



## Characterization of guava (*Psidium guajava*) germplasm based on leaf and fruit parameters

B SHIVA<sup>1</sup>, A NAGARAJA<sup>2</sup>, M SRIVASTAV<sup>3</sup>, SHAILI KUMARI<sup>4</sup>, A K GOSWAMI<sup>5</sup>, RAKESH SINGH<sup>6</sup> and M B ARUN<sup>7</sup>

ICAR-Indian Agricultural Research Institute, New Delhi 110 012

Received: 06 July 2016; Accepted: 27 October 2016

### ABSTRACT

Guava (*Psidium guajava* L.) is one of the most commercially cultivated fruit crops in India. A large number of diverse genotypes are available in India but their characterization is still lacking which needs to be focused to target a planned guava improvement programme in India. The present study was conducted to estimate the genetic relationship between 20 genotypes of *Psidium guajava* and two species, *P. friedrichsthalianum* and *P. pumilum*, by means of morphological characterization. Twenty-four parameters of leaf and fruit were included in the study. Guava genotypes showed significant variations for different leaf characters. Internodal length among the genotypes showed significant variation and it ranged between 1.36 to 4.76 cm. The size of leaf was found to have positive relationship with the plant vigour. Maximum fruit weight was observed in Thai guava (228.26 g) followed by Lucknow-49 (216.53g) and the minimum was in *P. pumilum* (13.0 g). The variation in these characters generated useful information for selection of parents for further guava breeding programme.

**Key words:** Characterization, Fruit character, Guava germplasm, Leaf character, Variability

Guava (*Psidium guajava* L.) is the most valuable cultivated species of the Myrtaceae family, popularly known as ‘poor man’s fruit’ or ‘apple of tropics’ (Nakasone and Paull 1998). It is a native to tropical America and distributed in many tropical and subtropical countries (Morton 1987). Guava fruit is commercially grown in India and outside India. It is popular due to its year round availability, rich nutritional and medicinal value, and affordable price, suitability for transportation, handling and consumer preference. It is the fifth most important fruit crop of India, occupying 3.38 % of the total area under fruit cultivation. It is widely grown all over the tropical and subtropical conditions. In India, wide range of variability in guava is reported. Guava represents an excellent source of vitamins-C, as well as calcium, zinc, phosphorus and iron (Singh 2005). Furthermore, fruits, leaves, flowers, roots, bark and stems are used in medicinal applications (Gutierrez *et al.* 2008, Kamath *et al.* 2008). Keeping in view of the above facts,

as well as the low cultivation costs, the guava crop is economically important in various tropical and subtropical countries (Rodriguez *et al.* 2010). It is the hardest crops among tropical fruit trees and excels most of the other fruit crops in productivity and adaptability. Majority of the variability of guava populations is due to the seedling origin, they are variable in fruit colour (both pulp and peel), pulp thickness, numbers of seed and other morphological and quality characters are also reported from different regions. Hence, there is a great potential for the application of characterization of tropical fruit crops like guava. It would further help in identification of potential parent genotypes for effective utilization in future breeding programme. Studies focus on characterization of wild species and local cultivars is still lacking in Indian breeding programme which plays a significant role for further crop improvement. The present study was carried out to characterize 24 guava germplasm on the basis of leaf and fruit characters.

### MATERIALS AND METHODS

A total of 22 genotypes of *Psidium guajava* and two species of *Psidium* were selected from the experimental orchard of the Division of Fruits and Horticultural Technology, IARI, New Delhi (Allahabad Safeda, Arka Amulya, Arka Mridula, Behat Coconut, Black Guava, Hafsi Red, Hissar Safeda, Hissar Surkha, Lalit, Lucknow-49, Pant Prabhat, Punjab Pink, Red Peel, Red type, Sasni Collection, Sasri Selection, Shweta, Snow White, Sour type,

<sup>1</sup>M Sc Student (e mail: banothshivaiari@gmail.com), <sup>2</sup>Senior Scientist (e mail: anrciah@gmail.com), <sup>3</sup>Principal Scientist (e mail: mns\_fht@rediffmail.com), <sup>4</sup>M Sc Student (e mail: shailiranchi51@gmail.com), <sup>5</sup> Scientist (e mail: amit.tkg@gmail.com), Division of Fruits and Horticultural Technology, Senior Scientist (e mail: arunk\_sst@iari.res.in), Division of Seed Science and Technology, ICAR-Indian Agricultural Research Institute, New Delhi 110 012. <sup>6</sup> Principal Scientist (e mail: singhnbpgr@yahoo.com), Division of Genomic Resources, ICAR- NBPGR, New Delhi 110 012.

TN Selection, Thai guava and Yellow type and *Psidium friedrichsthalianum* and *P. pumilum*. Twenty four parameters of leaf and fruit were included for the study (Leaf length, leaf width, leaf area, leaf lamina pubescence, petiole length, length and width ratio, leaf shape, shape of leaf apex, shape of leaf base, young leaf anthocyanin coloration, intensity of anthocyanin coloration in young leaf, fruit weight, fruit length, fruit width, core diameter, number of seeds/fruit, seed weight/ fruit, shape of fruit, colour of pulp, colour of fruit skin, total soluble solids, titrable acidity, vitaminC and antioxidant). Leaf area was measured with the help of leaf area meter (200 cm<sup>2</sup>) accordingly average leaf area was calculated. Average length of petiole of ten-leaves were taken from 3<sup>rd</sup> and 4<sup>th</sup> position from tip of the each bearing shoot was measured and expressed in cm as petiole length. A random sample of ten fully developed leaves from current growth of each plant was selected from the outside branches at the middle of canopy for the purpose of data recording. Rating of various characters was done in accordance with 'Guava Descriptor' published by All India Coordinated Research Project on Subtropical Fruits (AICRP-STF), CISH, Lucknow in the year 2011. The base and apex of leaf was observed visually and it was classified as round, acute and obtuse with the help of standardized procedure (Dutta 1996).

All observations on the fruit and its related parts were made at the matured to optimum ripening stage. Fruit characteristics were observed on five fruits per each tree. The physical observations on fruit shape, fruit surface, fruit diameter, fruit length, fruit weight, pulp colour and fruit colour were recorded. The experiments were laid out in randomized block design (RBD). The data on different parameters were analysed by using analysis of variance (ANOVA) by using Statistical Package using On line OP Stat software accessed from the following web page was used for analysis of ANNOVA <http://14.139.232.166/opstat/default.asp>.

## RESULTS AND DISCUSSION

### Leaf characters

Guava genotypes showed significant variations for different characters. Among 24 guava genotypes, the leaf length ranged from 5.07 cm to 15.41 cm in *P. pumilum* and Sour type, respectively (Table1). The leaf width ranged from 1.16 cm to 7.62 cm in *P. pumilum* and Pant Parbhat respectively. With respect to the petiole length, maximum (1.16 cm) petiole length was recorded in Sasni collections and minimum (0.31 cm) in *P. pumilum*. The guava genotypes also showed significant variations in leaf area. The maximum leaf area (60.92cm<sup>2</sup>) was recorded in Red type and minimum leaf area (10.93 cm<sup>2</sup>) in *P. pumilum*. The length and width ratio varied significantly among guava genotypes. The ratios were maximum in Hisar Safeda (2.63) followed by Lalit (2.51), whereas the minimum was recorded in *P. pumilum* (0.16). With respect to leaf shape, all guava genotypes fell under two category, viz. oblong and obovate. All genotypes

Table 1 Leaf characteristic of guava germplasm

Genotype	Leaf length (cm)	Leaf width (cm)	Petiole length (cm)	Leaf area (cm)	Length and width ratio
Allahabad Safeda	13.02	5.82	0.80	56.61	2.24
Arka Amulya	10.46	5.57	0.77	37.63	1.88
Arka Mridula	9.82	4.90	0.68	38.74	2.01
Behat coconut	11.66	5.71	0.74	54.78	2.06
Black guava	8.88	4.37	0.60	30.38	2.04
Hafsi Red	10.55	6.13	0.65	36.83	1.73
Hissar Safeda	13.98	5.31	0.69	58.83	2.63
Hissar Surkha	12.33	6.42	0.83	55.49	1.94
Lalit	14.70	5.88	0.64	59.46	2.51
Lucknow-49	11.48	5.27	0.87	51.35	2.18
<i>P.friedrichsthalianum</i>	7.01	3.57	0.32	18.20	1.97
<i>P. pumilum</i>	5.07	1.60	0.31	10.93	3.16
Pant Prabhat	14.91	7.62	0.69	59.87	1.96
Punjab Pink	8.36	3.81	0.39	26.64	2.20
Red peel	12.85	6.46	0.75	56.66	1.99
Red type	14.91	6.07	0.84	60.92	2.46
Sasni collection	13.33	7.07	1.16	57.42	1.90
Sasri selection	10.80	5.03	0.73	36.54	2.15
Shweta	14.55	5.41	0.63	59.47	2.70
Snow White	11.92	5.87	0.60	55.12	2.04
Sour Type	15.41	6.69	0.74	60.15	2.30
T.N selection	9.98	6.81	0.68	32.56	1.47
Thai guava	11.27	5.56	1.11	48.77	2.03
Yellow type	10.12	3.82	0.61	34.34	2.67
SEM±	0.36	0.21	0.04	1.88	0.11
CD (P = 0.05)	1.02	0.59	0.12	5.36	0.30

leaf shapes were oblong, except, Shweta. Similarly, the leaf base shape also fell under two category, viz. round and obtuse. Out of 24 genotypes, twenty-two genotypes had rounded leaf base shape, whereas in case of two genotypes the leaf base shape was obtuse (*P. pumilum* and Punjab Pink). The were leaf tip shape was grouped into four based on the above parameter. They obtuse, rounded, attenuate and acute. Twelve genotypes leaf tip shapes were obtuse, nine genotypes had rounded, two genotypes had acute (*P. pumilum* and Punjab Pink) and one genotype had attenuate (*P. friedrichsthalianum*). Pubescence on lower side of young leaf were dense and very dense. Two genotypes (Black guava and Lalit) recorded dense. All other twenty-two genotypes were observed to have very dense pubescence. Young leaf anthocyanin coloration was recorded *P. friedrichsthalianum*, *P. pumilum*, Pant Prabhat and Snow White found absent in these four genotypes respectively. All other 20 genotypes were observed for the presence of young leaf anthocyanin coloration. Black guava had a strong intensity of anthocyanin, fourteen genotypes

found to have medium intensity and nine genotypes were weak. The variation in terms of leaf characters observed in present investigation might be due to the varietal features and under genetic control and similar results were reported by Pandey *et al.* (1997).

#### Physico-chemical characters

Genotype variations related to fruit characteristics are summarized in Table 2. Wide range of variability was observed among the genotypes under study in respect of different physico-chemical attributes of guava fruits. Length, width and weight of fruit were the major components of fruit size. In general, there was a wide variation in these physical parameters among the genotypes and these differences were found statistically significant. The maximum fruit length (8.0 cm), was observed in Thai guava, followed by Hissar Surkha and Tamil Nadu selection and minimum in *P. pumilum* (3.12 cm). The fruit core diameter was recorded at maximum (4.46 cm) in Lalit, which was at par with Thai guava and Shweta. The minimum core diameter (1.86

cm) was recorded in *P. pumilum*. Change in geographical location or inherent genetic characters were the reasons behind variation in fruit length and width among different genotypes. Pandey *et al.* (2007) had also reported similar findings. There were significant differences among the genotypes with respect to fruit width. The fruit width was recorded at maximum (7.27 cm) in Thai guava and minimum (2.58 cm) in *P. friedrichsthalianum*. This variation may be due to phenotypic and genotypic interactions among the selections. Similar variations were observed by Phadnis (1970), Thonte and Chakrawar (1982) Biradar and Mukunda (2007). The individual fruit weight is important parameters during crop improvement programme in fruit crops while making selections. A significant variation with respect to fruit weight was observed among the genotypes under the present study. The maximum fruit weight was recorded in Thai guava, while minimum was noticed in *P. pumilum*. Other selections had medium fruit weight. This may be due to phenotypic and genotypic influence over the different selections which is in conformity with the findings of Singh

Table 2 Observation on physio-chemical parameters of guava genotypes

Genotype	Fruit weight (g)	Core diameter (cm)	No. of seeds/ fruit	Seed weight/ fruit (g)	TSS (%)	Titration acidity (%)	Vitamin-C (mg/g)	Antioxidant (mmol/g TROLOX)
Allahabad Safeda	106	2.73	366.67	3.24	11.57	0.25	167.93	21.53
Arka Amulya	139	3.90	364.67	3.39	11.73	0.41	135.93	13.20
Arka Mridula	92	2.77	195.33	1.72	10.60	0.36	83.00	10.97
Behat Coconut	170	3.87	364.33	3.43	11.13	0.37	99.07	18.07
Black guava	106	3.40	137.67	1.24	10.27	0.28	86.63	25.50
Hafsi Red	217	3.53	151.00	1.36	12.17	0.32	91.27	26.93
Hissar Safeda	189	3.93	369.33	3.36	12.13	0.29	184.47	19.27
Hissar Surkha	186	3.57	439.33	4.12	14.43	0.43	96.13	24.30
Lalit	172	4.46	332.67	3.13	15.43	0.52	94.10	22.40
Lucknow-49	95	3.67	311.33	2.90	12.43	0.36	187.70	20.43
<i>P.friedrichsthalianum</i>	14	2.07	90.67	0.62	9.67	0.49	74.33	14.77
<i>P. pumilum</i>	13	1.87	55.67	0.39	9.43	0.46	77.30	14.63
Pant Prabhat	177	3.60	421.67	4.05	12.40	0.42	161.30	19.47
Punjab Pink	81	3.53	141.00	1.15	13.47	0.43	92.80	22.80
Red Peel	116	3.13	115.67	1.02	11.43	0.38	82.43	22.90
Red type	112	2.70	133.00	1.09	10.30	1.45	170.80	22.77
Sasni collection	80	3.43	234.33	1.51	10.77	0.42	158.43	21.87
Sasri selection	138	3.53	325.67	3.17	12.33	0.43	174.20	22.41
Shweta	183	4.30	283.00	2.31	10.53	0.48	161.33	18.10
Snow White	91	3.43	256.00	2.16	11.30	0.37	128.43	25.20
Sour Type	18	3.20	228.33	1.45	10.20	0.37	87.87	24.10
TN selection	173	3.60	125.67	1.07	11.37	0.55	175.97	25.10
Thai guava	228	4.37	367.00	3.34	10.27	0.22	168.10	17.37
Yellow type	74	3.20	146.67	1.21	10.50	0.36	95.33	18.57
SEM±	7.00	0.11	10.22	0.09	0.26	0.04	4.15	2.88
CD (P = 0.05)	19.00	0.33	29.19	0.25	0.76	0.11	11.84	8.22

(1988) and Ram *et al.* (1997). Biradar and Mukunda (2007) and Raghav and Tiwari (2008) observed similar findings in their guava selections.

Seediness is the major problem in many fruit crops and more so in guava. It is also known in guava that complete seedlessness will result in deformed and misshapen fruits accompanied by reduction in fruit size. In guava, presence of a higher number of hard seeds per fruit is thought to be major drawbacks in any variety. Since the presence of seeds determine shape and size of the fruit, it is desirable to have cultivars with few and soft seeds. From the present study, it was observed that in general there was a wide variation with respect to these seed characters among the guava genotypes and these differences were found to be statistically significant. Minimum number of seeds per fruit was observed in *P. pumilum*, whereas maximum number of seeds (439.33) was recorded in Hisar Surkha. Such variation among the selections in seed characters may be attributed to genetic makeup of the plants. Seed number is known to be a function of fertility and effective fertilization. Variations in seed characters of guava fruit were also observed in red coloured selections (Patel *et al.* 2015).

Among the different factors influencing fruit quality, bio-chemical components in guava fruit are of utmost concern to assess the fruits suitability for dessert purpose or for processing. Total soluble solids indicate higher sugar content in the fruits and are considered as one of the important criterion for dessert quality. In the present study, Lalit recorded the maximum TSS (15.43 °Brix) over the other genotypes, while lower TSS was recorded by *P. pumilum*. It may be due to phenotypic and genetic constitution among the selections which might had necessitated consumption of nutrients and sinking more carbohydrates into the fruits, thus producing larger fruits with more TSS. This is in conformity with the findings of Ram *et al.* (1997), Athani *et al.* (2007). There was a wide variation in titratable acidity content among the fruits of various genotypes differed significantly. The titratable acidity was recorded minimum (0.22 %) in Thai guava, followed by Allhabad Safeda (0.25%), Black guava (0.28%) and Hisar Safeda (0.29%). Maximum titratable acidity (1.45%) was noticed in the fruits of Red type which may be attributed to the genetic makeup. Guava fruits are consumed for the nutritive value offered by ascorbic acid content promoting their dessert quality. Higher ascorbic acid content was observed in Hisar Safeda and Tamil Nadu Selection, while *P. friedrichsthalianum* (74.33 mg/100g) followed by *P. pumilum* (77.3 mg/100g), Red Peel (82.43 mg/100g) and Arka Mridula (83.00 mg/100g) produced fruits with lower ascorbic acid content. The larger variation in ascorbic acid content may be attributed as a varietal character and due to favourability of seasonal conditions. Similar trend was also reported by Gohil *et al.* (2006). There were significant differences among the genotypes with respect to antioxidant content. Among 24 genotypes, 17 genotypes were at par with Hafsi Red which had the maximum antioxidant content (26.93). However, the minimum antioxidant content was recorded in Arka Mridula

(10.97), which was at par with other five genotypes. Such variation in antioxidant content may be attributed to genetic makeup of the progenies. This is in conformity with the findings of Nakasone *et al.* (1976).

Based on the results obtained in the present study, it can be concluded that wide variation in terms of leaf characters and physico-chemical traits exists among guava genotypes. Leaf characters also showed variation among guava genotypes in terms of leaf area, length and width. Wide range of variability was observed among the genotypes with respect to different physico-chemical characteristics. Results suggested that the quantification of traits could help to understand the potential of germplasm in selection of potential parent for their future utilization in breeding programmes. The present study showed a high degree of variation among analyzed guava genotypes indicating that existing guava germplasms are important source of genetic diversity that can be used in the guava improvement programme.

#### ACKNOWLEDGEMENT

I express my sincere thanks to the Head, Division of Fruits and Horticultural Technology, ICAR- IARI, New Delhi, for providing me support and technical guidance in all course of my field and lab work.

#### REFERENCES

- Biradar S L and Mukunda G K. 2007. TG Seln. 5/12 – A promising genotype of Taiwan Guava from Bangalore. *Acta Horticulturae* **735**: 85–9.
- Athani S I, Patil P B, Swamy G S K, Sabarad A I and Gorabal K R, 2007, Studies on growth parameters and fruit characters in guava cultivars. *Acta Horticulturae* **735**: 271–5.
- Dutta A C. 1996. *Botany for Degree Students*, pp 25–46 Oxford University Press.
- Gohil S N, Garad B V, Shirsath H K and Desai U T 2006. Study on physico-chemical constituents in guava (*Psidium guajava*) under sub-arid zone of Maharashtra. *Scientific Horticulture* **10**: 139–47.
- Gutierrez RM, Mitchell S and Solis RVJ. 2008. *Psidium guajava*: a review of its traditional uses, phytochemistry and pharmacology. *Journal of Ethnopharmacology* **117**: 1–27.
- Kamath J V, Rahul N, Ashok, C K K and Lakshmi S M. 2008. *Psidium guajava*: a review. *International Journal of Green Pharmacy* **2**: 9–12.
- Morton JF 1987. Fruits of Warm Climates. Creative Resources Systems, pp 356–63.
- Nakasone HY and Paull RE 1998. *Tropical Fruits*, pp 93–8. CAB, Queensland, Wallingford.
- Pandey K K, Sharma A B and Patel M P. 1997. The varietal evaluation of guava (*Psidium guajava* L.). *Advances in Plant Sciences* **10**: 157–63.
- Pandey D, Shukla S K, Yadav R C and Nagar A K. 2007. Promising guava (*Psidium guajava* L.) cultivars for North Indian conditions. *Acta Horticulturae* **735**: 91–4.
- Patil S P, Mokashi A N and Kale L U. 2015. Evaluation of pink pulped navalur guava selections. *International Journal of Tropical Agriculture* **33**: 297–302.
- Phadnis N A. 1970. Improvement of guava (*Psidium guajava* L.)

- by selection in Maharashtra. *Indian Journal of Horticulture* **27**: 99–105.
- Preez R J and Welgemoed C P. 1990. Variability in fruit characteristics of five guava selections. *Acta Horticulturae* **275**: 351–60.
- Ram R A, Pandey D and Sinha G C. 1997. Selection of promising clones of guava cv. Allahabad Safeda. *Haryana Journal of Horticultural Sciences* **26**: 89–91.
- Raghav M and Tiwari J P 2008. Genetic variability and correlation analysis in guava. *Indian Journal of Horticulture* **65**:263–70.
- Rodriguez N N, Valdes J J, Rodriguez J A, Velasquez J B, Rivero D, Martinez F, Gonzalez, G, Sourd D G, Gonzalez L and Canizares J. 2010. Genetic resources and breeding of guava (*Psidium guajava* L.) in Cuba. *Biotechnologia Aplicada* **27**: 238–41.
- Santos C A F, José M C C, Flavio F S, Aloísio A V, Francisco R F, Juliano G P, Rita M E B, Rosa L B, Aparecida G C and Marciene A R. 2008. Preliminary characterization of *Psidium* germplasm in different Brazilian ecogeographic regions. *Pesquisa Agropecuária Brasileira* **43**: 437–40.
- Singh M. 1988. Performance of some cultivars of guava (*Psidium guajava* L.) with special reference to their commercial significance in the central gangetic plains. *Punjab Horticultural Journal* **28**: 50–5.
- Singh G. 2005. High density planting in guava- application of canopy architecture. *ICAR News* (April–June) **11**: 9–10.
- Thonte G T and Chakrawar V R. 1982. Physico-chemical characters of the certain types/ strains of guava (*Psidium guajava* L.). *Progressive Horticulture* **14**: 269–72.