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Research Article

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Morphological Characterization of Guava Genotypes Based on Leaf and Fruit Parameters under Mid-hill Conditions of Nepal

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Abstract

Guava (*Psidium guajava L.*) popularly known as poor man's apple is one of the common fruit crops cultivated in terai, inner terai and hilly areas of Nepal. There are numerous genotypes available within the country but absence of their proper characterization is impeding guava improvement program The present study was carried out with six guava genotypes (Apple guava, Bangalore, pear shaped, KG-1, Illam Selection and Bari) to investigate morphological characters viz leaf qualitative and fruit qualitative and quantitative characters. The single factor experiment was carried out in randomized complete block design with four replications at National Horticulture Research Centre farm, Khumaltar in the year 2019 and 2020 Four plants of each genotypes were studied which were planted in the year 2015. Four mature leaves and fruits were randomly collected for qualitative characterization and all marketable fruits were collected for the study under mid hill conditions. Among them Apple Guava and KG-1 were found promising due to its attractive fruit shape and size as well as preferable taste and aroma. While observing the fruit qualitative characters maximum fruit length was found in Pear Shaped (71.1 mm) and the minimum was found in Bari (50.2 mm). Similarly, the highest individual fruit weight was observed in Apple Guava (229.5 gm) and the lowest fruit weight was in Illam Selection (59.4 gm). Analysis of variance for different characters showed a high degree of variation among the genotypes. The variability in morphological characters generated valuable information which could be used for a choice of parents for guava breeding programs in the future.

Keywords: Breeding, improvement, fruit, qualitative, quantitative

Introduction:

Guava (*Psidium guajava L.*) which belongs to the Myrtaceae family, is a native of tropical America and is widespread throughout the tropical and subtropical areas (Chopda and Barrett, 2001). It is the most valuable cultivated species popularly known as "Poor man's fruit" or "apple of tropics" (Nakasone and Paull, 1998). It is one of the well-known fruit crop of Nepal occupying 0.30% of the total area under fruit cultivation of guava is 3853 ha and its production is about 30489 mt with a yield of 9.55 t/ha (MOAD, 2021). It is popular among Nepalese due to its year-round availability, rich medicinal and nutritional value, and affordable price. The cost of production of guava is low compared to other fruit crops as it can also be grown in marginal areas. The postharvest handling management is also quite easier. Guava is consumed fresh or made into processed products such as juice, nectar, puree, jam, and Jelly (Kashyap et al., 2001). Guava also exemplifies an excellent source of vitamin C as well as calcium, phosphorus, iron, and zinc (Singh. 2005).

About half of the existing guava orchards in Nepal are composed of the vegetatively propagated (specifically layered) plants (Shrestha et al., 2005). It is obvious that

All the authors declares that there is no any conflict of interest.

variable characters are found in different guava genotypes due to vegetative propagation. This is the reason of big potentiality of morphological characterization. It would also play significant role in identifying the superior parent genotypes in breeding program.

The present study was carried out to characterize 6 guava genotypes based on their leaf and fruit characters. The experiment was conducted to study the morphological characteristics of guava to select the superior guava genotypes suitable for commercial cultivation in mid-hill conditions.

Material and Methods:

Experimental site

The experiment was carried out at National Horticulture Research Centre (NHRC) farm Khumaltar from 2019 to 2020 with six genotypes of guava collected from Directorate of Agriculture Research (DoAR) Tarhara, Illam, and Chitwan. The genotypes are Apple Guava, Pear Shaped, Banglore, Bari, KG-1, and Illam Selection. Four plants of each genotype were planted in 2017 with spacing 2.5 X 2.5 m2 in pit size of 60 cm X 60 cm X 60 cm. At the time of plantation, the pits were filled with 20 farm yard manure (FYM), 326 gm Di-ammonium Phosphate (DAP) DAP, 524 gm urea, and 500 gm potash.

Characterization of leaves

Ten fully developed leaves were randomly selected from the outside branches from the mid of the canopy for data recording. Leaf shape and color of leaves were determined by eye estimation based on the descriptors developed by Central Institute for subtropical Horticulture CISH 2011.The leaf length and breadth were measured simply by using scale and expressed in centimeter (cm). All the observations on the leaf characters were made at the flowering stage.

Characterization of trees

Similarly tree habit, vigor, branching and foliage density, outer bark color were also observed at the flowering stage In addition, qualitative characters of fruit and yield attributing parameters were recorded based on the descriptors for guava developed by Central Institute for subtropical Horticulture (CISH 2011).

Characterization of fruits

All observations on the fruit and its related parts were made at matured ripening stage. Five fruits per tree were sampled randomly for study. The qualitative as well as quantitative observations were made on fruits according to CISH (2011).

Results and Discussion:

Characterization of guava leaves

Among the genotypes, KG-1 has the highest leaf length (14.5 cm) and leaf breadth (7 cm) however Illam selection has the lowest leaf length (10 cm) and leaf breadth (4.5 cm). The shape of a leaf, leaf apex, and leaf base of different guava genotypes showed a significant variation among them (Table 1). The leaf shapes are found such as ovate, round, and oblong. Ovate leaves were dominant over other shapes and they were found in genotype Apple Guava, Pear-shaped, and Bari where round shapes were found in Banglore and Oblong in Illam Selection and KG-1. Apiculate type of leaf apex shape was dominant over rounded acute and obtuse type. Apiculate leaf apex was found in Apple Guava, Banglore, and Bari. Similarly rounded leaf bases (Apple Guava, KG-1, Bari, and Illam Selection) were dominant over cordate leaf bases (Banglore and Pear Shaped). The color of the upper and lower surface of the lamina was green, reddish-green, dark green, and light green. The reddish-green color was found in Banglore which is significantly different from other genotypes followed by light green in Illam selection and green in Pear Shaped. The thickness of the lamina was observed thick in Apple guava, Banglore, and KG-1 and thin in Illam selection with intermediate thickness in Pear-Shaped and Bari. The variation is seen in qualitative leaf characters among guava genotypes. The variation observed in the study might be due to the specific genotypic and phenotypic varietal features among the genotypes. These results were also supported by (Pandey et al., 1997).

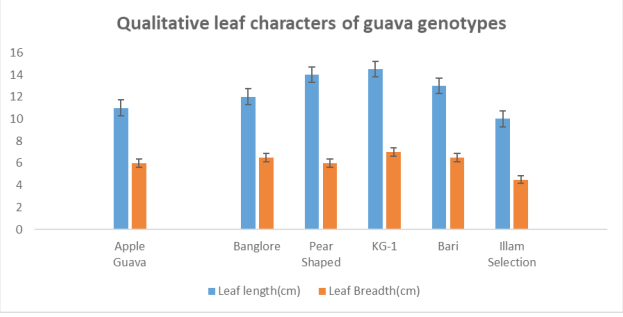

Figure 1: Leaf length and breadth of different genotypes of guava at NHRC Khumaltar

Characterization of Guava trees

The tree habit of guava genotypes was varied significantly. In mid-hill conditions the tree vigor was found vigorous in Apple Guava, Pear Shaped, KG-1,

Table1: Qualitative leaf characters of different genotypes of guava at NHRC Khumaltar in the year 2019 and 2020

Genotype	Leaf Shape	The shape of the leaf apex	The shape of the leaf base	Color of Lamina		
				Upper surface	Lower Surface	Thickness
Apple Guava	Ovate	Apiculate	Rounded	Green	Light green	Thick
Banglore	Round	Apiculate	Cordate	Reddish green	Reddish green	Thick
Pear Shaped	Ovate	Rounded	Cordate	Green	Green	Intermediate
KG-1	Oblong	Obtuse	Rounded	Dark green	Light green	Thick
Bari	Ovate	Apiculate	Rounded	Green	Light green	Intermediate
Illam Selection	Oblong	Acute	Rounded	Light green	Light green	Thin

and Bari followed by semi vigorous in Banglore and Illam Selection. Intermediate foliage and branching density were found dominant over dense and sparse ones. Intermediate branching density was observed in KG-1 and Bari, sparse in Banglore, and Illam selection dense in Pear-shaped. The outer bark color of different guava genotypes was also recorded. Greenish bark colors were dominant (Pear Shaped, Bari, and Illam selection) over Light brown (Apple Guava), Reddish-brown (Banglore), and Brownish (KG-1).

The results of this study were somehow agreed with the results showed by Gerhardt et al. (1995) The weather conditions i.e. microclimatic situations and soil properties directly or indirectly relies on tree growth which slightly varied among the genotypes.

Table 2: Tree characters and flower color of guava genotypes at NHRC Khumaltar in the year 2019 and 2020

Genotype	Tree habit	Tree vigor	Branching density	Foliage density	Outer bark Color	Flower color
Apple Guava	Spreading	Vigorous	Intermediate	Dense	Light brown	White
Banglore	Upright and open	Semi-vigorous	Sparse	Medium	Reddish-brown	Pink
Pear Shaped	Spreading	Vigorous	Dense	Dense	Greenish	White
KG-1	Upright and compact	Vigorous	Intermediate	Intermediate	Brownish	White
Bari	Upright and open	Vigorous	Intermediate	Intermediate	Greenish	White
Illam Selection	Upright and compact	Intermediate	Sparse	Dense	Greenish	White

Characterization of guava fruits

Qualitative characters of guava fruit

Matured fruits were collected from six genotypes of guava and different qualitative characters were observed. The results of different qualitative characters like fruit shape, fruit texture, pulp color, fruit puffiness, seed size, seed number, seed distribution, seed color, and seed hardness were recorded which are shown in table 3. Three different fruit shapes were recorded and a round shape was found to dominate among others. The fruit shape was oval type in Apple Guava and Bari are round type in Bangalore, KG-1 and Illam Selection. The fruit shape of genotype pear-shaped was significantly varied with typical pear-shaped fruits. Fleshy fruit textures was dominated over others. The fruit texture was found fleshy in Apple Guava, KG-1, Bari, and Illam Selection, gritty in Bangalore, and firm in Pear-shaped. The fruit puffiness was absent in two genotypes (Apple Guava and Bangalore). Big seed sizes were observed in KG-1 and Bari followed by Apple Guava, Banglore and Pear-shaped (medium seed size). Small seed sizes were significantly observed in the case of genotype Illam Selection. Few seeds were found dominant over many seeds among the studied genotypes. The genetic profile of the genotypes are the results of specific qualtitative traits of fruits which is also affected by the growing conditions. 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 a reduction in fruit size. In guava, the presence of a higher number of hard seeds per fruit is thought to be major drawback in any variety. Since the presence of seeds determines the shape

and size of the fruit, it is desirable to have cultivars with few and soft seeds (Shiva et al., 2016). Such variation among the selections in seed characters may be attributed to the genetic makeup of the plants. The 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 colored selections (Patel et al., 2015)

Table 3: Qualitative fruit characters of different guava genotypes at NHRC, Khumaltar in the year 2019 and 2020

Genotypes	Fruit Shape	Fruit texture	Fruit pulp color	Fruit puffiness	Seed size	Seed no.	Seed distribution	Seed color	Seed hardness
Apple Guava	Oval	Fleshy	White	Absent	Medium	Many	Uniform	Cream	Hard
Banglore	Round	Gritty	Pink	Absent	Medium	Many	Uniform	Pinkish	Hard
Pear Shaped	Pear	Firm	Creamy white	Present	Medium	Few	Uniform	Cream	Hard
KG-1	Round	Fleshy	White	Present	Big	Few	Uniform	Cream	Hard
Bari	Oval	Fleshy	White	Present	Big	Few	Uniform	Cream	Hard
Illam Selection	Round	Fleshy	White	Present	Small	Few	Uniform	Cream	Medium

Quantitative characters of guava fruits

A significant variation was obtained in the fruit length and fruit breadth in different guava genotypes. Fruit length of different guava genotypes showed a significant variation among them (Table 4) ranging from 50.2 mm to 71.1 mm. The highest fruit length was obtained in Pear Shaped (71.1 mm) followed by Apple Guava (70 mm), Illam Selection(59.4 mm), and KG -1 (58.6 mm). Fruit width of different guava genotypes ranged from 7.95 mm to 10.5 mm. The highest fruit width was observed in Pear Shaped (10.5 mm) followed by Illam Selection (9.2 mm) and KG-1 (9.15 mm). The lowest fruit width was observed in Banglore (7.95 mm). The highest individual fruit weight was found in Apple Guava (229.5 gm) followed by KG-1 (143.2 gm) and Banglore (105.7 gm). The lowest fruit weight was recorded in Illam selection (67.6 gm) followed by pear-shaped (90.2 gm).

When total soluble solids (TSS0B) and titratable acidity (TA %) were measured genotypes pear-shaped was found to be most sweet with TSS (10.5 0B) and TA (0.793%) followed by KG-1 with TSS (9.150B) and TA (0.688%).

The variation in fruit length and fruit breadth might be due to variation in genetic makeup of the cultivars. Similar findings were reported by Mitra et al. (1983), Azad et al. (1987) and Ullah et al. (1992). Change in geographical location or inherent genetic characters were the reasons behind the variation in fruit length and width among different genotypes (Methela et al., 2019) Similar variations were also observed by Phadnis (1970),

Table 4: Quantitative and physic-chemical fruit characters of different guava genotypes at NHRC Khumaltar in the year 2019 and 2020.

Genotypes	Fruit Length (mm)	Fruit width (mm)	Individual Fruit Weight (gm)	Total Soluble solids (TSS)	Tritatable Acidity (TA)	PH
Pear Shaped	71.1	10.5	90.2	10.5	0.793	4.283
Apple Guava	70	8.58	229.5	8.58	1	4.125
Banglore	57.5	7.95	105.7	7.95	0.688	4.03
KG 1	58.6	9.15	143.2	9.15	0.493	4.095
Illam Selection	59.4	9.2	67.6	9.2	0.465	4.322
Bari	50.2	8.08	91.3	8.08	0.54	3.853
Mean	61.1	8.19	121.3	8.19	0.663	4.118
F Test	*	*	**	*	ns	*
LSD	9.71	9.41	34.5	1.036		0.216
CV (%)	10.5	11.2	18.9	7.7	30.2	3.5

Thonte and Chakrawar (1982), Biradar and Mukunda (2007) in which they studied the fruit physical characters of different guava genotypes. The individual fruit weight is an important to yield attributing parameter during the crop improvement program in fruit crops while making selections. A significant variation to fruit weight was observed among the genotypes under the present study. This may be due to phenotypic and genotypic influence over the different selections which conforms with the findings of Singh (1988) and Ram et al. (1997). Biradar and Mukunda (2007) and Raghav and Tiwari (2008) observed similar findings in their guava selections. The individual fruit weight is an important to yield attributing parameter during the crop improvement program in fruit crops while making selections. A significant variation to fruit weight was observed among the genotypes under the present study. This may be due to phenotypic and genotypic influence over the different selections which conforms with the findings of Singh (1988) and Ram et al. (1997). Biradar and Mukunda (2007) and Raghav and Tiwari (2008) observed similar findings in their guava selections.

Conclusion:

Among the studied guava genotypes wide range of variation exists. The characterization of leaves showed variation in terms of shape and color. Tree habit also showed specifically different growth patterns along with vigour, branching density, foliage density and bark color. Similarly, fruit quality showed variation in terms of color, shape, surface smoothness and other physic- chemical characters. The highest total soluble solids (TSS0B) was found in Pear Shaped guava (10.5 0B) followed by KG-1 (9.150B) and Apple Guava (8.580B). Analysis of variance for different characters showed a high degree of variation among the genotypes. In terms of various morphological traits like plant vigour, uniformity, fruit size, shape and sweetness Apple Guava and KG-1 were found promising under mid hill conditions nearby Kathmandu valley areas. Thus the present study helps to identify the promising guava genotypes which could be an important source of genetic diversity that can be used in the guava improvement program.

Declaration of conflict of interest and ethical approval:

S. Pandey involved in designing, conducting study, analyzing and interpreting the results and preparing manuscript. I.P. Gautam involved in monitoring and supervising the experimental work, sharing guidelines for result interpretation and manuscript preparation. M. Dhakal, D. Ghimire and S. Poudel involved in conducting study and manuscript preparation.

The author declare no conflicts of interest regarding publication of this manuscript

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