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Evaluation of Guava Varieties for Growth, Yield and Quality Attributes in *Tarai* Conditions of Uttarakhand

Pratibha^{1*} and Shant Lal¹

¹Department of Horticulture, G.B.Pant University of Agriculture and Technology, Pantnagar- 263145 (Uttarakhand)

*E-mail: pratibhaborti@rediffmail.com

Abstract: The present investigation was carried out at Horticulture Research Centre, Patherchatta, G.B. Pant university of Agriculture and Technology, Pantnagar to study the morphological and reproductive traits of guava cultivars. The experiment was conducted in Randomized Block Design with eleven treatments and three replications. The treatment consisted of eleven cultivars *viz.*, Pant Prabhat, Sardar, Allahabad Safeda, Chittidar, Red Fleshed, Seedless, Seed Rolf, Apple Colour, River Side, Karela, Pear Shaped. The results showed significant variation in tree height, tree spread, stem girth, cross sectional trunk area, tree volume, annual increase in shoot length, number of leaf pairs per shoot, number of flower buds per branch, percent fruit set per cent, fruit retention, number of fruits per tree, yield, average fruit weight, average fruit length, fruit diameter, fruit volume, number of seeds per fruit, average weight of 100 seeds, total soluble solids, acidity, ascorbic acid, total sugars, TSS : acid ratio, sugar : acid ratio and pectin among the guava cultivars during both rainy and winter seasons. However, annual increase in shoot length and non reducing sugar during winter season did not differ significantly. In general, yield per tree found maximum during rainy season in all the cultivars as compared to winter season. Among the cultivars, Sardar gave maximum fruit yield followed Pant Prabhat during both rainy and winter season. In general most of the quality parameters were found maximum during winter season crop as compared to rainy season crop. On the basis of this study Sardar and Pant Prabhat have been found superior in yield and quality character in *tarai* conditions of Uttarakhand.

Key words: Guava, cultivars, growth, yield, quality.

INTRODUCTION

Guava (*Psidium guajava* L.) is one of the well known edible tree fruits of the tropical and subtropical climates. It is, a member of the Myrtaceae family, and native to tropical America, stretching from Mexico to Peru (Samson, 1986). Guava is one of the most common and popular fruit of India and well known as 'Poor man's apple' as it is available in plenty to every person at a low price and it is no way inferior to apple for its nutritional values (Sharma *et al.*, 1998). Guava has good potential in the fruit industry of our country because of its delicious taste, aromatic, sweet flavour and a fine balance of acid, sugar and pectin (Singh and Rao, 1996). Fruits are being processed in to various products like jam, jelly, puree, clarified juice, powder, toffee, flakes, nectar, butter paste and whole preserve (Attri and Singh, 2003). It is an excellent source of vitamin 'C' and pectin. About 95 cultivars of guava have been described but only 12-15 cultivars are grown commercially. Guava is an open pollinated and heterozygous crop with adequate genetic variation for selection of desirable commercial types (Nakasone and Paull, 1999). As guava is an important crop, it is necessary to select the better genotypes out of the existing material available in India and describe them for growth, yield and quality traits for their proper identification and further use. Therefore, the present studies were undertaken to find out variation in growth, yield and quality characters of eleven cultivars under *tarai* condition of Uttarakhand which can be further used as better cultivars of guava for Tarai area of U.P. and Uttarakhand.

MATERIALS AND METHODS

The experiment was conducted at Horticulture Research Centre, Patherchatta, Govind Ballabh Pant, University of Agriculture and Technology, Pantnagar, to find out suitable variety of guava for tarai regions of Uttarakhand. The experimental material consisted of eleven cultivars of guava namely Pant Prabhat,

Sardar, Allahabad Safeda, Chittidar, Red Fleshed, Seedless, Seed Rolf, Apple Colour, River Side, Karela, Pear Shaped. All the trees were five years old planted at 7×7 m distance and maintained under uniformed cultural practices during course of investigation. There were eleven treatments (cultivars) replicated thrice in randomized block design having one tree per replication. Data were recorded for both rainy and winter season on growth and vigour of the trees, leaf characters, yield parameters and quality parameters. The observations on growth and vigour of the trees were recorded in terms of tree height (measured with the help of measuring pole in meters), tree spread (measured in both the directions *i.e.* East-West and North- South and calculated by the formula $(N-S) + (E-W)/2$), trunk diameter (measured with the help of tree calipers at the marked point *i.e.* 10 cm above the ground level on the trunk in both the directions *i.e.* East-West and North-South), tree volume (calculated by the formula given by Westwood *et al.* (1983) as: Tree vol. (m^3) = $4/3\pi ab^2$, where, $a = 1/2$ of the tree spread (m) and $b = 1/2$ of the tree height (m) and shoot length (ten shoots from all the directions of each tree were selected).

A representative sample of ten leaves was taken randomly from all the directions of each tree in both rainy and winter season for recording data on leaf characters of the trees in terms of length of the leaves, breadth of leaves, Length and breadth ratio of leaf, leaf area (measured with the help of leaf area meter (LI-COR portable leaf area meter LI-3000 A). Yield parameters were recorded in terms of number of fruits per tree (by counting total fruits retained at the time of harvesting on trees), yield Kg/tree. Quality parameters were recorded in terms of fruit weight, fruit size by measuring length and diameter of fruits with the help of vernier calliperse, fruit volume by water displacement method, T.S.S. of pulp with the help of digital refractometer, acidity estimated by acid alkali titration method suggested by A.O.A.C. (1970). However, ascorbic acid content, reducing sugar, non reducing sugar, total sugar and

pectin were analyzed by using methods suggested by Ranganna, (1986). The data were statistically analyzed for analysis of variance according to Snedecor and Cochran (1999) following Randomized Block Design (RBD).

RESULTS AND DISCUSSION

The data on tree height (Table 1) revealed that it was maximum in Red Fleshed (3.79 m) followed by Pant Prabhat (3.68 m), but statistically these two cultivars were *at par* with respect of height, whereas, minimum tree height was found in Seed Rolf (2.67 m) preceded by Karela (2.68 m) but statistically these two cultivars were *at par* with each other. Maximum tree spread was found in cultivar Red Fleshed (5.10 m) followed by Pear Shaped (5.08 m) but statistically these two cultivars were *at par* with each other while minimum tree spread was recorded with Apple Colour preceded by Seed Rolf. The stem girth of the tree (Table 1)

differed significantly among the cultivars. Cultivar Seedless gave maximum stem girth which was *at par* with Pant Prabhat. Cultivar Apple Colour gave minimum stem girth which was *at par* with Karela. Maximum tree volume was found in Pant Prabhat (47.60 m³) followed by Pear shaped (43.12 m³) while minimum tree volume was found in Apple Colour (12.73 m³) preceded by Seed Rolf (18.02 m³). Similar findings were reported by Pathak *et al.* (1989); Subramaniyam and Dinesh (1993) and Sharma *et al.* (1998). The variation in growth and vigour might be due to the genetic variability as well as the agro-climatic conditions.

In rainy season the annual increase in shoot length varied significantly among the cultivars (Table 1), while, in winter season the annual increase in shoot length did not differ significantly. In rainy season the maximum increase in shoot length was found in Allahabad Safeda (16.37 cm) followed by

Table 1
Effect of cultivars on growth, vigour and leaf characters

Cultivars	Height (m)	Spread (m)	Stem girth (cm)	Tree volume (cm ³)	Shoot length (Annual Increase cm)		Leaf area (cm) ²		Leaf length (cm)		Leaf breadth (cm)		Length : Breadth	
					Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter
Pant Prabhat	3.68	4.98	14.58	47.60	16.23	8.13	72.03	81.37	14.26	15.24	6.49	6.94	2.18	2.19
Sardar	3.20	4.20	9.23	29.41	10.03	7.20	65.01	71.30	14.00	13.91	6.11	6.36	2.33	2.19
Allahabad Safeda	3.50	4.10	10.45	41.34	16.37	6.93	54.64	56.53	12.43	14.93	5.18	5.77	2.59	2.60
Chittidar	3.52	4.50	10.83	37.33	10.63	7.00	38.41	45.00	11.07	11.67	4.50	5.49	2.47	2.13
Red Fleshed	3.79	5.10	12.33	40.89	5.70	7.37	51.09	53.86	11.93	11.98	5.70	5.65	2.10	2.12
Seedless	3.48	4.10	14.67	37.86	10.95	7.25	54.06	66.70	11.90	12.15	6.15	6.75	1.94	1.80
Seed Rolf	2.67	3.59	9.75	18.02	10.10	7.05	44.35	45.14	11.80	12.03	4.68	4.99	2.03	2.39
Apple Colour	2.70	3.00	6.58	12.73	7.14	7.20	37.05	49.81	11.97	14.97	4.52	5.11	2.65	3.05
River Side	2.85	4.08	9.92	24.85	13.18	7.54	44.99	46.52	12.26	10.97	5.07	5.01	2.42	2.28
Karela	2.68	3.87	9.08	21.02	9.11	7.35	37.03	44.46	10.35	10.55	4.84	5.46	2.14	1.93
Pear Shaped	3.19	5.08	11.08	43.12	4.80	7.15	40.23	55.64	11.66	12.90	4.63	5.65	2.52	2.29
S _{Em} ±	0.25	0.27	0.74	3.92	1.84	1.38	2.95	3.14	0.32	0.96	0.13	0.18	0.12	0.20
CD at 5%	0.67	0.81	2.20	11.59	5.44	NS	8.71	9.28	0.95	2.84	0.38	0.54	0.36	0.59

Pant Prabhat (16.23 cm) while, the minimum increase in shoot length was found in Pear Shaped (4.80 cm) proceeded by Red Fleshed (5.70 cm). Maximum growth during spring season was due to the active growth phase, and congenial atmospheric conditions, while minimum growth in winter season was due to low temperature. Similar growth pattern of shoots was recorded by Rathore and Singh (1974) and Dwivedi *et al.* (1991). Leaf area differed significantly among the various cultivars (Table 1). Area of winter season leaves was greater than rainy season leaves. The findings are in conformity with the results reported by Bandopadhyay *et al.* (1992), Singh (1996), Singh (2003) and Raghava (2004) in guava. Length and breadth of the leaves varied significantly among the cultivars. In general leaf length was found maximum in winter season as compared to rainy season leaves (Table 1).

Pant Prabhat have maximum leaf length followed by Sardar while minimum leaf length was recorded in Karela for both rainy and winter seasons.

Maximum leaf breadth was recorded in Pant Prabhat followed by Seedless during both rainy and winter seasons while Chittidar gave minimum leaf breadth for rainy season and Seed Rolf gave minimum leaf breadth for winter seasons. The data on length and breadth ratio of leaves indicate that there was significant difference in length and breadth ratio of leaves of various cultivars. The maximum length and breadth ratio was observed in Apple Colour followed by Allahabad Safeda and minimum in Seedless during both rainy and winter seasons.

The data on total number of fruits per tree (Table 2) revealed that it was found maximum in rainy season as compared to winter season crop. During rainy season the total number of fruits per tree was found maximum in cultivar River Side (708.00) followed by Pear Shaped with minimum in Apple Colour (108.33) proceeded by Seedless. In winter season maximum number of fruits per tree was recorded in Sardar (81.33) followed by River Side with minimum in Seedless (18.00) proceeded by

Table 2
Effect of cultivars on yield and physical quality parameters of fruits

Cultivars	Number of fruits per tree		Yield (kg) per tree		Average fruit weight (g)		Average fruit length (cm)		Average fruit diameter (cm)		Average fruit volume (ml)	
	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter
Pant Prabhat	447.33	52.33	58.07	8.39	130.33	164.20	5.11	6.70	6.45	8.38	128.78	163.39
Sardar	621.00	81.33	62.39	12.60	119.50	155.10	6.88	7.10	6.11	6.83	118.13	152.94
Allahabad Safeda	563.33	43.67	52.0	6.09	99.73	141.42	5.82	6.22	6.07	6.39	97.32	138.54
Chittidar	447.67	38.00	41.47	4.80	93.37	129.83	4.98	5.29	5.85	5.77	89.34	126.38
Red Fleshed	526.67	39.67	53.89	5.24	103.40	133.30	5.18	5.69	4.82	5.68	99.41	128.56
Seedless	121.00	18.00	13.43	2.70	111.17	152.43	5.77	6.10	5.36	5.80	113.58	158.19
Seed Rolf	408.33	38.67	44.75	5.93	112.22	154.47	7.01	8.08	6.07	6.83	113.43	158.50
Apple Colour	108.33	21.00	7.76	2.22	69.44	116.27	4.78	5.39	4.45	5.00	63.33	118.17
River Side	708.00	54.00	41.03	4.76	58.76	86.67	6.58	7.34	4.79	5.72	62.07	84.94
Karela	468.67	41.00	30.40	3.71	65.30	93.27	5.40	5.53	4.95	6.05	65.3	90.19
Pear Shaped	650.00	53.00	55.78	6.92	85.07	131.46	6.04	5.54	5.67	5.55	85.07	125.53
SEm ±	74.17	5.62	6.30	0.769	4.25	5.33	0.16	0.35	0.77	0.21	3.99	5.29
CD at 5%	218.80	16.56	18.58	2.27	12.53	15.73	0.48	1.02	0.23	0.611	11.79	15.59

Apple Colour. The maximum number of fruits per tree in rainy season might be due to higher number of flower buds obtained in summer flowering. The variation in total number of fruits among cultivars might be due to the fruiting behaviour as affected by the genetic characters of the variations as well as the agro-climatic conditions. The findings are in conformity with the results reported by Singh (1996) and Sharma *et al.* (1998). Yield per tree varied significantly among the cultivars. Cultivar Sardar gave maximum Yield (62.39 kg per tree) followed by Pant Prabhat during both rainy and winter season. In rainy season minimum yield per tree was found in Apple Colour (7.76 kg per tree) followed by Seedless while in winter season Apple Colour gave minimum yield (2.22kg per tree) which was *at par* with Seedless. In general yield per tree found maximum rainy season in all the cultivars as compared to winter season. In an evaluation trial with different guava cultivars, Kundu and Mitra (1994), Aulakh and Kamboj (1996) and Aulakh (2004) also recorded highest yield in cultivar Sardar. The higher yield in rainy season was due to high percentage of fruit set and low flower/fruit drop in this season. The variation in the yield might be due to the fruiting behaviour as affected by the genetic characters of the variety as well as the agro-climatic conditions.

The average fruit weight differed significantly among the cultivars. Winter season fruits were found heavier than rainy season fruits. Maximum fruit weight was recorded in Pant Prabhat followed by Sardar and Minimum in River Side proceeded by Karela during both rainy and winter season. In rainy season maximum fruit length was found in cultivar Seed Rolf (7.01 cm) followed by Sardar (6.88 cm) and during winter season in Seed Rolf (8.08 cm) followed by River Side (7.34 cm) and Sardar (7.10 cm). Fruit length was recorded minimum in Apple Colour (4.78 m) in rainy season and in Chittidar (5.29 m) in winter season. Fruit diameter was found maximum in Pant Prabhat followed by Sardar and minimum in Apple Colour during both

rainy and winter seasons. In general winter season fruits had more volume as compared to rainy season fruits. Fruit volume was recorded maximum in Pant Prabhat followed by Sardar and minimum in River Side during both rainy and winter seasons. The average fruit weight, fruit volume, fruit length and fruit diameter were found less during rainy season might be due to more number of fruit per tree, limited exposure of light due to cloudy weather and more competition for photosynthates for fruit growth in rainy season, hence medium to smaller size fruits were obtained. Similar observations were recorded by Dwivedi *et al.* (1991), Singh (2000), Aulakh (2004).

Data pertaining to number of seeds per fruit (Table 3) varied significantly among the cultivars. During rainy season the cultivar Seedless was observed to produce minimum number of seed per fruit (5.00) followed by Seed Rolf. On the other hand, the highest number of seeds per fruit was recorded in Pear Shaped (473.37). During winter season again minimum number of seeds per fruit was recorded in Seedless followed by River Side while Pear Shaped possessed the highest number of seeds per fruit (499.75). During rainy season weight of 100 seeds was maximum in Red Fleshed (1.31 g) followed by River Side (1.02 g) while, the minimum value was recorded in Pant Prabhat (0.67 g) proceeded by Allahabad Safeda (0.70 g). During winter season weight of 100 seeds was found maximum in Red Fleshed (1.27g) followed by Sardar (1.03 g) and minimum value was found in Pant Prabhat (0.67g) and Allahabad Safeda (0.70 g).

All the cultivars of guava gave best quality of fruits during winter season followed by rainy season. Most of the quality parameters *viz* T.S.S., acidity, ascorbic acid, total sugars and pectin content were found more in winter season as compared to rainy season. During rainy season maximum TSS was recorded in Pant Prabhat (10.23%) followed by Seedless (9.90%). Minimum TSS was recorded in Apple Colour (7.11%) proceeded by River Side

Table 3
Effect of cultivars on seed attributes and chemical quality parameters of fruits

Cultivars	Average number of seed per fruit		Weight of 100 seeds (g)		Total soluble solids (%) <i>pu/bp</i>		Acidity (%)		Ascorbic acid (mg/100 g)		Total sugars (%)		Reducing sugar (%)		Non reducing sugar (%)		Pectin content (%)	
	R	W	R	W	R	W	R	W	R	W	R	W	R	W	R	W	R	W
Pant Prabhat	290.96	235.93	0.67	0.67	10.23	14.67	0.14	0.19	125.42	285.30	10.98	10.33	5.45	4.87	5.53	4.80	0.78	1.21
Sardar	280.30	253.82	1.00	1.03	9.63	14.17	0.21	0.25	126.57	298.69	8.50	9.35	4.23	5.20	4.27	5.00	0.89	1.30
Allahabad Safeda	472.72	291.44	0.70	0.70	9.88	14.63	0.21	0.23	114.26	280.39	9.3	9.82	4.10	5.53	5.20	4.81	0.92	1.34
Chittidar	435.23	367.90	0.95	0.96	7.73	13.07	0.17	0.52	82.65	164.50	7.46	8.16	3.24	4.50	4.22	4.35	0.74	0.95
Red Fleshed	406.80	326.58	1.31	1.27	8.22	11.03	0.16	0.41	73.42	160.40	6.53	7.58	2.82	4.45	3.71	4.18	0.77	0.83
Seedless	5.00	4.00	0.90	1.00	9.90	14.83	0.16	0.20	125.90	225.69	10.56	10.21	4.85	5.32	5.71	4.53	0.52	0.67
Seed Rolf	148.88	150.68	0.90	0.92	7.41	12.30	0.14	0.49	85.65	222.7	6.63	7.62	3.20	3.85	3.43	4.76	0.55	0.27
Apple Colour	265.90	193.23	0.94	0.94	7.11	10.24	0.18	0.21	125.86	270.60	8.42	8.96	4.64	4.98	3.78	4.52	0.87	1.26
River Side	176.84	141.43	1.02	0.98	7.41	9.43	0.57	0.80	128.77	280.36	5.13	6.27	3.00	3.50	2.13	3.91	0.89	1.21
Karela	342.15	323.20	0.88	0.86	7.74	7.74	0.15	0.21	115.26	178.90	6.3	7.33	3.18	4.5	3.12	3.85	0.58	0.77
Pear Shaped	473.37	499.75	0.76	0.77	8.38	8.38	0.14	0.36	76.47	180.65	7.12	8.21	4.05	4.72	3.07	4.58	0.76	0.90
SEm ±	18.13	11.02	0.22	0.34	0.52	0.58	0.19	0.23	4.05	9.72	0.44	0.25	0.23	0.35	0.25	0.26	0.52	0.14
CD at 5%	53.48	32.51	0.64	0.99	1.52	1.70	0.55	0.66	11.96	28.68	1.28	0.740	0.68	1.04	0.75	NS	0.15	0.42

(7.41%). During winter season maximum TSS content was found in Seedless (14.83%) which was *at par* with Pant Prabhat (14.67%) and Allahabad Safeda (14.63%). Minimum TSS content was recorded in Karela (7.74%) proceeded by Pear Shaped (8.38%). Winter season fruits possess good acidity content as compared to rainy season fruits. During rainy season maximum acidity (%) was present in River Side (0.57%) followed by Sardar and Allahabad Safeda (0.21%) while minimum acidity content was in Seed Rolf (0.14%) which was at par with Pant Prabhat and Pear shaped (0.14%). During winter season maximum acidity (%) was observed in River Side (0.81%) followed by Chittidar (0.52%) with minimum acidity (%) content in Pant Prabhat (0.19%) proceeded by Seedless (0.20%). Ascorbic acid content was found maximum in River Side (128.77 mg/100g pulp) followed by Sardar (126.57 mg/100g pulp) while minimum in Red Fleshed (73.42 mg/100g pulp) during rainy season. During winter season, maximum ascorbic acid content was found in Sardar (298.69 mg/100g pulp) followed by Pant Prabhat (285.30 mg/100g pulp) with minimum ascorbic acid content in Red Fleshed (160.40 mg/100g pulp) preceded by Chittidar (164.50 mg/100g pulp). Total sugar content was found maximum in Pant Prabhat and minimum in River Side during both, rainy and winter seasons. During rainy season reducing sugar (%) was found maximum in Pant Prabhat (5.45%) followed by Seedless (4.85%) and minimum was found in Red Fleshed (2.82%). During winter season maximum value of reducing sugar (%) was found in Allahabad Safeda (5.53%) followed by seedless (5.32%) and minimum in River Side (3.50%). Non reducing sugar was found maximum in Seedless (5.71%) followed by Pant Prabhat (5.53%) while minimum was found in River Side (2.13%) during rainy season. During winter season maximum non reducing sugar (%) was found in Sardar (5.00%) and minimum non reducing sugar (%) was found in Pear shaped (3.85%). Pectin content was found maximum in Allahabad Safeda (0.92%) followed by Sardar and River Side (0.89%) and minimum was

found in Seedless (0.52%) during rainy season. During winter season maximum pectin content was recorded in Allahabad Safeda (1.34%) followed by Sardar (1.30%). Cultivar Seed Rolf was found inferior in pectin content over other cultivars during winter season.

Winter season fruits had significantly higher values of various quality attributes as compared to rainy season fruits. The percentage of various constituents in the rainy season was low due to cloudy weather and presence of relatively more moisture which must have moved into the fruits from the wet soil. It diluted the organic metabolites, particularly sugars (Dwivedi *et al.* 1991). Rathore (1972) reported that low temperature during the ripening period of winter season crop in guava retard the excessive loss of respiratory substrates and also increased translocation of photosynthates from leaves to fruits resulted to best quality fruits in the winter season. Similar findings were also recorded by Dwivedi *et al.* (1991). Pandey and Singh (1998), Singh *et al.* (2002).

It can be concluded that there was significant variation in morphological, reproductive, yield and quality characters of various cultivars of guava. On the basis of overall performance for both rainy and winter seasons, cultivars Pant Prabhat and Sardar have been found superior.

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