stem, 32 progenies recorded green with red streak colour of stem and the parent Arka Kiran recorded with dark red colour stem. Anthocyanin colouration was present in a total of 32 progenies and absent in rest of 16 progenies while, it was present in the parent Arka Kiran. Similar finding was recorded by Singh *et al.* (2013) and observed that red coloured young shoots with anthocyanin colouration of young emerging leaves in genotype like Allahabad Safeda, Apple Colour, Banarsi Surkha, BS 6-12, CISH-G1, CISH-G3, CISH-G4, HS-1, L-49, Portugal, Punjab Pink, Red Fleshed, One kg, 6-4, 7-8, 12-11, 16-11, 17-8, 19-3 and 30-9.

In the identified progenies, twisted leaf pattern was present in PG 9-7 and PG 37-4 and it was absent in rest of the progenies including parent Arka Kiran. Out of 48 progenies studied, the trullate leaf shape was recorded in a total of 13 progenies and in parent Arka Kiran, 20 progenies recorded round leaf shape and 15 progenies recorded oblong leaf shape. Rounded shape of leaf base was recorded in 27 progenies and in parent Arka Kiran, obtuse shape of leaf base was recorded in 16 progenies and cordate shape of leaf base was recorded in 5 progenies. Acute shape of leaf tip was recorded in 13 progenies and in parent Arka Kiran, obtuse shape of leaf tip was recorded in 19 progenies and rounded shape of leaf tip was recorded in 16 progenies. Singh *et al.* (2016) reported similar findings after observing variance in leaf morphology between several genotypes. Elliptical leaf shape was present in Lucknow-49, Arka Amulya, Hisar Surkha and Thailand; whereas in the Pant Prabhat, Allahabad safeda, Hisar and G. Bilas oblong-shaped leaves have been observed. Punjab Pink, 17-16 and Shweta are three genotypes which exhibited lanceolate leaf shape. Out of 48 progenies studied, longitudinal grooves were present in only two progenies, namely PG 1-7 and PG 30-2 and it was absent in rest of the progenies including its parent Arka Kiran. Diameter of fruit's calyx cavity was uniformly small in all the progenies while it was large in the parent Arka Kiran. These outcomes align with the findings of Padilla-Ramirez and Gaona-Gonzalez (2010).

The observed progenies' tree heights ranged from 2.10 to 3.00 m, with a mean of 2.53 m. At the height of 3.00 m, PG 23-10 was found tallest, followed by PG 7-3 and PG 27-2; both of which were 2.95 m. With a height of 2.10 m, PG 15-9 was the shortest, followed by PG 38-4 at 2.11 m, and PG 1-7 and PG 35-1 at 2.16 m. Parent Arka Kiran recorded tree height as 2.17 m. Pandey *et al.* (2016) also reported the same and stated that tree height was significantly higher in Hybrid 21 (6.33 m), while Arka Amulya (4.83 m) had significantly lower tree height. The statistics reported in table 2 indicated that plant dispersion varied significantly in both north-south and east-west orientations among the progenies examined. In N-S direction, the tree spread of the observed progenies ranged from 1.31 to 3.25 m. It was highest in PG 8-6 (3.25 m), with a mean of 2.32 m and lowest in PG 1-2 (1.31 m). However, in E-W direction, the tree spread of the observed progenies ranged from 1.37 to 3.39 m, with a mean of 2.38 m. It was highest in PG 8-6 (3.39 m) and lowest in PG

Table 2: Comparative evaluation of half sib progenies of guava var. Arka Kiran for tree attributes*

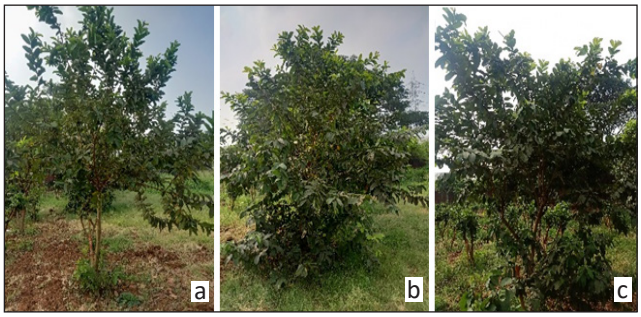
Sl. No.	Half sib progenies	Tree height	Tree spread (m)		Tree girth (cm)	Number of branches trees^{-1}	
			North-South	East-West		Primary	Secondary
1.	PG 1-2	2.75	1.31	1.37	6.53	6	24
2.	PG 1-3	2.55	2.63	2.48	7.35	5	24
3.	PG 1-7	2.16	1.86	2.29	6.84	5	27
4.	PG 2-7	2.44	2.66	2.39	6.54	4	21
5.	PG 2-8	2.66	2.28	2.43	5.70	3	18
6.	PG 3-2	2.78	2.48	2.36	6.60	4	26
7.	PG 3-7	2.65	2.25	2.42	8.45	3	18
8.	PG 4-2	2.72	2.99	2.94	6.64	3	19
9.	PG 5-5	2.66	2.34	2.30	8.41	3	21
10.	PG 5-8	2.94	2.15	2.19	9.13	6	21
11.	PG 6-9	2.53	2.51	2.39	8.66	5	18
12.	PG 7-3	2.95	2.25	2.31	7.15	6	17
13.	PG 7-4	2.46	2.16	2.25	8.23	6	15
14.	PG 8-5	2.70	2.84	2.93	7.35	4	26
15.	PG 8-6	2.65	3.25	3.39	6.20	3	21
16.	PG 8-7	2.53	2.34	2.45	5.80	6	20
17.	PG 8-10	2.46	2.14	2.24	6.10	5	23
18.	PG 9-5	2.78	2.60	2.64	6.70	5	25

Sl. No.	Half sib progenies	Tree height	Tree spread (m)	Tree girth (cm)	Tree girth (cm)	Number of branches trees^{-1}	
			North-South	East-West		Primary	Secondary
19.	PG 9-7	2.60	2.33	2.37	5.98	4	16
20.	PG 11-4	2.81	2.43	2.58	6.92	4	16
21.	PG 11-5	2.21	2.11	2.19	6.93	5	19
22.	PG 13-3	2.25	3.21	2.15	6.33	3	21
23.	PG 13-5	2.40	2.15	2.25	7.90	3	16
24.	PG 15-2	2.26	2.16	2.20	6.85	4	14
25.	PG 15-9	2.10	1.83	1.89	6.35	3	19
26.	PG 16-1	2.64	2.33	2.38	6.95	5	23
27.	PG 17-1	2.89	2.10	2.21	7.45	3	25
28.	PG 19-2	2.77	2.90	3.21	6.69	5	25
29.	PG 22-7	2.57	2.36	2.39	7.23	6	26
30.	PG 23-10	3.00	2.24	2.17	5.65	4	21
31.	PG 24-1	2.51	2.29	2.35	8.13	4	25
32.	PG 24-6	2.32	2.16	3.31	6.78	6	16
33.	PG 25-1	2.38	3.20	1.91	7.99	4	17
34.	PG 25-6	2.49	2.19	2.25	8.32	4	23
35.	PG 27-2	2.95	2.18	2.23	6.75	3	16
36.	PG 28-1	2.35	2.11	1.95	5.72	3	23
37.	PG 30-1	2.25	1.43	1.48	6.11	3	24
38.	PG 30-2	2.56	2.32	2.44	8.35	5	23
39.	PG 31-2	2.54	2.31	2.38	8.46	3	22
40.	PG 32-1	2.39	3.20	3.31	6.22	5	16
41.	PG 32-3	2.32	2.11	3.31	6.50	3	18
42.	PG 33-1	2.80	3.12	3.19	7.52	5	16
43.	PG 34-1	2.38	2.11	1.91	7.99	4	17
44.	PG 34-2	2.19	1.90	2.01	6.63	5	22
45.	PG 35-1	2.16	2.21	1.90	6.01	3	17
46.	PG 36-1	2.93	1.98	2.10	8.76	3	22
47.	PG 37-4	2.43	2.12	2.33	7.75	4	26
48.	PG 38-4	2.11	1.84	1.91	6.45	3	20
Check	Arka Kiran	2.17	1.88	2.62	6.00	4	23
	Mean	2.53	2.32	2.38	7.60	4.18	20.63
	Maximum	3.00	3.25	3.39	9.13	6	27
	Minimum	2.10	1.31	1.37	5.65	3	14
	SE of mean	0.04	0.06	0.06	0.13	0.15	0.51
	SD	0.25	0.43	0.44	0.94	1.07	3.60
	CV (%)	9.88	18.37	18.66	13.25	25.67	17.44

*Average of two season's data

1-2 (1.37 m) (Figure 1). Singh *et al.* (2018) also noted that genotype RJMG-3 (7.78 m) had the greatest plant spread (North-South); whereas genotype BSPG-9 had the least (5.11 m) plant spread (North-South).

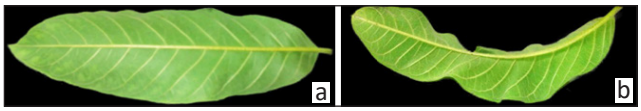
The girth of the progeny tree varied from 5.65 to 9.13 cm, with a mean of 7.60 cm. The girth of trees was considerably higher in PG 5-8 (9.13 cm), followed by PG 36-1 (8.76 cm); on the other hand, PG 23-10 (5.65 cm) had significantly



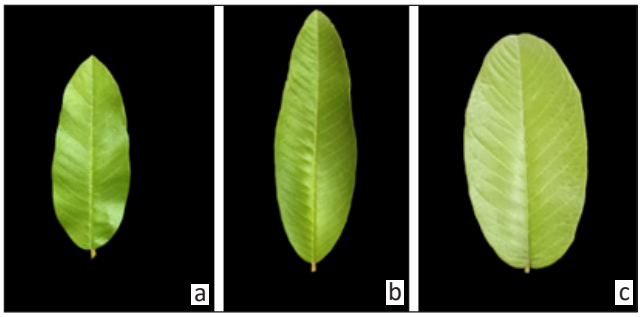
Character 1: Tree: Attitude of branches [a) Erect (Arka Kiran); b) Spreading (PG 25-1); c) Drooping (PG 31-2)]

Character 2: Young shoot: Colour of stem [a) Dark red (Arka Kiran); b) Green with red streak (PG 5-8); c) Green (PG 1-7)]

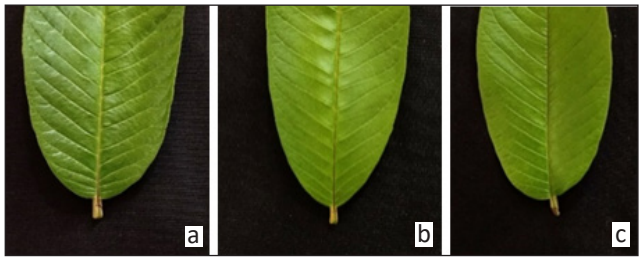
Character 3: Young leaf: Anthocyanin coloration [a) Present (Arka Kiran); b) Absent (PG 28-1)]



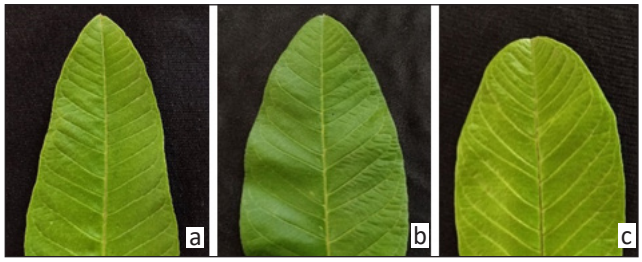
Character 4: Fully developed leaf: Twisting coloration [a) Absent (Arka Kiran); b) Present (PG 37-4)]



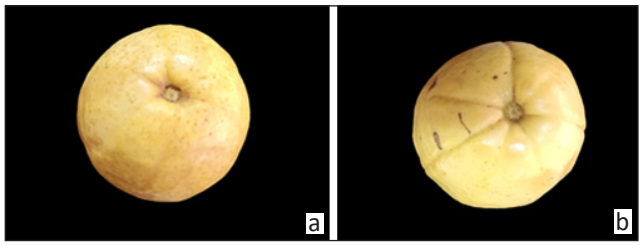
Character 5: Fully developed leaf: Shape coloration [a) Trullate (Arka Kiran); b) Oblong (PG 11-5); c) Round (PG 30-1)]



Character 6: Fully developed leaf: Shape of base coloration [a) Rounded (Arka Kiran); b) Obtuse (PG 32-3); c) Cordate (PG 5-8)]



Character 7: Fully developed leaf: Shape of tip coloration [a) Acute (Arka Kiran); b) Obtuse (PG 28-1); c) Rounded (PG 24-1)]



Character 8: Fruit: Longitudinal grooves [a) Absent (Arka Kiran); b) Present (PG 1-7)]

Character 9: Fruit: Diameter of calyx cavity [a) Large (Arka Kiran); b) Small (PG 1-7)]

Figure 1: Morphological description of selected half sib progenies of guava var. Arka Kiran

lower tree girth, followed by PG 2-8 (5.70 cm). The parent Arka Kiran recorded a tree girth of 6.00 cm. The coefficient of variation for tree girth was 13.25%. The study conducted by Athani *et al.* (2007) in cv. Seedless supported the findings of the current study. From table 2, it can be asserted that the number of primary branches in the progenies ranged from 3 to 6. The highest number was observed in PG 1-2, PG 5-8, PG 7-3, PG 7-4, PG 8-7, PG 22-7 and PG 24-6 (6); while least number was observed in PG 2-8, PG 3-7, PG 4-2, PG 5-5, PG 8-6, PG 13-3, PG 13-5, PG 15-9, PG 17-1, PG 27-2, PG 28-1, PG 30-1, PG 31-2, PG 32-3, PG 35-1, PG 36-1 and PG 38-4

(3). The number of secondary branches in the progenies varied between 14 and 27. It was found maximum in PG 1-7 (27) and least in PG 15-2 (14). Parent Arka Kiran had 4 major and 23 secondary branches. The findings confirm the assertion of Marak and Mukunda (2007) that the greater the plant spread and number of secondary and third order branches, the greater the fruiting potential as in the situation of A.C. Seln.10/2. The differences in the inherent traits of the germplasm, the climatic conditions and management practises could be contributing factors to the variation in tree attributes.

The range of the lengths of the new shoots of the progenies being monitored varied between 21.81 and 29.73 cm, with an average of 25.23 cm. The half sib progeny PG 34-1 had the maximum length of the shoots at 29.73 cm, followed by PG 13-3 (28.72 cm). Conversely, PG 32-3 had the shortest shoot length of 21.81 cm with PG 30-12 (1.85 cm) just slightly longer. The parent Arka Kiran recorded a shoot length of 24.86 cm. Comparable findings were reported by Patel *et al*. (2011), where leaves shoot^{-1} ranged between 36.83 and 45.50 in the genotypes that were studied. Leaves shoot^{-1} of progenies varied among 21.00 and 28.80 having a mean value of 24.50. Half sib progeny, PG 34-1 (28.80) produced a big leaves shoot^{-1}, followed by PG 13-3 (27.90); yet PG 30-1 (21.00) produced small leaves shoot^{-1}, followed by PG 13-5 (21.20). Parent Arka Kiran produced a shoot length of 23.90. The number of leaves per shoot^{-1} had a coefficient of variation of 7.76. The length of leaf blade varied from 10.90 cm to 16.80 cm, with its average of 13.97 cm. The highest leaf blade length (16.80 cm) recorded from PG 33-1, followed by PG 7-4 (16.72 cm). The lowest leaf blade length (10.90 cm) observed from PG 23-10, followed by PG 4-2 (11.00 cm). The parent Arka Kiran's leaf blade length was 15.18 cm. Leaf blade width classified over 5.00 cm and 7.80 cm, with an average of 6.50 cm. PG 37-4 has the highest width 7.80 cm following the PG 7-4 which had the leaf blade width of 7.70 cm. The parent Arka Kiran had a leaf blade width of 7.30 cm. These results agree with Singh *et al.* (2016). According to them, among the various genotypes, the longest leaf length (151.27 mm) was recorded by Punjab Pink, followed by 17-16 at 147.06 mm. In contrast, Lalit had the shortest leaf length (101.89 mm), followed by Thailand at 107.56 mm. The progeny leaf area was found to range between 40.63 cm^2 and 92.70 cm^2, with the mean being 65.65 cm^2. PG 7-4 recorded the largest leaf area (92.70 cm^2), followed by PG 1-7 (89.80 cm^2), while PG 4-2 recorded the smallest leaf area (40.63 cm^2), with PG 23-10 recording a leaf area of 43.32 cm^2. The parent Arka Kiran recorded leaf area of 79.79 cm^2 (Table 3). The observations of this study align with those of Shiva *et al.* (2017), who inferred that maximum leaf area was in red type (60.92 cm^2) and minimum leaf area in *P. pumilum* (10.93 cm^2). The differences in the genetic make-up of these progenies for various morphological characters may account for the variation in leaf characters among them (Pandey *et al.*, 2017).

Table 3: Comparative evaluation of half sib progenies of guava var. Arka Kiran for shoots and leaf characters*

Sl. No.	Half sib progenies	Length of new shoot (cm)	Number of leaves shoot^{-1}	Length of leaf blade (cm)	Width of leaf blade (cm)	Length/width ratio of leaf blade	Leaf area (cm^2)
1.	PG 1-2	25.60	24.30	15.20	6.41	2.37	70.15
2.	PG 1-3	26.23	25.22	13.80	7.00	1.97	69.55
3.	PG 1-7	28.60	27.10	16.52	7.55	2.19	89.80
4.	PG 2-7	24.30	23.20	15.10	6.06	2.49	65.88
5.	PG 2-8	23.30	22.22	14.50	6.32	2.29	65.98
6.	PG 3-2	25.02	24.35	13.33	7.02	1.90	67.38
7.	PG 3-7	23.00	22.20	11.20	6.32	1.77	50.96
8.	PG 4-2	24.61	23.80	11.00	5.13	2.14	40.63
9.	PG 5-5	25.06	24.55	13.68	5.15	2.66	50.73
10.	PG 5-8	26.11	25.23	14.60	6.05	2.41	63.60
11.	PG 6-9	27.06	26.45	15.20	6.43	2.36	70.37
12.	PG 7-3	25.00	24.32	12.50	5.00	2.50	45.00
13.	PG 7-4	25.20	24.40	16.72	7.70	2.17	92.70
14.	PG 8-5	24.09	23.21	14.70	7.30	2.01	77.26
15.	PG 8-6	23.40	22.60	13.30	6.30	2.11	60.33
16.	PG 8-7	27.51	26.75	14.40	7.20	2.00	74.65
17.	PG 8-10	27.20	26.00	14.66	6.38	2.30	67.34
18.	PG 9-5	22.62	21.80	14.20	7.50	1.89	76.68
19.	PG 9-7	22.90	22.10	11.80	6.60	1.79	56.07
20.	PG 11-4	24.32	23.50	14.72	6.39	2.30	67.72

Sl. No.	Half sib progenies	Length of new shoot (cm)	Number of leaves shoot^{-1}	Length of leaf blade (cm)	Width of leaf blade (cm)	Length/width ratio of leaf blade	Leaf area (cm^2)
21.	PG 11-5	27.28	26.58	13.80	7.00	1.97	69.55
22.	PG 13-3	28.72	27.90	15.20	7.09	2.14	77.59
23.	PG 13-5	22.01	21.20	16.50	6.70	2.46	79.60
24.	PG 15-2	25.43	24.70	15.34	5.20	2.95	57.43
25.	PG 15-9	26.21	25.39	14.50	6.25	2.32	65.25
26.	PG 16-1	24.02	23.10	13.05	6.50	2.01	61.07
27.	PG 17-1	22.89	22.00	14.20	6.11	2.32	62.47
28.	PG 19-2	22.43	21.50	12.80	6.30	2.03	58.06
29.	PG 22-7	26.29	25.52	15.22	6.90	2.21	75.61
30.	PG 23-10	24.21	23.20	10.90	5.52	1.97	43.32
31.	PG 24-1	24.85	24.00	12.70	6.80	1.87	62.18
32.	PG 24-6	27.20	26.31	13.30	5.50	2.42	52.67
33.	PG 25-1	26.19	25.20	13.00	6.89	1.89	64.49
34.	PG 25-6	23.90	23.00	11.67	6.60	1.77	55.46
35.	PG 27-2	24.13	23.40	14.00	7.00	2.00	70.56
36.	PG 28-1	23.25	22.50	13.00	6.91	1.88	64.68
37.	PG 30-1	21.85	21.00	11.50	6.40	1.80	52.99
38.	PG 30-2	25.54	24.62	14.04	5.80	2.42	58.63
39.	PG 31-2	27.59	26.63	14.50	5.50	2.64	57.42
40.	PG 32-1	28.46	27.54	14.90	6.41	2.32	68.77
41.	PG 32-3	21.81	26.80	13.26	5.50	2.41	52.51
42.	PG 33-1	26.13	25.35	16.80	7.00	2.40	84.67
43.	PG 34-1	29.73	28.80	14.10	6.52	2.16	66.19
44.	PG 34-2	26.80	26.00	15.30	6.90	2.22	76.01
45.	PG 35-1	26.14	25.29	13.62	7.20	1.89	70.61
46.	PG 36-1	27.90	27.00	13.21	6.31	2.09	60.02
47.	PG 37-4	26.33	25.56	14.30	7.80	1.83	80.31
48.	PG 38-4	23.11	23.00	13.50	6.80	1.99	66.10
Check	Arka Kiran	24.86	23.90	15.18	7.30	2.08	79.79
	Mean	25.23	24.50	13.97	6.50	2.17	65.65
	Maximum	29.73	28.80	16.8	7.80	2.95	92.70
	Minimum	21.81	21.00	10.9	5.00	1.77	40.63
	SE of mean	0.28	0.27	0.20	0.10	0.04	1.62
	SD	1.97	1.90	1.43	0.69	0.26	11.32
	CV (%)	7.81	7.76	10.22	10.63	12.21	17.25

*Average of two season's data

The number of fruits tree^{-1} among the observed progenies ranged from 43 to 105, with an average of 73.55. PG 1-7 exhibited the utmost number of fruits tree^{-1} (105), followed by PG 36-1 (104 fruits tree^{-1}). The lowest number was observed in PG 16-1 (43 fruits tree^{-1}) with PG 8-5, PG 15-2 and PG 37-4 each recording 45 fruits tree^{-1}. Arka Kiran contained 86 fruits tree^{-1}. The progenies exhibited a wide range of individual fruit weights which varied from 41.62 g to 228.60 g having an average value of 130.99 g. The highest weight of fruit was recorded as 228.60 g in PG 24-6 following 210.00 g, exhibited by PG 1-7. Maximum fruit weight was 228.60 g in PG 24-6, followed by PG 1-7 (210.00 g). Minimum fruit weight was 41.62 g in PG 2-8, followed by PG 3-2 (64.09 g). Arka Kiran's fruit weight was 220.00 g. Results were in

accordance with Mahour *et al.* (2012). Between progenies, maximum yield was 22.45 kg tree^{-1} in PG 24-6, followed by PG 11-5 (20.90 kg tree^{-1}). The greater fruit yield of progeny PG 24-6 is due to its higher values of yield-contributing characters. Conversely, PG 2-8 produced least yield of 3.47 kg tree^{-1}; while PG 9-7 showed slightly more yield of 4.13 kg tree^{-1}. The fruit length of the progenies ranged between 5.00 and 9.50 cm, with an average value of 6.44 cm. The parent Arka Kiran exhibited the longest fruit length at 9.50 cm, followed by PG 24-6 at 8.30 cm. On the contrary, PG 8-7 registered the shortest fruit length of 5.00 cm, followed by PG 3-2 at 5.10 cm. The fruit width of the progenies ranged from 4.64 cm to 8.26 cm, with a mean of 6.25 cm. Arka Kiran has produced the widest fruit of 8.26 cm, followed by PG 34-1 at 8.16 cm; while PG 6-9 registered as the narrowest at 4.64 cm, followed by PG 3-2 at 4.81 cm. The fruit circumference varied from 12.60 cm to 25.50 cm, with an average of 20.26 cm. PG 24-6 registered as the largest fruit circumference at 25.50 cm, followed by PG 32-1 and PG 35-1, both at 24.50 cm. The smallest circumference was recorded in PG 2-8 at 12.60 cm, followed by PG 3-2 at 15.10 cm. The parent Arka Kiran recorded fruit circumference of 15.50 cm. The coefficient of variation for fruit circumference was 12.33% (Table 4). Khan *et al.* (2019) similarly documented that the largest fruit length was found in the Philippines (5.75 cm), whereas the smallest fruit length was recorded in Shweta (4.64 cm). The fruit diameter varied from 4.42 cm to 6.29 cm with Kafri exhibiting the largest diameter (6.29 cm) and Kohir Round the smallest (4.42 cm). Fruit pulp thickness of the progenies noted varied from 0.52 cm to 1.53 cm, with a mean of 1.11 cm. The highest pulp thickness was noticed in PG 1-7 and PG 22-7 (1.53 cm), followed closely by PG 8-6 and PG 24-6 (1.52 cm). Thinnest pulp thickness was seen in PG 1-2 and PG 2-8 (0.52 cm), followed by PG 5-5 and PG 32-3 (0.62 cm). Arka Kiran fruit pulp thickness was 1.33 cm (Table 4). The increase in pulp thickness in PG 1-7 and PG 22-7 might be due to higher pulp weight and fruit weight with few seeds in the aforementioned genotypes. The same observation was made by Pandey *et al.* (2016) and Patel *et al.* (2007), where maximum pulp thickness was seen in seedless varieties. Variation in progeny in different fruit traits might be caused by the variation in the intrinsic traits of the germplasm.

Table 4: Comparative evaluation of half sib progenies of guava var. Arka Kiran for different physical characteristics of fruit*

Sl. No.	Half sib progenies	No. of fruits tree^{-1}	Individual fruit weight (g)	Fruit yield (kg tree^{-1})	Fruit length (cm)	Fruit width (cm)	Fruit circumference (cm)	Pulp weight (g)	Fruit pulp thickness (cm)
1.	PG 1-2	65	86.82	5.26	5.20	5.15	18.70	77.52	0.52
2.	PG 1-3	79	151.18	11.30	6.70	6.26	21.70	123.92	1.34
3.	PG 1-7	105	210.00	19.04	8.20	7.96	23.60	173.55	1.53
4.	PG 2-7	82	97.20	6.75	5.80	5.92	19.30	79.02	0.83
5.	PG 2-8	89	41.62	3.47	5.20	5.31	12.60	33.84	0.52
6.	PG 3-2	83	64.09	4.82	5.10	4.81	15.10	52.11	0.91
7.	PG 3-7	75	126.72	8.81	6.60	5.69	20.40	103.02	0.95
8.	PG 4-2	85	72.94	5.63	5.20	5.05	15.40	59.30	0.63
9.	PG 5-5	78	141.45	10.82	6.70	6.50	20.20	116.90	0.62
10.	PG 5-8	99	128.63	12.30	6.50	6.07	20.50	106.31	1.32
11.	PG 6-9	68	66.82	4.15	5.20	4.64	16.10	53.89	1.34
12.	PG 7-3	59	109.98	6.23	6.20	6.33	19.20	88.69	1.21
13.	PG 7-4	75	139.17	9.92	6.60	6.41	20.60	112.23	1.18
14.	PG 8-5	45	105.28	4.38	6.00	6.00	19.00	85.59	0.81
15.	PG 8-6	66	145.88	9.48	6.80	6.67	20.30	118.60	1.52
16.	PG 8-7	57	82.59	4.28	5.00	4.95	18.50	67.15	1.13
17.	PG 8-10	78	143.53	11.21	6.80	6.73	22.20	116.69	0.92
18.	PG 9-5	96	109.40	10.09	6.10	5.98	20.10	89.67	1.47
19.	PG 9-7	55	86.39	4.13	5.20	5.50	18.80	70.81	1.26
20.	PG 11-4	78	107.60	8.04	6.00	5.88	19.90	88.93	0.93
21.	PG 11-5	100	200.24	20.90	7.00	6.86	23.30	165.49	1.24
22.	PG 13-3	98	117.34	10.96	7.00	6.86	19.10	97.78	1.32
23.	PG 13-5	56	116.40	6.02	6.10	5.98	19.00	93.87	1.26

Sl. No.	Half sib progenies	No. of fruits tree^{-1}	Individual fruit weight (g)	Fruit yield (kg tree^{-1})	Fruit length (cm)	Fruit width (cm)	Fruit circumference (cm)	Pulp weight (g)	Fruit pulp thickness (cm)
24.	PG 15-2	45	201.22	9.05	7.70	7.62	24.10	171.15	1.51
25.	PG 15-9	66	101.18	6.29	5.90	5.67	19.80	81.60	0.91
26.	PG 16-1	43	202.11	8.37	6.60	6.53	20.40	172.11	1.23
27.	PG 17-1	57	106.19	5.81	5.90	5.78	20.00	87.04	1.34
28.	PG 19-2	48	132.79	5.89	6.50	6.07	20.40	109.65	1.27
29.	PG 22-7	61	133.86	7.87	6.50	6.37	20.40	110.63	1.53
30.	PG 23-10	53	155.25	7.79	6.70	6.57	21.80	128.31	1.43
31.	PG 24-1	62	122.52	7.09	6.30	6.18	20.60	101.26	1.21
32.	PG 24-6	98	228.60	22.45	8.30	7.55	25.50	188.93	1.52
33.	PG 25-1	102	132.50	13.48	6.50	6.44	21.30	108.61	1.31
34.	PG 25-6	58	100.50	5.39	5.90	5.27	19.80	81.64	0.65
35.	PG 27-2	74	102.01	7.28	6.10	6.16	20.50	82.80	0.70
36.	PG 28-1	61	175.50	10.68	8.20	7.88	22.10	145.04	1.29
37.	PG 30-1	62	153.69	9.34	6.80	6.54	21.80	123.94	1.26
38.	PG 30-2	59	112.00	6.33	5.60	5.66	20.50	92.56	0.85
39.	PG 31-2	96	123.30	11.45	6.20	6.02	21.60	101.90	0.92
40.	PG 32-1	98	205.02	19.78	6.30	6.18	24.50	173.39	1.38
41.	PG 32-3	98	90.00	8.57	6.20	6.02	19.10	74.38	0.62
42.	PG 33-1	52	127.30	6.14	6.70	6.84	20.30	105.21	1.21
43.	PG 34-1	103	195.80	19.98	8.00	8.16	24.30	160.49	1.43
44.	PG 34-2	60	123.30	6.81	6.30	6.36	20.20	101.07	1.11
45.	PG 35-1	89	200.00	17.58	8.10	7.86	24.50	163.93	1.00
46.	PG 36-1	104	91.00	8.94	6.20	6.02	19.00	74.59	0.67
47.	PG 37-4	45	110.50	4.66	5.40	4.91	21.00	89.62	1.22
48.	PG 38-4	53	121.00	6.15	6.30	5.63	20.10	100.00	0.81
Check	Arka Kiran	86	220.00	18.89	9.50	8.26	15.50	181.82	1.33
	Mean	73.55	130.99	9.39	6.44	6.25	20.26	107.89	1.11
	Maximum	105	228.60	22.45	9.50	8.26	25.50	188.93	1.53
	Minimum	43	41.62	3.47	5.00	4.64	12.60	33.84	0.52
	SE of mean	2.73	6.34	0.70	0.13	0.12	0.36	5.32	0.04
	SD	19.12	44.38	4.93	0.94	0.87	2.49	37.24	0.30
	CV (%)	25.99	33.88	52.53	14.65	14.03	12.33	34.52	27.00

*Average of two season's data

Seeds fruit^{-1} in the inspected progenies varied between 111.22 and 630.95, with a mean of 299.60. PG 16-1 exhibited the utmost number of seeds fruit^{-1} (630.95), followed by PG 15-2 (500.73). PG 2-8 exhibited the least number of seeds (111.22). Arka Kiran had 428.98 seeds fruit^{-1}. When comparing Arka Kiran with PG 1-7, which had nearly identical fruit weights, PG 1-7 exhibited a lower seed count (341.52 seeds fruit^{-1}) compared to Arka Kiran (428.98 seeds fruit^{-1}). Less the number of seed in fruit forms, more the pulp thickness and variations in the genetic makeup of different genotypes. Marak and Mukunda (2007) also reported that among 272 open-pollinated seedling progenies of Apple Color, A.C. Sel. 6/10 contained the lowest seed count (142 seeds). The 100 seed weight of the progenies ranged between 0.51 g and 2.43 g, with a mean of 1.20 g. PG 16-1 had the highest seed weight (2.43 g), followed by PG 15-2 (1.89 g). The lowest seed weight was noticed in PG 2-8 (0.51 g), followed by PG 3-2 at 0.59 g. The weight of 100 seeds for Arka Kiran was 1.70 g. The lower seed weight might be due to a smaller number of seeds, smaller seed size and smaller fruit

size. Singh *et al.* (2015) also found similar results, where 100 g fruit weight of seed varied from 0.93 g to 3.12 g. The total seed weight fruit^{-1} ranged from 1.46 g to 6.85 g, with a mean of 3.42 g in the progenies. PG 16-1 had the highest total seed weight fruit^{-1} (6.85 g,), followed by PG 15-2 (5.50 g). The lowest total seed weight fruit^{-1} was found in PG 2-8 (1.46 g), followed by PG 6-9 (1.67 g). Total seed weight fruit^{-1} of Arka Kiran was 4.77 g. Lower total seed weight fruit^{-1} is perhaps because of having less number of seeds fruit^{-1} and less fruit weight. Results of the current study are aligning with the findings of Asrey *et al.* (2007). The observed offspring exhibited a range of seed hardiness, from a minimum of 4.98 Kgf to a maximum of 7.08 Kgf, with an average of 5.79 Kgf. The greatest seed hardiness (7.08 Kgf) was observed in PG 23-10 and closely resembled that of PG 30-1 and PG 32-3 (6.78 Kgf). PG 1-7 possessed the least seed hardiness (4.98 Kgf), while PG 2-7 and PG 3-7 trailed behind closely (5.16 Kgf). The parent Arka Kiran recorded seed hardiness of 5.29 Kgf. The diversity in seed hardiness among genotypes may be linked to the genetic composition of the plants. Singh *et al.* (2017) also recorded the parallel results among the guava hybrids. Among the observed progenies, the highest seed hardness was found in Allahabad Safeda × Shweta, reaching 16.48 kg cm^{-2}. They were immediately succeeded by Allahabad Safeda × Lalit (16.39 kg cm^{-2}), Allahabad Safeda × Purple Guava (15.35 kg cm^{-2}) and Allahabad Safeda × Arka Kiran (13.86 kg cm^{-2}). Progenies varied in pulp-to-seed ratio from the lowest of 23.11 to the highest of 43.28, with the mean of 31.64. The highest pulp-to-seed ratio of 43.28 belonged to PG 1-7 and then PG 34-1 (39.58). Contrarily, the lowest pulp to seed ratio was seen in PG 2-8 (23.11), followed by PG 16-1 (25.12) (Table 5). Higher pulp to seed ratio of genotypes is perhaps due to higher weight of fruit relative to the less weight of seeds fruit^{-1}. The results also agree with Gangappa *et al*. (2022).

Table 5: Comparative evaluation of half sib progenies of guava var. Arka Kiran for seed attributes*

Sl. No.	Half sib progenies	No. of seeds fruit^{-1}	Weight of 100 seeds (g)	Total seed weight fruit^{-1} (g)	Seed hardiness (Kgf)	Pulp to seed ratio
1.	PG 1-2	288.89	1.03	2.97	5.88	26.12
2.	PG 1-3	400.36	1.54	4.38	5.38	28.31
3.	PG 1-7	341.52	1.27	4.01	4.98	43.28
4.	PG 2-7	246.66	1.01	2.87	5.16	27.55
5.	PG 2-8	111.22	0.51	1.46	5.28	23.11
6.	PG 3-2	133.97	0.59	1.70	5.52	30.65
7.	PG 3-7	278.56	1.10	3.18	5.16	32.35
8.	PG 4-2	148.55	0.67	1.84	5.42	32.18
9.	PG 5-5	405.64	1.63	4.50	5.31	26.00
10.	PG 5-8	257.05	1.09	3.01	5.98	35.26
11.	PG 6-9	131.76	0.60	1.67	5.56	32.35
12.	PG 7-3	261.37	1.06	3.00	5.86	29.56
13.	PG 7-4	355.81	1.40	3.97	5.75	28.25
14.	PG 8-5	273.91	1.10	3.13	5.90	27.35
15.	PG 8-6	338.56	1.34	3.80	5.96	31.25
16.	PG 8-7	166.61	0.71	2.03	5.60	33.09
17.	PG 8-10	320.36	1.30	3.62	5.70	32.27
18.	PG 9-5	240.83	0.97	2.80	5.44	32.08
19.	PG 9-7	230.28	0.98	2.69	5.36	26.36
20.	PG 11-4	277.06	1.13	3.17	5.42	28.06
21.	PG 11-5	406.61	1.59	4.57	5.54	36.25
22.	PG 13-3	233.26	0.96	2.77	5.46	35.26
23.	PG 13-5	255.85	1.02	2.96	5.60	31.68
24.	PG 15-2	500.73	1.89	5.50	5.36	31.11
25.	PG 15-9	227.41	0.92	2.67	5.50	30.58
26.	PG 16-1	630.95	2.43	6.85	5.56	25.12
27.	PG 17-1	253.29	1.04	2.94	5.62	29.64
28.	PG 19-2	369.48	1.47	4.14	6.00	26.48

Sl. No.	Half sib progenies	No. of seeds fruit^{-1}	Weight of 100 seeds (g)	Total seed weight fruit^{-1} (g)	Seed hardiness (Kgf)	Pulp to seed ratio
29.	PG 22-7	377.07	1.50	4.24	5.40	26.12
30.	PG 23-10	452.45	1.77	5.06	7.08	25.35
31.	PG 24-1	260.08	1.06	3.01	6.12	33.59
32.	PG 24-6	457.53	1.81	5.16	5.32	36.64
33.	PG 25-1	246.94	1.02	2.91	5.64	37.26
34.	PG 25-6	269.03	1.08	3.08	5.42	26.54
35.	PG 27-2	240.70	0.99	2.82	5.72	29.34
36.	PG 28-1	351.77	1.40	4.01	5.60	36.18
37.	PG 30-1	366.12	1.42	4.13	6.78	30.00
38.	PG 30-2	235.32	0.95	2.77	6.66	33.45
39.	PG 31-2	251.73	1.01	2.94	6.01	34.68
40.	PG 32-1	456.43	1.74	5.06	6.38	34.29
41.	PG 32-3	152.82	0.66	1.92	6.78	38.78
42.	PG 33-1	352.96	1.43	3.99	6.48	26.34
43.	PG 34-1	359.71	1.45	4.05	6.18	39.58
44.	PG 34-2	314.28	1.28	3.57	6.66	28.34
45.	PG 35-1	402.15	1.63	4.55	6.40	36.00
46.	PG 36-1	160.45	0.72	2.00	6.16	37.25
47.	PG 37-4	213.81	0.90	2.51	6.54	35.74
48.	PG 38-4	243.30	1.02	2.85	6.38	35.09
Check	Arka Kiran	428.98	1.70	4.77	5.29	38.12
	Mean	299.60	1.20	3.42	5.79	31.64
	Maximum	630.95	2.43	6.85	7.08	43.28
	Minimum	111.22	0.51	1.46	4.98	23.11
	SE of mean	15.19	0.06	0.16	0.07	0.65
	SD	106.34	0.39	1.11	0.49	4.52
	CV (%)	35.49	32.51	32.49	8.38	14.28

*Average of two season's data

The TSS of the observed progenies ranged from 7.00 to 12.6 °Brix, with a mean of 9.55 °Brix. The Total Soluble Solids (TSS) concentration of the progenies varied significantly. PG 1-7 exhibited the highest TSS (12.6 °Brix), followed by Arka Kiran (12.00 °Brix). Conversely, PG 7-4 and PG 27-2 contained the lowest TSS (7.00 °Brix), while PG 15-9 contained 7.20 °Brix. The differences in the TSS levels observed are genetically and environmentally determined. The genetic makeup and the phenotypic composition of the progenies may influence the absorption of the nutrients and the distribution of the carbohydrates to the fruits. Additionally, seasonal variations can also impact TSS levels. A high TSS of 13.25 °Brix has also been recorded previously by Agrawal (2010) in seedless guava variety. Titratable acidity of the progenies observed ranged from 0.19% to 0.29%, averaging 0.23%. Maximum titratable acidity (0.29%) exhibited in PG 35-1, followed by PG 1-7 and Arka Kiran (0.28%). PG 1-3, PG 15-9 and PG 27-2 had the minimum titratable acidity (0.19%), while PG 30-1, PG 31-2 and PG 38-4 had 0.20%. Genetic constitution of the individual progenies may lead to variation in titratable acidity. According to Patel *et al.* (2015), the overall titratable acidity increases steadily during the initial 105 days of the development of the fruits. It is due to the rise in the biosynthesis rate of organic acids. Ascorbic acid content of the progenies varied from 156.89 to 220.42 mg/ 100 g and averaged 181.45 mg/ 100 g. Maximum ascorbic acid concentrations of 220.42 mg/ 100 g was observed in PG 28-1, while PG 1-7 had 203.73 mg/ 100 g. Conversely, the lowest level of ascorbic acid was seen in PG 25-1 (156.89 mg/ 100 g), succeeded by PG 15-9 (161.20 mg/ 100 g). The large fluctuation in ascorbic acid level might be ascribed to seasonal favourability and progeny varietal character. Suryakanth and Mukunda (2007) also inferred that the selection 5/10 had the highest ascorbic acid concentration (224.20 mg/ 100 g) among the observed genotypes. The ratio of the progenies' sugar to the acid varied from 14.56 to 29.55 and averaged 21.97. The highest ratio of the sugar to the acid was that of PG 5-8 (29.55) and then PG 4-2

(29.50). The lowest ratio of the sugar to the acid was that of PG 7-4 (14.56), then PG 2-8 (18.13). The parent Arka Kiran recorded sugar/acid ratio of 20.11. High total sugar content (6.72%) coupled with moderate acid content (0.28%) was found in the genotype PG 1-7 indicating better dessert quality of fruit. The phenotypic and genetic components of the progeny may have improved by nutrient uptake and increased the accumulation of additional carbs in the fruits, which might be attributed to high level of sugar/acid ratio. Additionally, the prevailing agro-climatic conditions were also favour the development of high-quality fruit. The ratios of the observed sugar to the observed acids are consistent with the results reported by Marak and Mukunda (2007). The pectin content of the progenies varied from 0.46% to 0.73%, averaging 0.57%. PG 35-1 recorded the highest pectin content (0.73%), while PG 1-7 recorded 0.71%. PG 27-2 recorded the lowest pectin content (0.46%), while PG 1-3, PG 15-9, PG 33-1 and PG 38-4 recorded 0.47%. The differences in the pectin content may both be genetic and environmental. The results reported in this study are consistent with the outcomes observed by Deshmukh *et al.* (2013) and Mehta *et al.* (2016). The content of the observed reducing sugars ranged from 2.03% to 4.23%, with an average of 3.05%. The utmost content of the observed reducing sugars exhibited in PG 1-2 (4.23%), while PG 5-8 recorded 3.95%. The lowest content of the observed reducing sugars was in PG 1-3 (2.03%). Arka Kiran recorded 3.66% of the content of the reducing sugars. The content of the observed non-reducing sugars varied from 1.15% to 3.08%, averaging 1.98%. PG 5-5 exhibited the utmost content of the observed non-reducing sugars (3.08%), while PG 1-7 recorded 3.06%. The least concentration of the observed non-reducing sugars exhibited in PG 7-4 (1.15%). Arka Kiran recorded 2.12% of the content of the non-reducing sugars. The content of the observed total sugars varied between 3.64 to 6.72%, averaging 5.05%. PG 1-7 recorded the highest content of the observed total sugars (6.72%), while PG 5-8 recorded 6.50%. The lowest was recorded in PG 7-4 and PG 27-2 (3.64%) with PG 15-9 slightly higher (3.82%). The parent Arka Kiran recorded total sugar content of 5.63%. The significant variations among the progenies for reducing, non-reducing sugar and total sugar content may be attributed due to genetic makeup and phenotypic features of genotype. They were in conformity with the findings of Mahmoud and Peter (2014) and ended up concluding that maximum reducing sugar (5.93%) and non-reducing sugar were found in the number 99 genotype. Lycopene content of the progenies varied between 0 and 6.14 mg/ 100 g, with the mean of 4.69 mg/ 100 g. PG 34-1 contained the highest amount of lycopene (6.14 mg/ 100 g); while PG 1-7 contained 6.10 mg/ 100 g. Lycopene was absent with respect to PG 16-1 and PG 25-6. PG 1-2 and PG 2-7 (3.25 mg/ 100 g) recorded the lower lycopene content. The parent Arka Kiran recorded lycopene content of 5.98 mg/ 100 g (Table 6). The greater variability in lycopene concentration might be due to seasonal favourability. Patel *et al.* (2015) conducted a study on seven genotypes and observed similar trends in lycopene content. They have found that the selection-3 has demonstrated the highest lycopene content (5.10 mg/ 100 g); while selection-9 exhibited the lowest lycopene content (1.70 mg/ 100 g).

Table 6: Comparative evaluation of half sib progenies of guava var. Arka Kiran for fruit quality attributes*

Sl. No.	Half sib progenies	Total soluble solids (°Brix)	Titratable acidity (%)	Ascorbic acid content (mg/ 100 g)	Sugar/ acid ratio	Pectin content (%)	Reducing sugar (%)	Non-reducing sugars (%)	Total sugars (%)	Lycopene content (mg/ 100 g)
1.	PG 1-2	10.10	0.22	185.62	25.14	0.51	4.23	1.30	5.53	3.25
2.	PG 1-3	8.20	0.19	176.20	25.00	0.47	2.03	2.72	4.75	3.61
3.	PG 1-7	12.60	0.28	203.73	24.00	0.71	3.66	3.06	6.72	6.10
4.	PG 2-7	11.50	0.27	201.00	22.56	0.66	3.80	2.29	6.09	3.25
5.	PG 2-8	8.70	0.24	177.23	18.13	0.58	2.69	1.66	4.35	5.11
6.	PG 3-2	8.10	0.21	176.20	19.67	0.56	2.60	1.53	4.13	3.34
7.	PG 3-7	9.70	0.23	185.30	23.61	0.54	3.33	2.10	5.43	3.65
8.	PG 4-2	11.20	0.22	198.20	29.50	0.54	3.52	2.97	6.49	4.21
9.	PG 5-5	11.20	0.23	197.10	27.91	0.58	3.34	3.08	6.42	3.68
10.	PG 5-8	11.60	0.22	198.10	29.55	0.56	3.95	2.55	6.50	5.95
11.	PG 6-9	8.50	0.23	175.60	19.22	0.55	2.49	1.65	4.42	4.26
12.	PG 7-3	8.20	0.22	176.30	19.00	0.53	2.77	1.41	4.18	5.95
13.	PG 7-4	7.00	0.25	172.40	14.56	0.57	2.49	1.15	3.64	5.82
14.	PG 8-5	8.30	0.21	173.40	20.90	0.52	2.89	1.50	4.39	4.65
15.	PG 8-6	10.00	0.23	182.30	23.04	0.56	3.11	2.19	5.30	3.94
16.	PG 8-7	9.10	0.22	171.30	22.32	0.54	3.12	1.79	4.91	5.29
17.	PG 8-10	8.70	0.22	193.20	20.14	0.54	2.29	1.46	4.43	5.65

Sl. No.	Half sib progenies	Total soluble solids (°Brix)	Titratable acidity (%)	Ascorbic acid content (mg/ 100 g)	Sugar/ acid ratio	Pectin content (%)	Reducing sugar (%)	Non-reducing sugars (%)	Total sugars (%)	Lycopene content (mg/ 100 g)
18.	PG 9-5	11.10	0.26	199.70	23.04	0.62	3.43	2.59	5.99	4.42
19.	PG 9-7	9.80	0.23	186.60	22.13	0.57	2.92	2.23	5.09	4.62
20.	PG 11-4	9.20	0.24	163.20	19.21	0.57	3.10	1.51	4.61	4.81
21.	PG 11-5	11.20	0.26	197.20	21.96	0.66	3.69	2.02	5.71	5.82
22.	PG 13-3	11.50	0.24	172.30	26.83	0.61	3.60	2.84	6.44	5.93
23.	PG 13-5	9.70	0.23	174.10	22.35	0.57	2.92	2.22	5.14	5.68
24.	PG 15-2	9.20	0.23	173.20	22.00	0.54	3.03	2.03	5.06	5.81
25.	PG 15-9	7.20	0.19	161.20	20.08	0.47	2.39	1.42	3.82	4.71
26.	PG 16-1	9.00	0.21	162.30	23.29	0.51	2.89	2.00	4.89	0.00
27.	PG 17-1	8.70	0.25	164.10	19.28	0.61	2.93	1.89	4.82	5.77
28.	PG 19-2	8.30	0.22	166.20	19.23	0.53	2.74	1.49	4.23	5.81
29.	PG 22-7	9.20	0.21	174.20	22.33	0.52	2.95	1.75	4.69	5.86
30.	PG 23-10	9.30	0.24	175.30	20.92	0.57	2.95	2.07	5.02	4.94
31.	PG 24-1	9.10	0.21	192.30	22.52	0.52	2.97	1.76	4.73	3.98
32.	PG 24-6	11.40	0.23	195.20	24.91	0.58	3.55	2.18	5.73	5.56
33.	PG 25-1	9.20	0.23	156.89	20.39	0.60	3.03	1.66	4.69	5.25
34.	PG 25-6	11.50	0.23	200.50	27.00	0.55	3.85	2.36	6.21	0.00
35.	PG 27-2	7.00	0.19	170.10	19.16	0.46	2.31	1.33	3.64	5.29
36.	PG 28-1	10.80	0.27	220.42	20.85	0.69	3.15	2.62	5.63	5.16
37.	PG 30-1	7.90	0.20	171.50	21.15	0.51	2.64	1.58	4.23	4.73
38.	PG 30-2	8.53	0.22	175.30	20.14	0.56	2.65	1.78	4.43	3.56
39.	PG 31-2	8.20	0.20	174.40	22.10	0.51	2.63	1.79	4.42	4.99
40.	PG 32-1	10.20	0.23	188.62	23.48	0.60	3.05	2.35	5.4	4.44
41.	PG 32-3	9.21	0.24	194.60	20.29	0.61	3.00	1.87	4.87	4.36
42.	PG 33-1	8.60	0.21	165.30	21.43	0.47	2.81	1.69	4.50	5.30
43.	PG 34-1	11.60	0.27	201.00	21.78	0.69	3.43	2.45	5.88	6.14
44.	PG 34-2	8.50	0.21	176.20	21.43	0.52	2.73	1.77	4.50	5.39
45.	PG 35-1	11.10	0.29	196.70	19.62	0.73	3.41	2.28	5.69	3.45
46.	PG 36-1	9.20	0.23	163.97	20.78	0.58	3.12	1.66	4.78	5.75
47.	PG 37-4	9.34	0.24	176.20	19.96	0.59	2.99	1.80	4.79	4.53
48.	PG 38-4	8.60	0.20	173.70	22.75	0.47	2.81	1.74	4.55	4.48
Check	Arka Kiran	12.00	0.28	185.32	20.11	0.69	3.66	2.12	5.63	5.98
	Mean	9.55	0.23	181.45	21.97	0.57	3.05	1.98	5.05	4.69
	Maximum	12.60	0.29	220.42	29.55	0.73	4.23	3.08	6.72	6.14
	Minimum	7.00	0.19	156.89	14.56	0.46	2.03	1.15	3.64	0.00
	SE of mean	0.20	0.003	2.00	0.41	0.01	0.07	0.07	0.11	0.19
	SD	1.40	0.02	14.01	2.87	0.06	0.47	0.48	0.79	1.31
	CV (%)	14.71	10.43	7.72	13.09	11.48	15.33	24.22	15.66	27.84

*Average of two season's data

A panel of 10 judges conducted a sensory evaluation, rating the fruit on a 9-point hedonic scale (Table 8). It's crucial to consider that besides the fruit's physical and biochemical properties, organoleptic qualities like taste, aroma and texture significantly impact overall consumer acceptance of a variety. The overall acceptability of fruits was judged based on taste texture, flavor, colour and appearance of the fruit pulp. PG 1-7 (8.9) received the highest score for colour and appearance of fruit which clearly indicates that the visual appeal of this selection is superior when contrasted with other selected genotypes. Even with respect to texture, taste and flavour of the pulp, PG 1-7 (8.9) received highest score when compared to the remaining selections. For overall acceptability, the progeny PG 1-7 achieved the highest score of 8.9 points out of 9, surpassing all other selected progenies (Table 7). They were in conformity with the findings of Shukla *et al.* (2012), who they identified two most promising genotypes MPUAT S-1 (8 to 10) and MPUAT S-2 (7.5 to 10) on the basis of organoleptic scoring.

Table 7: Organoleptic qualities of selected half sib progenies of guava var. Arka Kiran

Sl. No.	Half sib progenies	Colour and Appearance	Texture	Taste	Flavour	Overall acceptability
1.	PG 1-7	8.9	8.7	8.9	8.9	8.9
2.	PG 5-8	8.5	8.5	8.7	8.7	8.5
3.	PG 11-5	8.7	8.5	8.7	8.7	8.7
4.	PG 13-3	8.6	8.5	8.5	8.5	8.5
5.	PG 24-6	8.4	8.5	8.5	8.5	8.5
6.	PG 25-1	8.4	8.4	8.4	8.4	8.4
7.	PG 28-1	8.5	8.4	8.3	8.3	8.4
8.	PG 32-1	8.3	8.4	8.3	8.3	8.3
9.	PG 32-3	8.5	8.4	8.5	8.5	8.4
10.	PG 34-1	8.8	8.7	8.7	8.7	8.8
11.	PG 35-1	8.6	8.5	8.4	8.4	8.5
12.	PG 36-1	8.5	8.6	8.5	8.5	8.5
Check	Arka Kiran	8.4	8.5	8.5	8.5	8.5
	Mean	8.55	8.51	8.53	8.53	8.53
	Maximum	8.9	8.7	8.9	8.9	8.9
	Minimum	8.3	8.4	8.3	8.3	8.3
	SE of mean	0.05	0.03	0.05	0.05	0.05
	SD	0.17	0.10	0.17	0.17	0.17
	CV (%)	2.00	1.22	2.05	2.05	1.99

Table 8: Sensory rating of guava (9-point hedonic scale)

Characteristics	Colour and Appearance	Texture	Taste	Flavour	Overall acceptability
Like extremely	9	9	9	9	9
Like very much	8	8	8	8	8
Like moderately	7	7	7	7	7
Like slightly	6	6	6	6	6
Neither like nor dislike	5	5	5	5	5
Dislike slightly	4	4	4	4	4
Dislike moderately	3	3	3	3	3
Dislike very much	2	2	2	2	2
Dislike extremely	1	1	1	1	1

Conclusion

In summary, considering the assessment of multiple physico-chemical attributes of half-sibling progenies of guava cultivar Arka Kiran, it was observed that progeny PG 1-7 was the superior one, with respect to maximum intensity of fruit pulp color, fruit quality, seed characteristics, yield and organoleptic properties. This indicates that PG 1-7 is a promising progeny that deserves further attention for commercial use among the progenies analyzed.

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