The Bioscan 11(3): 1765-1770, 2016 (Supplement on of Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

EVALUATION OF DIFFERENT GUAVA (*PSIDIUM GUAJAVA* L.) GENOTYPES UNDER TARAI CONDITION OF UTTARAKHAND

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KEYWORDS
Evaluation
Fruit shape
Genotypes
Seed hardness

Received on :
17.01.2016

Accepted on :
25.07.2016

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ABSTRACT
Present investigation deals with the evaluation of eight guava genotypes. The results were obtained for the quality and biochemical characters. The genotype Allahabad Safeda recorded highest fruit weight (150.60g) and fruit diameter (8.01cm). The genotype MPUAT Sel-2 recorded highest fruit length (6.62cm).The genotype RCGH-7 recorded highest fruit volume (140.80 mL), non reducing sugar (6.20%) and sugar acid ratio (45.46). The genotype Arka Kiran recorded lowest number of seeds (114.00), highest fruit yield (25.23 kg/plant), acidity (0.47%), reducing sugar (7.78%) and total sugars (13.48%). The genotype CISH-G-35 recorded lowest Fresh weight of 100 seeds (0.78g). The genotype RCGH-1 recorded lowest dry weight of 100 seeds (0.77g) and highest ascorbic acid (203.28). The genotype RCGH-11 recorded highest seed hardness (15.83 kg cm^{-2}). The genotype MPUAT Sel-1 recorded highest TSS (8.20%), TSS : acid ratio (34.05), longest storage life (15 days) and maximum genotype score (8.22). Most of the genotypes were observed with round shaped fruit and fruit apex, broadly rounded shaped fruit base, greenish yellow fruit skin colour, smooth fruit skin surface, milky white fruit flesh colour, juicy fruit pulp texture, vertical fruit cavity and small seed size.

INTRODUCTION

Guava popularly known as "Apple of tropics" is an important fruit crop of the world. It is a member of the Myrtaceae family, is native to tropical America, stretching from Mexico to Peru (Samson, 1986). Presently, it is the fifth most important fruit crop in India after mango, banana, citrus and papaya with annual production of 3.66 million tons from 0.268 million hectares, accounting for 4.1 per cent of total fruit production with productivity of 13.7 metric ton per hectare (Anonymous, 2014). Besides, being rich source of pectin, vitamin C is reported to be 2-5 times higher than in the fresh orange juice. It is also a fair source of vitamin A, calcium, phosphorous, pantothenic acid, riboflavin, thiamin and niacin. The ripe fruits are relished equally by both the rich and poor. It is a small tree with prolific-bearing habit and bears more than once a year. Guava has good potential in the fruit industry of our country because of its delicious taste, aromatic, sweet flavor and a fine balance of acid, sugar and pectin (Singh and Rao, 1996). The trees are quite hardy and give satisfactory return without much care and have the ability to adopt in wide range of soils and climatic conditions. Besides having high nutritive values it can be grown satisfactorily even in adverse situation (Rathore, 1976).

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 (Nakasone and Paull, 1999). A new genotype is emerges as a result of natural or manmade crosses. They are altogether different in yield as well quality characteristics. As guava is one of the most important crop, it is required to select the better genotypes out of the existing new available material and characterize them for morphological and biochemical traits for their identification and further use. Performance of different guava accessions varies significantly with cultivars, location, agro-climate and soil type *etc*. The variation with regard to growth and bearing habits, yield, flesh colour and quality among different guava cultivars were also reported by Chadha *et al*. (1981) and Ojha *et al*. (1985) in different parts of the country. Therefore, the present study was undertaken to study the physico-chemical characteristics of various genotypes of guava genotypes and to find out the suitable cultivar of guava for *Tarai* region of Uttarakhand on the basis of yield and quality characters.

MATERIALS AND METHODS

Three newly developed guava hybrids *viz*., MPUAT Sel-1, MPUAT Sel-2, CISH-G-35, RCGH-1, RCGH-7 and RCGH-11 and two commercial cultivars *viz*., Allahabad Safeda and Arka Kiran were evaluated for their yield and quality traits at Horticulture Research Centre, Patharchatta, Govind Ballabh Pant University of Agriculture and Technology (29 ºN latitude, 79.3ºE longitudes and 243.84 msl) during 2014-15. The climatic condition of experimental site was humid subtropical. The data was statistically analyzed by method of analysis of variance using RBD as described by Panse and Sukhatme (1985). The experiment consisted of eight treatments, each as a genotype. All the treatments were replicated five times and one tree served as a unit of treatment in each replication. Ten fruits were randomly harvested from each plant for recording observations. Growth and yield parameters were taken in terms

of yield (kg/tree), fruit weight (g), fruit length (cm), fruit diameter (cm), fruit volume (ml), number of seed/100 g fruit weight, seed hardness (kg cm^{-2}), fresh and dry weight of seed (g). Seed hardness were measured by Mecmesin Basic force (BFG 1000N, England) using an 8mm probe and expressed as kg cm^{-2}. Maximum fraction force required to crack a seed was recorded on 10 seed per fruit. The fruit quality was studied in terms TSS (ºB), acidity (%), TSS: acid, sugar: acid, ascorbic acid (mg/100g), total sugar (%), storage life of fruit and Organoleptic test. Total soluble solid (TSS) was determined with the help of digital refractometer. Acidity was determined by titrating the juice against N/10 NaOH and expressed as per cent citric acid. Ascorbic acid content of fruit was determined with the help of the method given in A.O.A.C. 2000 and total sugar was analyzed as per method given by Lane and Eynon method reported by Ranganna, (1986). For storage life of guava fruit were harvested at 80% maturity (green stage) from an orchard. Fruit were selected for uniformity of size and colour, blemished and diseased fruit were discarded.Ten fruit in each treatment were stored at ambient room temperature and moisture condition. Fruits were evaluated regularly every four days for palatability until the fruits get decayed. The fruits tested by a panel composed of 5 members collaborated on the evaluation. All of them were regular consumers of guava fruits. Sensory evaluation descriptive test was used to evaluate the sensorial profile of the samples. The panel evaluated the attributes *viz*., colour intensity, sweetness, acidity, aroma, consistency and acceptability using a 9-point hedonic scale where 1 was the lowest value and 9 the highest explained in thesis by Pratibha, (2005). Data were expressed as the mean of all the scores. The qualitative traits that could not be numerically counted were rated on the basis of categories described in descriptor designed by CISH, Lucknow.

RESULTS AND DISCUSSION

The average fruit weight differed significantly among the cultivars. Maximum fruit weight (150.60 g) was recorded in Allahabad Safeda followed by RCGH-7 but statistically these two genotypes were *at par* with each other. On the other hand

Table 1: Effect of genotypes on fruit weight, fruit length, fruit diameter and fruit volume

Genotypes	Average fruit weight (g)	Average fruit length (cm)	Average fruit diameter (cm)	Average fruit volume (ml)
MPUAT Sel-1	102.40	4.94	6.04	99.00
MPUAT Sel-2	100.00	6.62	6.45	102.20
Arka Kiran	104.80	4.45	4.6	100.72
CISH-G-35	92.60	5.10	5.93	101.20
Allahabad Safeda	150.60	6.36	8.01	92.08
RCGH-7	139.40	5.61	5.35	140.80
RCGH-1	98.60	5.32	5.67	136.00
RCGH-11	136.40	5.97	7.09	120.60
CD at 5%	12.95	0.49	0.524	23.63
SEm ±	4.47	0.17	0.17	8.15

Table 2 : Effect of genotypes on number of seeds per 100 fruit weight and weight of 100 seeds (g)

Genotypes	No. of seed /100g fruit weight	Seed Weight (g) Fresh	Dry	Seed Hardness kg cm^{-2}	Fruit yield (kg/plant)
MPUAT Sel-1	138.20	1.36	0.93	14.00	20.25
MPUAT Sel-2	129.60	1.67	0.86	14.56	10.42
Arka Kiran	114.00	0.79	0.79	10.49	25.23
CISH-G-35	134.60	0.78	1.05	9.68	09.81
Allahabad Safeda	134.60	1.48	0.85	12.59	20.47
RCGH-7	119.60	1.70	1.19	12.86	08.34
RCGH-1	134.60	1.35	0.77	15.80	20.60
RCGH-11	120.60	1.72	0.81	15.83	14.28
CD at 5%	10.47	0.15	0.251	2.103	3.61
SEm ±	3.61	0.051	0.086	0.74	1.24

Table 3 : Effect of genotypes on total soluble solids, acidity, ascorbic acid and total sugar content of fruit

Genotypes	Total soluble solids (%)	Acidity (%)	Ascorbic acid (mg/100 g pulp)	TSS : acid
MPUAT Sel-1	8.20	0.30	181.54	34.05
MPUAT Sel-2	7.76	0.31	163.68	26.29
Arka Kiran	7.54	0.47	176.00	17.79
CISH-G-35	6.92	0.33	178.20	26.49
Allahabad Safeda	7.58	0.23	190.52	32.78
RCGH-7	7.76	0.28	179.08	31.45
RCGH-1	6.68	0.39	203.28	20.31
RCGH-11	6.88	0.38	177.32	24.56
CD at 5%	0.85	0.098	8.32	9.07
SEm ±	0.29	0.034	2.87	3.13

Table 4: Effect of genotypes on reducing, non reducing sugar, TSS: acid, sugar: acid content of fruit

Genotypes	Reducing sugar (%)	Non Reducing sugar (%)	Total sugar (%)	Sugar : acid
MPUAT Sel-1	3.58	3.20	6.77	23.27
MPUAT Sel-2	4.43	3.91	8.34	27.69
Arka Kiran	7.78	5.69	13.48	29.59
CISH-G-35	4.23	4.24	8.47	28.47
Allahabad Safeda	5.36	3.66	9.03	41.13
RCGH-7	5.67	6.20	11.87	45.46
RCGH-1	5.11	4.78	9.90	25.33
RCGH-11	4.64	3.89	8.53	22.93
CD at 5%	0.86	1.99	1.72	11.36
SEm±	0.29	0.69	0.59	3.92

Table 5 : Effect of genotypes on Storage life and Organoleptic test of fruit

Genotypes	Storage life of fruits (days)	Organoleptic test
MPUAT Sel-1	15	8.22
MPUAT Sel-2	9	5.96
Arka Kiran	12	6.32
CISH-G-35	10	6.24
Allahabad Safeda	13	5.76
RCGH-7	11	6.36
RCGH-1	11	7.34
RCGH-11	7	5.88
CD at 5%	-	0.79
SEm±	-	0.27

minimum fruit weight (92.6 g) was observed in CISH-G-35 proceeded by RCGH-1. The findings were in support with the study of Chadha *et al*. (1981). Fruit length and fruit diameter varied significantly among the genotypes (Table 7). The maximum fruit length (6.62 cm) was found in genotype MPUAT Sel-2 followed by Allahabad Safeda but statistically these two genotypes were *at par* with each other. Fruit length (4.45 g) was found minimum in Arka Kiran followed by MPUAT Sel-1 but statistically these two genotypes are *at par* with each other. The maximum fruit diameter (8.01 cm) was observed in genotype Allahabad Safeda followed by RCGH-11 which was *at par* with each other. Fruit diameter (4.6 cm) was found minimum in Arka Kiran followed by RCGH-7 but statistically these two genotypes were *at par* with each other. Fruit length and diameter were found minimum in Chittidar. Similar results were also reported by Chadha *et al*. (1981). Similarly, fruit diameter was recorded highest in RCGH-4 while lowest in Allahabad Safeda. These observations were in accordance with the result of Babu *et al*. (2002).

Fruit volume differed significantly among the genotype (Table 1). Maximum fruit volume (140.8 mL) was found in genotype RCGH-7 followed by RCGH-1 but statistically these two genotypes were *at par* with each other. Fruit volume was minimum in Allahabad Safeda (92.08) followed by MPUAT Sel-1 but statistically these two genotypes were *at par* with each other. Similar results were also found by Raghava, (2004).

Number of seeds per 100 g fruit weight varied significantly among the genotypes (Table 8). The maximum number of seeds (138.20) was found in genotype MPUAT Sel-1 followed by Allahabad Safeda, CISH-G-35 and RCGH-1 however these four genotypes were *at par* with one another. Number of seeds was minimum in Arka Kiran (114.0) followed by RCGH-7 but statistically these two genotype were *at par* with each other. The findings are in conformity with the results reported by Mitra *et al*. (1983).The fresh weight of 100 seeds (1.72 g) was found maximum in RCGH-11 followed by RCGH-7 which was *at par* with each other. While the minimum value was

Total soluble solids content among the various genotypes showed significant variation (Table 3).The maximum TSS (8.20 %) was recorded in MPUAT Sel-1 followed by MPUAT Sel-2, RCGH-7, Arka Kiran and Allahabad Safeda but statistically these five genotypes were at par with each other. However minimum TSS (6.68 %) was recorded in RCGH-1 proceeded by RCGH-11 but statistically these two genotype were at par with each other. The findings are in conformity with the results reported by Singh *et al*. (2002) who reported that maximum T.S.S. was found in winter season crop of cultivar Allahabad Safeda while minimum T.S.S was found in Kohir Safeda. Similar results have also been reported by Dwivedi *et al*. (1991).

Acidity (%) varied significantly among the different genotype (Table 3). The maximum acidity (0.47 %) was found in Arka Kiran followed by RCGH-1 but statistically these two genotypes were at par with each other. On the other hand minimum acidity (0.23 %) content was found in Allahabad Safeda followed by RCGH-7 but statistically these two genotype were at par with each other. The findings are in conformity with the results reported by Deshmukh *et al*. (2013) who found that the mean results, lowest acidity were recorded in RCGH-1. However highest acidity was observed in Lalit as reported by Singh (2003).

The data on ascorbic acid content shows that ascorbic acid content varied significantly among the genotypes (Table 3). The maximum acid content was found in genotype RCGH-1 (203.28 mg/100g pulp) followed by Allahabad Safeda but statistically these two genotype were at par with each other. Minimum ascorbic acid content was found in MPUAT Sel-2 (163.68 mg/100g pulp) followed by Arka Kiran but statistically these two genotype were at par with each other. Variation in ascorbic acid content has been reported by many workers viz. Deshmukh *et al*. (2013) found that mean ascorbic acid content was recorded highest in RCGH-1 and minimum in Lalit. Similar result was also reported by Pandey *et al*. (2007).

There was significant variation among the different genotypes to be higher for this trait (Table 4). The maximum total sugars (%) was recorded in Arka Kiran (13.48%) followed by RCGH-7 but statistically these two genotype were at par with each other. However minimum total sugars (%) was observed in MPUAT Sel-1 proceeded by MPUAT Sel-2. The findings are in conformity with the results reported by Mahour *et al*. (2012)

Table 6 : Morphological description of fruits of guava genotypes

Genotypes	Fruit shape	Fruit base shape	Fruit apex shape	Fruit skin colour	Fruit flesh colour	Fruit pulp texture	Fruit skin surface	Fruit cavity	Seed size
MPUAT Sel-1	Round	Flattened	Broadly rounded	Greenish yellow with Red dotted	Milky white	crispy			
Smooth	Horizontal	Small							
MPUAT Sel-2	Roundish ovate	Broadly rounded	Pointed	Straw yellow	Milky white	juicy	Slightly rough	Vertical	Medium
Arka Kiran	Spherical	Broadly rounded	Rounded	Greenish yellow	Dark pink	juicy	Smooth	Vertical	Small
CISH-G-35	Roundish ovate	Broadly rounded	Rounded	Greenish yellow	Milky white	juicy	smooth	Vertical	Medium
Allahabad Safeda	Round	Flattened	Broadly rounded	Yellowish white	Milky white	crispy	Smooth	Horizontal	Bold
RCGH-7	Roundish ovate	Broadly rounded	Rounded	Greenish yellow	Yellowish white	juicy	Smooth to rough	Vertical	Small
RCGH-1	Round	Broadly rounded	Pointed	Greenish yellow	Milky white	crispy	Smooth	Vertical	Small
RCGH-11	Roundish ovate	Broadly rounded	Necked	Greenish yellow	Milky white	crispy	Smooth	Horizontal	Bold

they observed that maximum total sugars were found in Apple Colour whereas, the minimum total sugars were found in Chittidar.

The data on influence of genotypes on reducing sugars varied significantly (Table 4). The maximum value of reducing sugar (7.78 %) was recorded in Arka Kiran followed by RCGH-7. The minimum value of reducing sugar (3.58 %) was recorded in MPUAT Sel-1 proceeded by CISH-G-35.The findings are in conformity with the results reported by Mahour *et al*. (2012). They found that maximum reducing sugars was found in Abuwala whereas minimum reducing sugar was found in Dharwar.

Significant variation for non reducing sugar (%) was observed among the different genotype (Table 4). The maximum non reducing (6.20 %) was found in RCGH-7 followed by Arka Kiran but statistically these two genotypes were at par with each other while minimum value was observed in MPUAT Sel-1 (3.20 %) proceeded by Allahabad Safeda. This result is being supported with the findings of Mahour *et al*. (2012) they found maximum non reducing sugar was found in Surkhi whereas the minimum non-reducing sugar was found in Chittidar.

There was significant variation among different genotype for TSS: acid ratio (Table 3). The maximum TSS: acid ratio (34.05) was recorded in genotype MPUAT Sel-1 followed by Allahabad Safeda but statistically these two genotype were at par with each other while minimum value was recorded in Arka Kiran (17.79) proceeded by RCGH-1.This result is in accordance with the findings of Pratibha (2005) who observed maximum TSS: acid ratio was noticed in Pant Prabhat whereas minimum value of TSS: acid ratio was noticed in River Side.

Performance of different genotype varied significantly for sugar: acid ratio (Table 4). The maximum sugar :acid ratio (45.46) was found in RCGH-7 followed by Allahabad Safeda but statistically these two genotypes are at par with each other. Minimum sugar: acid ratio was found in RCGH-11 (22.93) proceeded by MPUAT Sel-1.The results are in accordance with Pratibha (2005) who observed maximum sugar : acid ratio was noticed in Pant Prabhat whereas minimum value of sugar : acid ratio was found in River Side.

recorded in CISH-G-35 (0.78 g) proceeded by Arka Kiran. The dry weight of 100 seeds (1.92 g) was recorded maximum in RCGH-7 followed by CISH-G-35 but statistically these two genotypes were *at par* with each other. On the other hand

minimum value was recorded in RCGH-1 (0.77 g) proceeded by Arka Kiran. The findings are in conformity with the results reported by Pratibha, (2005).Maximum fraction force required to crack a seed was recorded in genotype RCGH-11 (15.83 kg cm^{-2}) followed by RCGH-1 whereas minimum fraction force required to crack a seed was recorded in genotype CISH-G-35 (9.68 kg cm^{-2}) followed by Arka Kiran.

Total soluble solids content among the various genotypes showed significant variation (Table 3).The maximum TSS (8.20 %) was recorded in MPUAT Sel-1 followed by MPUAT Sel-2, RCGH-7, Arka Kiran and Allahabad Safeda but statistically these five genotypes were at par with each other. However minimum TSS (6.68 %) was recorded in RCGH-1 proceeded by RCGH-11 but statistically these two genotype were at par with each other. The findings are in conformity with the results reported by Singh *et al*. (2002) who reported that maximum T.S.S. was found in winter season crop of cultivar Allahabad Safeda while minimum T.S.S was found in Kohir Safeda. Similar results have also been reported by Dwivedi *et al*. (1991).

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The data on yield per tree shows that yield per tree varied significantly among the genotypes (Table 2). Arka Kiran recorded maximum yield (25.23 kg per tree) followed by RCGH-1 but statistically these two genotypes were at par with each other. Minimum yield per tree was found in RCGH-7 (8.34 kg per tree) followed by CISH-G-35 but statistically these two genotype were at par with each other. These results are supported with the finding of Dubey *et al*. (2016) fruit yield were recorded highest in Arka kiran. This type of variation might be attributed to phenotypic and genotypic interactions among the hybrids and cultivars under test condition. The variation in number of fruits per tree and fruit yield due to cultivar in guava has also been reported by Patel *et al*. (2011).

Acceptability of different genotypes varied significantly (Table 5). Maximum score (8.22) was given to MPUAT Sel-1 followed by RCGH-1 (7.34) whereas minimum score was given to Allahabad Safeda (5.76).These results are in accordance with the findings of Mark and Mukunda (2007) who studied ten open pollinated progenies of guava and revealed that A.C.Seln. 6/10 was an outstanding one with organoleptic taste of pulp. Further, the overall acceptance of the fruit for organoleptic qualities was also highest.

Fruit firmness is often the first of many quality major attributes judged by the consumer and is, therefore, extremely important parameters in overall product acceptance. Storage life of fruit varied significantly. Maximum storage life of fruit given to MPUAT Sel-1 (15 days) followed by Allahabad Safeda (13 days) where as minimum storage shelf life of fruit was recorded in RCGH-11 (7 days).

Considerable difference was observed among genotypes considering fruit skin colour, fruit flesh colour, fruit shape, shape of fruit at the base and apex, fruit surface, fruit pulp texture, fruit cavity and seed size as presented in (Table 6). Fruit shape was spherical in only one genotype Arka Kiran while it was rounded in MPUAT Sel-1, Allahabad Safeda and RCGH-1. Fruits were roundish ovate in rest of the 4 genotypes. Shape of fruit apex was 'Necked' in case of RCGH-11 while it was 'pointed' in the case of MPUAT Sel-2 and RCGH-1. Fruit apex was 'rounded or broadly rounded in rest of the 5 genotypes. Shape of fruit base was 'Flattened' in MPUAT Sel-1 and Allahabad Safeda however shape of fruit base was broadly rounded in rest of the genotypes. So MPUAT Sel-1 and Allahabad Safeda can be distinguished from rest of the genotypes taking just shape of fruit base into consideration. The fruit skin colour was dark green with red dotted in case of MPUAT Sel-1 while it was straw yellow in MPUAT Sel-2. It was greenish yellow in all other genotypes. Fruit skin colour was 'greenish yellow with red dotted' MPUAT Sel-1 making it easily distinguishable from all other genotypes. The fruit skin surface was slightly rough in case of MPUAT Sel-2 however rest genotypes have smooth skin surface. The fruit flesh colour was dark pink in case of Arka Kiran and yellowish white in RCGH-7. However fruit flesh colour was milky white in case all other genotypes. So Arka Kiran can be distinguished from rest of the genotypes on the basis of fruit flesh colour into consideration. The fruit pulp texture was crisp in case MPUAT Sel-1, Allahabad Safeda, RCGH-1, and RCGH-11. It was juicy in rest 4 genotypes. Variation was also observed among the genotype for fruit cavity. It was horizontal in MPUAT Sel-1, Allahabad Safeda and RCGH-11. It was vertical in all other genotypes. The seed size was bold in case of Allahabad Safeda and RCGH-11 while it was medium in MPUAT Sel-2 and CISH-G-35. However seed size was small in case all other genotypes.

ACNOWLEDGEMENT

Financial assistance rendered by the university is duly acknowledged. I would also like to thanks ICAR for providing me a junior research fellowship during my entire research.

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