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Genetic diversity, heritability, genetic advance and correlation coefficient in guava (*Psidium guajava*)

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ABSTRACT

A study was conducted during 2003–05 to evaluate genetic diversity, heritability, genetic advance and correlation coefficient of some promising selections of guava (*Psidium guajava* L.) with the commercial varieties under Indo-Gangetic region of Uttar Pradesh. Wide range of plant height (3.40–6.80 m), leaf length (8.20–13.90 cm), size of flower (2.31–4.63 cm), pollen grain size (18.01–26.80 µ), fruit length (8.46–14.41 cm), fruit diameter (3.00–18.15 cm), fruit weight (34.01–290.26 g) and days required to fruit maturity (116–177 days) were observed. Among the qualitative traits, the range of total soluble solids (10.48–21.26%), acidity content (0.23–1.33%), total sugar content (7.46–14.36%), reducing sugar (3.65–8.44%), non-reducing sugar (3.53–8.52%), ascorbic acid content (79.38–517–68 mg) and seeds/fruit (26.89–115.85) were recorded. Heritability of the parameters was very high and range was 75.18 (size of flower) to 99.00 (reducing sugar content). Genetic advance range was recorded between 0.270 (length of fruit) and 1.423 (weight of fruit). Genotypic covariance range was between 12.144 (pollen grain size) and 70.43 (weight of fruit). Phenotypic covariance range was found in between 12.208 (days required to fruit maturity) and 71.768 (weight of fruit). Phenotypic correlation coefficient was positive with fruit diameter, weight of fruit, days required to fruit maturity and TSS with size of flower. Seeds/fruit had positive correlation with acidity content. Total soluble solids had positive correlation with acidity content, total sugar content, reducing sugar and non-reducing sugar content.

Key words: Heritability, Genetic advance, *Psidium guajava*, Quality, Reproductive traits, Vegetative traits

Guava (*Psidium guajava* L.) is one of the most important fruit crops of India, occupying fourth and fifth place, respectively in importance in term of area planted and of production (Yadav and Shanker 2010). It is a hardy crop and can be grown satisfactorily on marginal soils with minimum care. It is considered as poor man's apple due to cheapness and high nutritive values in addition to its availability in the market (Kumar *et al.* 2009). The plant of guava is miracle for waste land with inbuilt hardiness has immense potential for its exploitation in waste land of Uttar Pradesh. It is a self-pollinated crop with narrow genetic base. The precise study of guava germplasm available in the natural habitat shall boost up the pace of improvement of the crop through various improvement devices. To evolve improved cultivars with better quality, information on association of quantitative and qualitative characters are of immense value in selection. A large number of local varieties are under cultivation in the Indo-Gangetic region of Uttar Pradesh along with commercial cultivars. However, information on the performance of these cultivars and extent of genetic variation for different quantitative and qualitative characters in agro-climatic situation of this region is lacking.

Qualitative parameters are directly associated to the consumers to whom lastly the produce likely is to be disposed off. Heritability, genetic advance coefficient of variance and correlation coefficient for a character are hurdle in crop improvement if they are slow or negligible in progress. Guava crop is well acclimatized in Allahabad-Kanpur belt (Indo-Gangetic region) and these regions have several strains which need to be identified, compared, selection and further improved for commercialization. Keeping in view, the present investigation was aimed to assess fourteen cultivars (local and commercial) of guava for their quantitative and qualitative attributing characters and observed the extent of genetic variation under Indo-Gangetic regions of Uttar Pradesh.

MATERIALS AND METHODS

The investigation was carried out at the Department of Horticulture of the University during 2003–05. Ten-year old plants of 14 varieties/selections (V_1–V_{14}) were taken for the

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study. Out of which, 4 (V_1-V_4) were commercial cultivars of the area, viz 'Allahabad Safeda', 'L 49', 'Apple Colour', and 'Red Fleshed Guava'; 4 (V_5–V_8) selections and 6 (V_9–V_{14}) cultures. The experiment was conducted under randomized block design replicated three times and pooled data of two years were analyzed as per the method suggested by Gomez and Gomez (1984). Plant height, plant canopy, leaf length, flower size and pollen grain size was measured as per standard methods. Fruit length was measured from the point of pedicel attachment to the calyx end. The diameter was measured at highest perimeter. Number of fruits weighed in one kg were taken and averaged as weight of one fruit in gram. Time needed in days from full bloom to fruit colour turning stage was taken as days required to fruit maturity. Seeds/fruit was measured after decaying 10 ripe fruits and their seeds counted and averaged as of seeds/fruit. Chemical parameters, viz TSS, acidity, total sugar, reducing sugar and non-reducing sugar were analyzed as per standard procedure (AOAC 1998). Heritability, genetic advance, coefficient of variance and correlation coefficient were worked out as per the method given by Al-jibouri *et al.* (1958)

RESULTS AND DISCUSSION

All the physical characters (Table 1) showed significant variability. Highest plant height (6.80 m) was recorded in Culture II while as lowest height was recorded (3.40 m) in 'L 49' with the coefficient of variation of 21.35%. The high range of variation in case of tree characteristics may be attributed to genetic makeup of individual seedling tree, variation in soil condition, age and environmental conditions. Some dwarf plants were also observed in Selection II (3.50 cm) and Culture III (3.52 cm). Longest leaf (13.90 cm) was recorded in Culture IV and shortest leaf (8.20 cm) in Selection II. Largest flower size (4.63 cm) was recorded in Culture VI and smallest flower size (2.31 cm) in Selection IV. Large pollen grain size was found in Selection IV (26.80 µ), whereas small pollen size (18.0 µ) in Culture VI with very low coefficient of variation (4.76%). Fruit length varied from 8.46 (Selection II) to 14.41 cm (Selection III) with coefficient of variation of 8.66%. However, the fruit diameter varied from 3.00 cm (Culture IV) to 10.51 cm ('Apple Colour'). Maximum fruit weight (290.20 g) was observed in 'Allahabad Safeda' followed by 'L 49' and 'Apple Colour', while as minimum fruit weight in Culture II (34.01 g). Data further revealed that the genotype under the name of culture (I-IV) have less than 100 g fruit weight. The variation in fruit weight was because of genetic behaviour of different cultivars or genotypes with bigger or smaller sizes varying with weight. (Prasad and Bankar 2000). However Panday *et al.* (2007) recorded guava fruit weight which varied from 130 to 275 g under Lucknow conditions. Wide variability in fruit maturity was observed which ranged from 116.75 (Culture V) to 177.06 days ('L 49'). Maximum seed/fruit (115.85) was recoded in Culture III and minimum (26.89) in Culture IV. Culture IV can be taken in breeding programme to reduce seed content of commercial importance varieties. Grate range among the physical parameter was observed which needs further critical observation and

Table 1 Phenotypic variability in guava

Treatment		Plant height (m)	Leaf length (cm)	Flower size (cm)	Pollen grain size (µ)	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Time required to fruit maturity (days)	Seeds/ fruit
'Allahabad Safeda'	(V1)	6.20	9.80	3.35	23.87	13.45	9.78	290.26	160.73	98.15
'L 49'	(V2)	3.40	12.80	3.35	23.96	13.68	10.34	255.98	177.06	85.20
'Apple Colour'	(V3)	5.20	10.40	3.17	25.55	13.48	10.51	238.63	169.30	88.28
'Red Fleshed Guava'	(V4)	4.20	9.80	3.17	24.45	10.66	10.21	155.30	172.11	81.35
Selection I	(V5)	4.12	10.00	3.14	25.41	10.60	4.53	164.34	139.57	68.96
Selection II	(V6)	3.50	8.20	3.69	24.21	8.46	4.66	126.65	155.56	110.45
Selection III	(V7)	5.80	12.20	4.31	25.05	14.41	3.80	80.45	147.86	83.88
Selection IV	(V8)	4.18	10.00	2.31	26.80	14.23	3.63	49.06	137.60	39.10
Culture I	(V9)	5.12	12.79	2.83	24.38	13.95	3.50	66.86	126.93	39.60
Culture II	(V10)	6.80	10.20	2.76	19.47	13.56	4.35	57.27	140.98	114.78
Culture III	(V11)	3.52	9.80	2.75	18.43	13.38	3.05	34.01	137.13	115.85
Culture IV	(V12)	5.18	13.90	2.68	24.83	13.50	3.00	50.43	122.35	26.89
Culture V	(V13)	4.60	10.80	3.57	26.75	13.36	4.05	56.63	116.75	51.55
Culture VI	(V14)	5.30	11.22	4.63	18.01	13.46	5.86	75.01	145.56	121.43
Mean		4.75	10.83	3.26	23.65	12.80	5.80	121.49	146.39	79.75
		±0.27	±0.29	±0.26	±0.30	±0.29	±0.29	±3.73	±1.07	±3.43
Range		3.40–6.80	8.20–13.90	2.31–4.63	18.01–26.80	8.46–14.23	3.0–10.51	34.01–290.26	116.75–177.06	26.89–121.43
CV (%)		21.35	10.24	30.83	4.76	8.66	19.13	8.94	6.66	15.44
CD (*P*=0.05)		1.23	0.58	0.23	0.49	0.61	0.61	2.81	10.95	6.32

Table 2 Variability in qualitative attributes of guava fruit

Treatment		TSS (°B)	Acidity (%)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	Ascorbic acid (mg/100 g of edible)
'Allahabad Safeda'	V_1	14.23	0.49	8.46	4.30	3.53	173.88
'L 49'	V_2	15.38	0.53	8.46	4.36	3.58	210.34
'Apple Colour'	V_3	14.80	0.52	7.62	3.72	4.28	180.83
'Red Fleshed Guava'	V_4	15.53	0.79	8.15	4.41	4.26	173.59
Selection I	V_5	13.38	0.78	7.86	5.46	4.41	202.10
Selection II	V_6	10.48	0.51	7.46	4.46	4.58	185.09
Selection III	V_7	16.52	0.32	8.06	3.75	4.50	138.54
Selection IV	V_8	14.50	0.23	12.46	7.78	5.41	166.49
Culture I	V_9	15.61	1.15	11.43	5.41	5.53	79.38
Culture II	V_{10}	13.55	1.08	9.55	7.55	4.68	517.67
Culture III	V_{11}	21.26	1.33	9.65	7.63	5.65	183.33
Culture IV	V_{12}	18.53	0.46	9.02	5.44	8.52	170.94
Culture V	V_{13}	15.60	0.48	14.36	8.44	5.80	201.51
Culture VI	V_{14}	18.50	0.47	10.43	3.65	5.55	138.54
Mean		15.56±0.30	0.65±0.26	9.50±0.29	5.45±0.29	5.02±0.29	123.78±30.78
Range		10.48–21.26	0.23–1.33	7.46–14.36	3.65–8.44	3.53–8.52	79.38–210.34
CV(%)		7.3050	151.2920	11.6631	20.0623	21.9123	24.8660
CD (P=0.05)		0.49	0.65	9.50	5.45	5.02	123.78

selection for the desirable traits like seed number and sweetness of fruit.

The data presented in Table 2 reveal wide variation in chemical composition of the fruit of all the genotypes. The TSS ranged from 10.48 to 21.26°B with mean of 15.56°B and coefficient of variation 7.30%. TSS was found to be maximum in culture III (21.26°B), followed by culture IV (18.53°B) and minimum in selection II (10.48°B). Low acidity in fruit has an important role in determining consumer acceptability and market appeal. Acidity ranged from 0.23 (selection IV) to 1.33% (Culture III) with mean of 0.65% and high coefficient of variation (151.29%). Dinesh and Reddy (2001) has also recorded variation in acid content, ranging between 0.15 and 2.47% in guava fruit.

Total sugar content was maximum (14.36%) in Culture V and minimum (7.46%) in Selection II. The reducing sugar ranged from 3.65% (Culture VI) to 8.44% (Culture IV) with mean of 5.45% and coefficient of variation is 20.06%. Non-reducing sugar was maximum (8.52%) in Culture IV while lowest (3.53%) in 'Allahabad Safeda'. Ascorbic acid content was recorded maximum (517.67 mg/100 g edible parts) in Culture III and lowest (79.38 mg/100 g) in Culture II. Qualitative traits are more demanding attributes in export purpose. Our results are also in conformity of the findings of Singh and Kumar (2002) and Parihar *et al.* (2002).

Highest heritability (99.00) was associated with reducing sugar content, followed by pollen grain size (98.95). Lowest heritability (75.18) was observed in size of flower (Table 3). Genetic advance was maximum in weight of fruit (1.423) while lowest (0.241) in days required to fruit maturity. Genotypic and phenotypic covariance which were maximum with weight of fruit that are (70.431) and (71.768), respectively (Table 3). Higher heritability coupled with high genetic advance ensured substantial improvement of the traits which could be achieved through direct selection. Sirisena and Senanayake (2000) have also reported high magnitude of heritability for fruit weight in several diverse accessions of *Musa*.

Table 3 Heritability, genetic advance, genotypic and phenotypic covariance in guava

Character	Heritability	Genetic advance	Genotypic covariance	Phenotypic covariance
Flower size (cm)	75.18	0.38	19.29	19.77
Pollen grain size (μ)	98.95	0.24	12.14	12.20
Fruit length (cm)	98.20	0.27	13.22	13.34
Fruit diameter (cm)	98.52	1.04	51.23	51.61
Fruit weight (g)	96.30	1.42	70.43	71.76
Days required for fruit	88.61	0.24	12.43	13.21
Seeds/fruit	98.52	0.78	38.61	38.90
Total soluble solids (%)	98.73	0.64	16.78	16.89
Acidity (%)	91.23	0.96	48.96	51.26
Total sugar (%)	86.20	0.39	20.83	22.43
Reducing sugar (%)	99.00	0.63	30.94	31.09
Non-reducing sugar (%)	86.19	0.46	24.26	26.13

Association among traits measured by a correlation coefficient (Table 4) revealed a significant and positive correlation of size of flower with diameter of fruit (0.142), weight of fruit (0.124), days require fruit maturity (0.202),

Table 4 Phenotypic correlation coefficient among different characters in guava

Character	Flower size	Pollen grain size	Fruit length	Fruit diameter	Fruit weight	Days required fruit maturity	Seeds/ fruit	Total soluble solids	Acidity	Total sugar	Reducing sugar	Non-reducing sugar
Flower size (cm)	1.000											
Pollen grain size (μ)	–0.195	1.000										
Fruit length (cm)	–0.095	–0.095	1.000									
Fruit diameter (cm)	0.142	0.105	–0.978	1.000								
Fruit weight (cm)	0.124	0.105	–0.168	0.862	1.000							
Days required fruit maturity	0.202	–0.015	–0.229	0.824***	0.747***	1.000						
Seeds/fruit	0.445**	–0.728***	0.253	0.257	0.176	0.448	1.000					
Total soluble solids (%)	0.018	–0.452	0.534	–0.213	–0.380	–0.280	–0.007	1.000				
Acidity (%)	–0.372	–0.523**	–0.059	–0.183	–0.216	–0.119	0.249	0.247	1.000			
Total sugar (%)	–0.15	0.09	0.41	–0.42**	–0.52***	–0.60***	–0.40**	0.198	0.001	1.00		
Reducing sugar (%)	–0.55***	0.01	0.199	–0.55***	–0.58***	–0.62***	–0.25	0.12	0.30	0.66	1.00	
Non-reducing sugar (%)	–0.232	–0.0177	0.203	–0.618	–0.656	–0.684	–0.466	0.493	–0.020	0.361	0.327	1.00

* *P*=0.05 ** *P*=1% *** *P*= 0.01%

seeds/fruit (0.445) and TSS (0.018), while it showed negative correlation with pollen grain size, acidity content, reducing, non-reducing and total sugar content. Pollen grain size had positive correlation with fruit diameter (0.105), fruit weight (0.105), TSS (0.097). Length of fruit showed positive correlation with number of seeds/fruit (0.253), TSS (0.534), reducing (0.199), non-reducing (0.203) and total sugar content (0.421). Diameter of fruit showed positive correlation with weight of fruit (0.862) and days required to fruit maturity (0.824). Weight of fruit had positive correlation with number of seeds/fruit (0.176). Correlation studies between fruit weight and its components and their relative contribution to qualitative attributes have of great value in planning and evaluating breeding programme.

Total sugar had positive correlation with pollen grain size (0.097), fruit length (0.412) and acidity content (0.001). The TSS had positive correlation with size of flower (0.018), length of fruit (0.534). Acidity content had positive correlation with no of seeds/fruit (0.249). Reducing sugar content had positive correlation with length of fruit (0.199) TSS (0.122) and acidity (0.303). Non-reducing sugar content also had positive correlation with fruit length (0.203) and TSS (0.493). This results are in conformity of the findings of Kumar *et al.* (2004).

Conclusively, all the physical parameters had showed significant variability and provide great opportunity in breeding programme to get desired variety. Similarly, chemical characters also reflected potential variation. Heritability, genetic advance coefficient of variance and correlation coefficient analysis showed encouraging results to transfer desired traits into elite cultivar.

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