Estimating the morphological variability of Guava (*Psidium guajava* L.) genotypes in Jabalpur district, India

ABSTRACT

As variability is crucial for crop improvement, it is better to characterise several genotypes that are derived from either seedlings or wild types. This research facilitates the identification of cultivars, genotypes, and the elimination of identical plants within populations. The study was conducted in year 2022-23with thirty-three guava genotypes of Jabalpur district to examine various morphological characteristics such as tree height, trunk girth and canopy diameter,branching attitude, stem colour in young shoots, branching density, mature leaf colour, leaf shape, leaf base shape, leaf tip shape, leaf curvature and leaf twisting. The experimental investigation was carried out at the Fruit Research Station, Imaliya, under the Department of Horticulture at the College of Agriculture, Jabalpur, Madhya Pradesh. Genotypes exhibited notable diversity in their morphological traits with respect to height, gith, canopy and several leaf-based characteristics.For the estimation of diversity, the DUS guideline of UPOV was followed. All the genotypes in this study aged between eight to thirteen years.Descriptive statistics showed that, the height of the trees varied between 2.78m (JG-322) and 6.12m (JG-325). The trunk girth ranged between27.21cm (JG-314) to87.23cm (JG-319). The canopyinthe east-west direction ranged from 4m (JG-325) to 8.34m(JG-322) whereas, in north-south direction varied 3.68m (JG-325) to 8.41m (JG-322). The observed diversity in these traits yielded significant insights that might drive the selection of parental plants for an advanced guava breeding initiative.

Keywords: Guava, diversity, genotype, canopy, descriptive statistics, morphological

1. INTRODUCTION

Guava, scientifically known as *Psidium* sp., is a well recognised fruit in the Indian subcontinent. It is often referred to as the 'poor man's fruit' and the 'apple of the tropics' (Nakasone and Paull, 1998). According to Mitra and Bose (1990), cultivation of this plant on the Indian subcontinent dates back to the early 17th century. It is grown in tropical and sub-tropical regions because of its favourable environment. The most often grown species is the *Psidium guajava* L., generally known as the common guava (Pathak and Ojha, 1993). It is said to have originated in tropical South America. This crop is grown in Hawaii, Cuba, Pakistan, and India. India is a prominent global producer of guava with a total production of 50 lack MT in 2022 (Ministry of Agriculture and Farmers Welfare, 2022). Madhya Pradesh constitutes about 17.20% of the total production of India.This fruit is considered the third most significant in terms of both area and production, behind mango,banana, jackfruit, pineapple, and melon. Its popularity stems from its consistent availability throughout the year, reasonable cost, abundant nutritional and therapeutic benefits, and its ability to be easily transported, handled, and preferred by consumers. Guava is a rich source of vitamins-C, calcium, phosphorus, iron, and zinc, as stated by Singh in 2005. An intake of one hundred grams of guava per person is enough to fulfil the daily recommended amount of vitamin C and iron. Guava has varying amounts of calcium, phosphorus, potassium, sulphur, salt, chlorine, iron, and magnesium, according to FAO (2009). In addition to roots, bark, stems, leaves, flowers, and fruits, many parts of plants are used for medicinal purposes (Kamath *et al*., 2008). The cultivation of this has a moderate cost but is of considerable economic relevance (Rodriguez *et al*., 2010). Different guava germplasm exhibits variable features as a result of their seedling origin. These populations exhibit variations in fruit colour (both pulp and peel), pulp thickness, number of seeds, and other morphological and qualitative characteristics, as seen in various areas. Therefore, guava has significant potential for the use of characterisation. This will have a substantial impact on future crop improvement. For a breeder, it is crucial to develop high-yielding varieties by selectively breeding from the available genotypes. The objective of this research was to analyse and describe the leaf and fruit characteristics of 33 guava genotypes. The experiment was conducted to examine the morphological traits of guava and identify the best guava germplasm that is well-suited for commercial production.

2. MATERIALS AND METHODS

UNDER PEER REVIEW

Plant material

For studying the diversityin guava based on tree and leaf character,33 genotypes were selected in the year 2022-23.Among these, 3 genotypes were considered as checksi.e., Allahabad Safeda, L-49 and Chittidar variety. Outof 33 genotypes,27 genotypes (JG-301, 302, 303, JG-304, JG-305, JG-306, JG-307, JG-308, JG-309, JG-310, JG-311, JG-312, JG-313, JG-314, JG-315, JG-316, JG-317, JG-318, JG-319, JG-320, JG-321, JG-322, JG-323, JG-324, JG-325, JG-326, JG-327, JG-328, JG-329, JG-330, Allahabad Safeda, L-49 and Chittidar) were selected from Fruit Research Station, Imaliya, Department of Horticulture, College of Agriculture, JNKVV, Jabalpur (M.P.), and 6 were taken from farmers fieldat Kundam (JG-317, JG-322 & JG-323) and Majhauli (JG-324, JG-326 & JG-330) blocks of Jabalpur district. These plants aged between 8 to 13 years.

Morphological analysis of tree and leaf:

All morphological parameters to study the genotypes were taken as per the DUS (Distinctness, Uniformity and stability) guidelines given by UPOV (2020) (International Union for the Protection of New Varieties of Plants). Thirteen Parameters of tree(Attitude of branching, young shoot colour of stem, branching density) and leaf (mature leaf colour, shape of leaf, shape of leaf base, shape of leaf tip, curvature of leaf, leaf twisting) were characterized for each genotype as per the DUS guideline.

Parameters as tree height, trunk girth, Crown diameter (East-West direction), Crown diameter (North-South direction)were measured. For measuring tree height, Abney level instrument was used. Trunk girth at the height of 1.0meters and canopy diameter in East-west & North- South direction were measured with the help of measuring tape.

Statistical analysis:

For analyzing the survey data of these genotypes,descriptive statisticsprovided the measure of mean, minimum, maximum, standard deviation and coefficient of variation were used.

3. RESULT AND DISCUSSION

Morphological analysis of tree and leaf

Variability wasobserved in morphologicalattributes of tree and leaf of guava genotypes. The coefficient of variation for the quantitative traits of tree and leaf ranged from 19.62% to 30.49%. Tree height ranges from 2.78 m to 6.12 m. Maximum tree height (6.12m) was recorded in genotype JG-322 and minimum (2.78m) was recorded in JG-325. Maximum trunk girth (87.2cm) was recorded in JG-319 whereas minimum (27.2cm) was measured in JG-314. Variation also observed in the canopy diameter of the tree, The maximum (8.34m) canopy diameter in East- West direction was observed in JG-322 and the minimum (4 m) was recorded in JG-325. Also, in North-South Direction, canopy diameter was found maximum (8.41 m) in genotype JG-322 and minimum in genotype JG-325. The coefficient of variation for tree height, trunk girth, canopy diameter in east- west and north-south direction were 22.17, 30.49, 19.62 and 20.17 respectively. The growth diversity resulting from the genetic composition of genotypes that have emerged from open pollination of seeds. Conversely, the soil and microclimate of the location also had a role in the manifestation of the intrinsic traits of certain genotypes. Singh *et al.* (1976) and Singh and Khan (1989) have revealed that the habit of tree growth and its use for vegetative development are significant diagnostic characteristics in the selection of genotypes.

Sharma *et al.* (2010) also documented a range of plant habits in guava, spanning from upright to drooping. The findings of this investigation were somewhat consistent with the results reported by Gerhardt *et al.* (1995). The development of trees is influenced by genetic makeup,weather conditions, specifically microclimatic circumstances and soil qualities, which exhibit modest variations between different genotypes.

UNDER PEER REVIEW

Table .1 Tree height, trunk girth, canopy diameter (East-West) and canopy diameter (North-South) of thirty-three guava genotypes

Genotypes	Tree height (m)	Trunk girth (cm)	Canopy diameter (East- West) (m)	Canopy diameter (North-South) (m)
JG-301	4.18	50.3	6.73	6.24
JG-302	3.73	35.0	6.19	5.95
JG-303	4.61	44.9	6.98	6.80
JG-304	2.82	43.8	4.02	3.87
JG-305	5.23	75.4	7.77	7.47
JG-306	5.52	64.8	7.08	6.99
JG-307	5.63	81.4	7.95	8.03
JG-308	3.27	50.7	5.44	5.20
JG-309	5.74	69.4	8.32	8.03
JG-310	3.44	43.1	5.54	5.20
JG-311	3.57	55.0	6.05	5.95
JG-312	4.86	46.3	7.90	7.65
JG-313	4.63	82.1	7.03	6.80
JG-314	2.96	27.2	4.21	4.06
JG-315	3.00	51.1	4.66	4.63
JG-316	4.12	65.5	6.38	6.14
JG-317	2.97	47.7	4.38	4.25
JG-318	4.36	75.1	6.79	6.33
JG-319	4.23	87.2	7.49	7.32
JG-320	3.51	49.0	5.93	5.39
JG-321	3.19	61.0	4.95	5.01
JG-322	6.12	42.9	8.34	8.41
JG-323	3.50	30.9	5.56	5.39
JG-324	4.14	54.3	6.55	6.14
JG-325	2.78	42.8	4.00	3.68
JG-326	4.59	46.7	6.88	6.43
JG-327	4.59	38.5	6.93	6.71
JG-328	3.27	40.6	5.20	5.10
JG-329	3.83	41.1	6.23	6.05
JG-330	4.81	47.1	6.78	6.24
Allahabad Safeda	4.88	36.5	7.30	7.09
L-49	5.06	30.9	7.47	7.11
Chittidar	4.87	41.3	7.30	6.99
Mean	4.18	**51.5**	**6.37**	**6.14**
Max.	6.12	**87.23**	**8.34**	**8.41**
Min.	2.78	**27.21**	**4.00**	**3.68**
CV.	22.17	**30.49**	**19.62**	**20.17**

Significant variance was seen in the chosen genotype with regards to the attitude of branching, young shoot colour of the stem and branching density. The branching attitude was documented as upright, spreading, and drooping. A total of nine genotypes exhibited an erect type, whereas seventeen genotypes had a spreading type of branching pattern. Three genotypes, namely JG-301, JG-303, JG-305, JG-309, JG-310, JG-311, JG-312, JG-316, JG-317, JG-321, JG-323, JG-324, JG-327, JG-330, Allahabad Safeda, L-49, and Chittidar, were identified as exhibiting a drooping type characterised by a dominant spreading branching pattern, as opposed to the erect and drooping types. The range of colours seen in the young shoot of the stem included green, reddish green, light green, medium red, and dark red. Among the 33 genotypes, 14 exhibited a green colour, 12 displayed a reddish green colour, 3 displayed a light red colour, 1 displayed a medium red colour, and 3 displayed a dark red colour on the young shoot stem. The predominant colour seen in the young shoot of the stem is green, which is found in several cultivars including JG-310, JG-311, JG-315, JG-316, JG-318, JG-323, JG-324, JG-327, JG-328, JG-329, JG-330 and Chittidar. Three types of branching density were recorded which are sparse, medium and dense type of branching. 4 genotypes were seen sparse type of branching, 19 genotypes (JG-301, JG-307, JG-309, JG-310, JG-311, JG-316, JG-317, JG-318, JG-320, JG-322, JG-324, JG-325, JG-326, JG-327, JG-329,

UNDER PEER REVIEW

JG-330, Allahabad Safeda, L-49 & Chittidar) which medium density which dominates other and rest 10 genotypes have the dense type of branching. Significant variances among the genotypes, which have value for crop development programmes and may be included into the production of high-quality planting material for further use and multiplication (Parihar and Pandey, 2019).

Table .2 Attitude of branching, branching density, young shoot color of the stem and mature leaf color of stem thirty-three guava genotypes

Genotypes	Attitude of branching	Branching density	Young shoot colour of the stem	Mature leaf colour
JG-301	Spreading	Medium	Green	Medium green
JG-302	Erect	Dense	Green	Medium green
JG-303	Spreading	Dense	Dark red	Medium green
JG-304	Drooping	Sparse	Dark red	Dark green
JG-305	Spreading	Dense	Green	Dark green
JG-306	Drooping	Dense	Green	Medium green
JG-307	Erect	Medium	Green	Medium green
JG-308	Erect	Dense	Green	Dark green
JG-309	Spreading	Medium	Green	Light green
JG-310	Spreading	Medium	Reddish green	Light green
JG-311	Spreading	Medium	Reddish green	Light green
JG-312	Spreading	Dense	Green	Medium green
JG-313	Erect	Dense	Medium red	Light green
JG-314	Erect	Sparse	Green	Medium green
JG-315	Drooping	Sparse	Reddish green	Medium green
JG-316	Spreading	Medium	Reddish green	Light green
JG-317	Spreading	Medium	Dark red	Medium green
JG-318	Drooping	Medium	Reddish green	Light green
JG-319	Erect	Dense	Green	Dark green
JG-320	Erect	Medium	Light red	Dark green
JG-321	Spreading	Dense	Light red	Dark green
JG-322	Drooping	Medium	Light red	Dark green
JG-323	Spreading	Sparse	Reddish green	Dark green
JG-324	Spreading	Medium	Reddish green	Dark green
JG-325	Erect	Medium	Green	Dark green
JG-326	Erect	Medium	Green	Dark green
JG-327	Spreading	Medium	Reddish green	Medium green
JG-328	Erect	Dense	Reddish green	Dark green
JG-329	Drooping	Medium	Reddish green	Dark green
JG-330	Spreading	Medium	Reddish green	Dark green
Allahabad Safeda	Spreading	Medium	Green	Light green
L-49	Spreading	Medium	Green	Medium green
Chittidar	Spreading	Medium	Reddish green	Light green

Significant diversity in features such as mature leaf colour, leaf shape, leaf base shape, leaf tip shape, leaf curvature and leaf twisting were seen among the leaves of various genotypes. Three types of classification have been conducted for mature leaf colour, including light green, medium green, and dark green. The dominant leaf colour across the several genotypes (JG-304, JG-305, JG-308, JG-319, JG-320, JG-321, JG-322, JG-323, JG-324, JG-325, JG-326, JG-328, JG-329, JG-330) is a dark green colour. The shape of leaf seen were ovate, trullate, rounded, oblong, obovate, and obtrullate. Among these types, the oblong leaf shape was the most prevalent. A total of 16 genotypes (JG-301, JG-303, JG-304, JG-305, JG-306, JG-312, JG-314, JG-316, JG-318, JG-321, JG-323, JG-324, JG-326, JG-329, Allahabad Safeda, Chittidar) exhibited an oblong leaf form. A range of leaf base shapes, including obtuse, rounded, cordate, and asymmetric, were seen, with the round shape being the most prevalent among the 15 genotypes (JG-301, JG-302, JG-303, JG-304, JG-305, JG-306, JG-307, JG-

UNDER PEER REVIEW

308, JG-313, JG-314, JG-320, JG-321, JG-322, JG-326, Chittidar). The study identified five distinct variations in leaf tip shape, namely apiculate, acute, obtuse, rounded, and retuse. The dominant leaf tip form seen in 18 genotypes (JG-302, JG-305, JG-307, JG-308, JG-309, JG-310, JG-311, JG-313, JG-315, JG-317, JG-318, JG-319, JG-327, JG-328, JG-329, JG-330, L-49, Allahabad Safeda) is the obtuse type of shape. Characterization on the basis of leaf curvature was also done in which weak curvature, medium curvature, strong curvature and some genotype doesn't have any type of curvature. Weak type of curvature were predominantly with 20 genotypes (JG-302, JG-305, JG-306, JG-309, JG-311, JG-312, JG-313, JG-315, JG-316, JG-317, JG-318, JG-323, JG-324, JG-325, JG-326, JG-328, JG-329, JG-330, Allahabad Safeda, L-49). Genotypes JG-305, JG-307, JG-312, JG-316, JG-318, JG-320, JG-326, Chittidar, and Allahabad Safeda exhibited leaf twisting.

The diversity in the morphological characteristics of leaves across different genotypes of guava were also observed. The observed diversity in the research might perhaps be attributed to the distinct genotypic and phenotypic characteristics shown by the genotypes. Pandey *et al*. (1997) and Shiva *et al*. (2017) both corroborated these findings.

Table .3 Shape of leaf, shape of leaf base, shape of leaf tip, curvature of leaf and leaf twisting thirty-three guava genotypes

Genotypes	Shape of leaf	Shape of leaf base	Shape of leaf tip	Curvature of leaf	Leaf twisting
JG-301	Oblong	Rounded	Retuse	Medium	Absent
JG-302	Obtrullate	Rounded	Obtuse	Weak	Absent
JG-303	Oblong	Rounded	Retuse	Strong	Absent
JG-304	Oblong	Rounded	Rounded	Medium	Absent
JG-305	Oblong	Rounded	Obtuse	Weak	Present
JG-306	Oblong	Rounded	Apiculate	Weak	Absent
JG-307	Rounded	Rounded	Obtuse	Absent	Present
JG-308	Ovate	Rounded	Obtuse	Strong	Absent
JG-309	Obovate	Cordate	Obtuse	Weak	Absent
JG-310	Obtrullate	Cordate	Obtuse	Strong	Absent
JG-311	Ovate	Cordate	Obtuse	Weak	Absent
JG-312	Oblong	Cordate	Rounded	Weak	Present
JG-313	Obtrullate	Rounded	Obtuse	Weak	Absent
JG-314	Oblong	Rounded	Acute	Absent	Absent
JG-315	Rounded	Asymmetric	Obtuse	Weak	Absent
JG-316	Oblong	Obtuse	Retuse	Weak	Present
JG-317	Obtrullate	Cordate	Obtuse	Weak	Absent
JG-318	Oblong	Obtuse	Obtuse	Weak	Present
JG-319	Ovate	Cordate	Obtuse	Medium	Absent
JG-320	Obovate	Rounded	Acute	Absent	Present
JG-321	Oblong	Rounded	Acute	Absent	Absent
JG-322	Ovate	Rounded	Apiculate	Medium	Absent
JG-323	Oblong	Obtuse	Rounded	Weak	Absent
JG-324	Oblong	Asymmetric	Acute	Weak	Absent
JG-325	Obtrullate	Obtuse	Acute	Weak	Absent
JG-326	Oblong	Rounded	Rounded	Weak	Present
JG-327	Trullate	Obtuse	Obtuse	Medium	Absent
JG-328	Trullate	Asymmetric	Obtuse	Weak	Absent
JG-329	Oblong	Obtuse	Obtuse	Weak	Absent
JG-330	Obtrullate	Cordate	Obtuse	Weak	Absent
Allahabad Safeda	Oblong	Obtuse	Obtuse	Weak	Present
L-49	Obtrullate	Obtuse	Obtuse	Weak	Absent
Chittidar	Oblong	Rounded	Acute	Absent	Present

UNDER PEER REVIEW

CONCLUSION

There is significant variation seen across the 33 genotypes of guava. The characteristics of trees display variability in their branching attitude, stem colour on young shoots, density of branching, mature leaf colour, leaf shape, shape of leaf tip, leaf curvature and leaf twisting. The many characteristics that were measured include tree height, trunk girth and canopy diameter. The coefficient of variance for these characters varied from 19.62% to 30.49%. The used variabilities have the potential to be employed in future breeding initiatives pertaining to guava germplasm. Various genotypes with desirable traits like dwarfing with maximum canopy spread can be considered for guava improvement as well as study for variation in the leaf characteristics will provide a better understanding for their photosynthesis and metabolic activity in the plant. The authors propose the need for further guava germplasm collection in order to enhance the diversity of desirable features.

REFERENCES

Anonymous. Guava: Guidelines for the conduct of tests for distinctness, uniformity and stability. International Union for the Protection of New Varieties of Plants, Geneva, Switzerland. 2020; p 1-35

Dubey M, Kumar R, Kumar J, Kumar A.Morphological and physico-chemical characteristics of guava genotypes. Research on Crops. 2016; 17(2): 276-282.

FAO. United Nations Development Programme. Soil Survey Project of Bangladesh. 2009; 3: 101- 159

Kamath JV, Rahul N, Ashok CKK, Lakshmi SM. Psidium guajava: a review. International Journal of Green Pharmacy. 2008; 2: 9–12.

Mitra SK, Bose TK (Eds.). Fruits Tropical and subtropical. Naya Prokash, Calcutta. 1990; pp. 278-303.

Nakasone HY, Paull RE. Tropical Fruits. CAB, Queensland, Wallirgford. 1998; pp 93–8.

Pandey KK, Sharma AB, Patel MP. The varietal evaluation of guava (*Psidium guajava* L.). Advances in Plant Sciences. 1997; 10: 157–163.

Parihar N and Pandey CS. Studies on morphological variability in bael (*Aegle marmelos*correa) gene pool of kymoreplateau and satpura hill region. International Journal of Agriculture Sciences. 2019; 11(6): pp 8078-8081.

Pathak RK, Ojha CM (Eds.). Genetic resources of guava. In: Advance in Horticulture. Vol. 1, Fruit Crops, Part-1. Maihotra Publishing House, New Delhi. 1993; pp. 143-147.

Rodriguez NN, Valdes JJ, Rodriguez JA, Velasquez JB, Rivero D, Martinez F, Gonzalez G, Sourd DG, Gonzalez L, Canizares J. Genetic resources and breeding of guava (*Psidium guajava* L.) in Cuba. BiotecnologíaAplicada. 2010; 27: 238–41.

Sharma A, Sehrawat SK, Singhrot RS, Tele A. Morphological and chemical characterization of Psidium Species. NotulaeBotanicaeHortiAgrobotanici Cluj-Napoca. 2010; 38(1): 28-32.

Sharma AB, Patel MP, Pandey KK, Pandey A. Assessment of some commercial varieties of guava (*Psidium guajava* L.). Advances in Plant Sciences. 1998; 11(1): 187-191.

Shiva B, Nagaraja A, Srivastav M, Kumari S, Goswami A, Singh R, Arun M. Characterization of guava (*Psidium guajava* L.) germplasm based on leaf and fruit parameters. The Indian Journal of Agricultural Sciences. 2017; 87(5): 634-638.

Singh G. High density planting in guava- application of canopy architecture. ICAR News (April–June). 2005; 11: 9–10.

UNDER PEER REVIEW

Singh RD, Khan NA. Varietal trial on guava. Group Workers Meeting for Subtropical Fruits Research Report. 1989; 96(2): 256-268.

SinghUR, Pandey IC, UpadhyayNP, Tripathi BM. Description of some guava (*Psidium guajava* L.) cultivars. Haryana Journal of Horticulture Science. 1976; 5(3&4): 142-149.

UNDER PEER REVIEW