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GROWTH AND YIELD PERFORMANCES OF GUAVA *(Psidium guajava)* VARIETIES

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ABSTRACT

Lack of high yielding varieties with desirable quality characteristics is one of the constraints limiting guava production in Sri Lanka. The performances of 6 selections made out of 60 introduced varieties at the Horticultural Farm, Horana in 1990, were tested over 5 consecutive fruiting seasons commencing in 1997. Depending on fruit yield, mean fruit weight, yield per unit sectional area of trunk and the number of fruit contained per kilo gram, 4 selections, 208-5, 208-15, B-1 and B-2 were identified as potential high yield varieties. Their mean yields ranged from 17.9 t/ha to 20.7 t/ha compared to 11.3 t/ha and 12.1 t/ha obtained from 2 recommended varieties Alahabad and Saffieda respectively. Also, those were of desirable fruit quality characteristics such as low seed content with flesh recovery, high total soluble solids, low acid levels and acceptable taste. The yield of selections varied slightly from season to season. These varieties have a good adaptability to different environments.

KEY WORDS: Guava varieties, *Psidium guajava*, Yield

INTRODUCTION

The guava (*Psidium guajava*) originated in tropical America, often referred as the Apple of the tropics, is a delicious fruit. It excels in productivity, hardiness, adaptability and ascorbic acid (Vitamin C) content from most other fruits (Chapman *et. al.*, 1979; Batten, 1981, 1983). Apart from fresh consumption, fruit serves many uses in processing such as jelly, juice, paste, nectar, puree and ice cream. Guava thrives at an altitude of 1500 m above the sea level with an annual rainfall of 100-200 cm. Although it is grown at a mean temperature of 23^0C -28^0C it can survive at high temperatures as high as 45^0C. It is well adapted to drought as well as and temporary water logged conditions. It displays some tolerance to salinity. Even though it is best grown in deep fertile, well drained loamy soils, with a wide range of pH values of 4.5-8.2, it can also be grown in marginal land that are suitable for other crops (Batten, 1984; Menzel, 1985).

Guava shows diversity in productivity and fruit quality, which may be possibly due to cross-pollinated nature of the crop. Fruits are highly variable in size, shape, flesh colour, skin colour, flesh recovery, flavour and aroma. Some seedlings produce small, seedy, gritty, musky fruits. Where as a few selected types could produce large, less seeded, smooth textured, pleasantly flavoured and attractive fruits. Processing types are strongly acidic, with red or pink colour attractive flesh, high flesh recovery, total soluble solids and ascorbic acid content. Dessert varieties are less acidic with white flesh and attractive peel colours, which are important features for the fresh market.

One of the constraints limiting guava production in Sri Lanka is lack of suitable varieties for the consumer. Most of the existing guava crops were propagated from cross-pollinated, unselected mother plants resulting in low productivity with poor quality fruits. Even though 2 varieties of guava, Alahabad and Saffieda were recommended a long time back, their varietal characteristics seem not to be retained at present. As such, investigations were carried out at the Regional Agricultural Research and Development Centre, Bombuwela with the objectives of identifying varieties with high yielding and acceptable quality parameters, in order to upgrade the present production of guava in Sri Lanka.

MATERIALS AND METHODS

Out of 60 introduced guava accessions, established at the horticultural farm, Horana, 6 varieties were selected on the basis of total fruit yield and taste of fruits. Selected trees were vegetatively propagated through air layering. Layered plants, including 2 recommended varieties, Alahabad and Saffieda and Bangkok Giant (a popular variety among farmers) were evaluated in a RCB design with 3 replications at Regional Agricultural Research and Development Centre, Bombuwela in 1995. Two plants were taken for each treatment with spacing of 5m x 5 m (400 plants/ha.) with a guard row of seedling guava. Plants were established according to recommended cultural practices of the Department of Agriculture (DOA). Yield data including total fruit weight, mean fruit weight were recorded and number of fruits per kilo gram was assessed at an interval of 7-14 days, during 5 fruiting seasons of *maha* 1997/98, *yala* 1998, *maha* 1998/99, *yala* 1999 and *maha* 1999/ 2000. Percent fruit yield over 2 standard Varieties in *maha 1999*/2000 was calculated taking Alahabad and Saffieda for yellowish green fruited varieties and red fleshed respectively.

Plant growth dimensions of tree height, canopy spread, trunk cross sectional area and number of primary branches arising from main trunk were measured at fruit harvest in *maha* 1999/2000 season. Yield per cross sectional area of trunk was calculated for varieties tested. Correlation analysis was done to determine the relationship between above growth parameters and fruit yield. Fruit quality characteristics such as peel colour, flesh colour, peel thickness, percent seed content total soluble solids (TSS), titratable acidity, crispyness and taste were analysed in varieties tested by the Food Technology Unit, HORDI, according to AOAC, 1984. Percentage TSS was directly determined by using light refractometer. For determination of titratable acidity, 1 ml of juice was diluted in 10 ml distilled water and titrated with 0.1 N NaOH to an end point of colour change from orange to salmon pink. Percentage acidity was calculated according to AOAC (1984).

Using standard British colour chart for fruits, colour of peel and flesh was assessed. Taste was recorded on the observations made by a tasting panel of 6 persons, using a score ranging from 1-3 (1-not acceptable, 2- moderately acceptable and 3-acceptable). An environmental index was computed, by using the mean yield of all varieties tested in a season taken as the numerical grading of the environment of the season. By correlation analysis, the varietal yield and the environmental index of each season, correlation co-efficient was calculated to determine the varietal adaptability to different environments (Eberhart and Russel, 1966).

All variables were subjected to ANOVA. Data of number of primary branches was transformed by using square root transformation. For the mean separation DMRT was conducted.

RESULTS AND DISCUSSION

Vegetative Growth parameters of guava varieties and their effect on fruit yield

Tree Height

Tree height of tested varieties ranged from 1.6 m-5.5 m. Three height groups of varieties, dwarf, short and medium were observed. Out of all B-1 variety was the shortest and most widely spread canopy, exhibiting a lateral growth habit (table1). It is therefore wider space is required to establish this variety. Variety B-2 belonged to moderate height group with a stem height of 3.2 m. Also, it showed a good fruiting ability and yield was not significantly ($p=0.05$) different to the highest yielder, 208-5 (table 2). Varieties 208-15, 208-5, Saffieda and Bangkok Giant (BG) fell under medium height group. All of them had shown similarity in heights; their yielding ability differed markedly. Varieties 208-5 and BG 208-15 and Saffieda were found to be maximum, 4th highest and lowest yielder respectively. Alahabad, 206-6 and 206-8 were also low yielders and they were not significantly ($p=0.05$) different from Saffieda, but they were the tallest of all (tables 1 and 2). As such, no significant ($p=0.05$) relationship was found between tree height and fruit yield.

Tree Canopy Spread

There was a significant ($p=0.05$) variation in canopy spread among different varieties evaluated, ranging from 4.3-6.4m. The control variety, Saffieda had grown into the largest canopy spread of 6.4 m and it was recorded the lowest yield of 12.1 t/ha. Where as canopy spread of 208-5, BG and 206-6 was large and out of them 206-6 was the least producer (table 1 and 2). Where as, other 2 varieties were the highest producers. Although B-1, B-2,

208-15, 206-8 and Alahabad had moderately spread canopies, their yield potential differed tremendously. Correlation analysis showed no significant (p=0.05) relationship between yield and canopy spread of different varieties.

Table.1 Vegetative Growth Parameters of Guava Varieties and Correlation Coefficient (r) between Varietal Yield and Growth Parameters.

Variety	*Tree Height (m)*	*Canopy Spread (m)*	*# Primary Branches*	*Trunk Cross Sectional Area* $(cm)^2$	*Yield (maha 1999/00) (t/ha/yr)*
206-6	5.37 a	4.25 c	2.67	107.83 b	13.60 c
208-15	4.08 b	5.21 b	2.33	55.68 c	19.01 ab
208-5	4.23 b	4.49 b	2.67	34.43 cd	21.27 a
Bangkok Giant	4.02 b	4.62 c	2.67	23.02 d	22.30 a
B-1	1.57 d	5.28 b	3.33	20.14 d	18.47 b
206-8	5.51 a	5.42 b	2.67	123.14 b	14.60 bc
Alahabad	5.31 a	5.26 b	3.00	147.89 a	11.61 c
Saffieda	4.14 b	6.44 a	2.00	13.85 d	12.70 c
B-2	3.18 c	4.70 b	2.67	23.07 d	21.04 a
Correlation Coefficient(r)	-0.54 ns	-0.50 ns	0.11 ns	-0.91*	
C.V%	7.22%	7.88%	12.65%	22.94%	

Means denoted in a column followed by same letter are not significantly different according to DMRT at p = 0.05; * - Significant at p=0.05; ns-not significant

Number of Primary Branches

No significant (p=0.05) differences were observed in number of primary branches among varieties tested. All varieties had grown into 1.6-1.9 mean number of branches. It shows that branching habit of guava was not a varietal characteristic. Chapman *et al.,* (1986) revealed that correlation analysis showed no relationship between any of the above described tree dimensions (including tree trunk girth) and accumulated marketable yield of 5 guava varieties tested in Australia.

Data of current experiment revealed that significant (p=0.05) differences existed in all 3 dimensions recorded. It shows the heterogeneity of the population from which these were selected. But no correlation with yield was found for any of 3 tree dimensions measured. According to findings of Shikhamany *et al.,* (1978) canopy spread plus trunk girth was correlated with yields of guava in India.

Trunk Cross Sectional Area

Significant (p=0.05) differences in cross sectional area of tree trunk of guava varieties were found. Varieties, Alahabad, 206-8 and 206-6 had grown into larger tree trunks than others (table 1). But, productivity of these varieties was low (table 2). Similarly, varieties, with high yielding ability had developed small trunks (tables 1 and 2). As such, co-relation analysis showed significant co-relation between varietal yield and trunk cross sectional area of guava varieties evaluated. How ever, variety Saffieda had the smallest trunk growth, but fruit yield was relatively low when compared to varieties with low trunk girth. This may be a varietal characteristic of Saffieda.

Yield Performances of Guava Varieties

Total Fruit Yield

Table 2. Total fruit yield of 9 guava varieties during 5 fruiting seasons tested at RARDC, Bombuwela and Correlation Correfficient (r) between Varietal Yield and Environmental Index.**

	Fruit Yield (t/ha/yr)						*Correlation Corefficient (r)*
Variety	*maha 1997/98*	*yala 1998*	*maha 1998/99*	*Yala 1999*	*maha 1999/00*	*Mean*	
206-6	12.11 d	13.97 c	13.24 d	9.96 c	13.60 c	12.58	-
208-15	16.41 bc	18.55 b	20.55 bc	14.87 b	19.01 ab	17.88	0.95*
208-5	18.28 ab	21.33 a	22.54 a	16.91 ab	21.27 a	20.07	0.97*
Bangkok Giant	20.78 a	23.41 a	24.70 a	18.88 a	22.30 a	22 01	-
B-1	16.86 b	19.80 ab	20.83 b	15.11 b	18.47 b	18.21	0.97*
206-8	15.48 a	16.75 bc	16.61 cd	11.15 c	14.60 bc	14.92	-
Alahabad	12.27 d	13.59 cd	10.87 e	8.13 c	11.61c	11.29	0.72 ns
Saffieda	12.17 d	11.98 d	13.45 d	10.32 c	12.70c	12.12	0.91*
B-2	19.57 a	20.25 a	22.85 ab	16.41 b	21.04 a	20.02	0.96*
Environ -mental Index	15.99	17.74	18.40	13.53	17.18		

Means denoted in a column followed by same letter are not significantly different according to DMRT at p=0.05; **r- Correlation coefficient between varietal yield and Environmental Index; *- Significant at p=0.05; ns- not significant

Out of 6 selected varieties evaluated, along with 2 recommended varieties, Saffieda and Alahabad 208-5, B-2 and Bangkok Giant significantly out yielded other varieties in all 5 fruiting seasons. Bangkok Giant (BG) a popular variety among farmers recorded high yields which was not significantly (p=0.05) different to yields of 208-5, and B-2. Mean yields recorded were 22.01, 20.07 and 20.02 t/ha/yr for varieties BG, 208-15 and B-2 respectively. The second best yielders were B-1 and 208-15 with an average

harvest of 18.21 and 17.88 t/ha/yr respectively. Eventhough yields of 206-8 were significantly (p=0.05) not different to that of 208-15 in 4 out of 5 seasons, (except for *yala* 1999, which was not a favourable season for fruit formation). Fruit size of 206-8 was not acceptable as it produced relatively small fruits when compared to other varieties (table 3).

Environmental Index (E.I.) was calculated by totaling the fruit yield of all varieties in the experiment per season and divided by number of varieties evaluated. In general varietal yield varied with the environmental conditions of the season. Consequently, E.I. tended to become varied. E.I. was in a range of 16-18.5 with in *maha* 1997/1998, *yala* 1998, *maha* 1998/1999 (table 2). Where as, during *yala 1999*, productivity of not only guava but also mostly other fruit crops had decreased. Prevalence of continuously high rainfall, during flowering was unfavourable for fruit set. Whereas, by *maha* 1999/2000 weather conditions were conducive for fruiting and E.I. of 17.2 was obtained (table 2).

When E.I. of 5 cropping seasons and varietal yield of 4 promising varieties and 2 standard varieties was computed, significant (p=0.05) co-relation coefficients of 0.96, 0.97, 0.96,0.95 and 0.91 were shown in 208-5, B-1, B-2, 208-15 and Saffieda respectively. While Alahabad was did not show a significant (p=0.05) relationship (table 2). These results indicate high adaptability of these varieties to different environments of the cropping seasons.

Percent fruit yield of guava over standard varieties:

Higher percentage of mean yield over standard varieties were indicated in 4 promising varieties of 208-5, B-1, B-2 and 208-15 varying from 177.8-147.5. The variety BG showed the highest yield increase of 195% over Alahabad variety. Where as 206-6 and 206-8 were recorded much lower increase over the control, Saffieda. However all 6 varieties tested in the experiment have shown yield increases (table 3).

Table 3. Yield parameters of guava varieties.

Variety	*% yield over Saffieda and Alahabad*	*Mean Fruit Weight (g)*	*# fruit per kg*	*FruitYield per trunk cross sectional area (kg/cm ^{2})*
206-6	103.80	85.62 e	12 a	0.32d
208-15	147.52	140.79 d	7 c	0.86 c
208-5	177.77	233.06 b	4 e	1.73 b
BG	194.95	240.11 a	4 e	2.42 a
B-1	161.29	176.61	6 d	2.29 a
206-8	123.01	104.28 e	10 b	0.30 d
Alahabad	-	93.91 e	11 a	0.20 d
Saffieda	-	182.92 bc	6 d	0.16 d
B-2	177.33	202.24 b	5 d	2.29 a
C.V%	-	7.69%	4.68%	7.68%

Means denoted in a column followed by same letter are not significantly different according to DMRT at p = 0.05.

Mean fruit weight and number of fruits contained per kilogram:

Out of all 208-5 and BG had formed largest fruits having a mean fruit weight of 233 g and 240 g, respectively. While B-2 had moderate sized fruits, which was not significantly different to that of Saffieda. Mean fruit weight of 208-15 was smaller than Saffieda, but fruit size was acceptable. Variety 206-6 had the smallest fruits of all and it was not significantly (p=0.05) different from Alahabad (table 3).

When number of fruits containing per kg was considered, it ranged from 4-12 in all varieties (table 3). Due to large fruit size of 208-5 number of fruits holding per kg was 4. Where as, values for B-2, B-1 and 208-15 were 5, 6 and 7 fruits per kg respectively. Small fruited varieties such as 206-6, 206-8 and Alahabad held the maximum number of fruits per kg. Similar results of 4-7 fruits per kg were found in some other guava varieties tested in Australia (Chapman *et al.,* 1986).

Yield per trunk cross sectional area:

Yield per cross sectional area of trunk showed a significant (p=0.05) differences for 9 varieties tested in the experiment. This measure indicates that out of total assimilates produced by plant, amount of it translocates to fruits and wood or structural parts of stem. Higher values were obtained for B-2 and B-1, which had produced 2nd and 3rd highest yielders. However, variety 208-5 was the maximum yielder, yield per cross sectional area was comparatively low. The varieties with low yielding ability showed significantly lower values (table 3). Therefore this value was found to be a reliable indicator for yield determination. Westwood and Roberts (1970) also indicated that yield per unit cross sectional area of stem to be a good measure

of yield efficiency in apples. Chapman *et al.*, (1986) indicated this measure in guava was a useful index for yield efficiency.

Table 4. Fruit quality characteristics of guava varieties*

	Varieties							
	BG	*208-5*	*B-1*	*208-15*	*206-8*	*B-2*	*Saffi.*	*Alaha.*
Mean fruit wt(gm.)	383.83	449.20	227.75	148.40	70.00	230.89	219.60	122.20
Peel Thickness(cm)	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2
Peel Colour	YGG 144-6	YGG 144-AB	YGG 144-B	YGG 144-A	YGG 144-C	GYG 1-C	YGG 144-BC	YGG 144-AB
Flesh Colour	YGG 150-D	YGG 150-D	YGG 155-A	Red G 38-A	Red G38-A	YG 4D	Red G36BC	OWG 159 CD
% Seed content	4.8	4.2	5.3	7.2	12.2	7.4	13.5	14.4
Middle Circumference (cm)	29.2	29.4	24.0	16.6	14.3	24.6	24.2	13.5
Length (cm)	12.0	15.5	11.8	8.2	8.1	13.0	11.3	7.5
Brix value	8.0	8.0	10.0	9.0	9.0	8.0	9.0	7.0
% Acidity	0.5	0.6	0.6	0.6	0.8	0.5	0.3	0.6
***Crispyness*	C	C	C	NC	NC	C	NC	NC
**** Taste*	A	A	A	A	MA	A	A	MA

Analysed by Food Technology Unit, HORDI; * *C- Crispyness; NC- Not Crispy;
** * A- Acceptable, MA- Moderately Acceptable

Variety 208-5 produced the largest fruits with highest middle circumference and low seed content, while B-1 and B-2 had moderate sized fruits with less seeds. Variety 208-15 was red fleshed, with acceptable fruit size and slightly acidic. This could be used for a table fruit as well as for processing (table. 4). As varieties 208-5, B-1 and B-2 are yellowish green fleshed varieties having crispyness and good taste they could be taken as fresh fruit varieties. 206-8 was unsuitable due to its high seed content and small fruit size (table. 4).

CONCLUSION

Out of 6 guava varieties evaluated, along with 2 recommended varieties (Saffieda and Alahabad) 4 varieties, 208-5, B-2, B-1 and 208-15 were found to be promising. These were identified on the basis of total fruit yield, mean fruit weight, percentage yield increase over the control varieties, yield increase over control varieties, yield per unit cross sectional area of trunk and number of fruit per kg. and desirable fruit quality parameters such as low seed content, high Total Soluble Solids, slight acidity and acceptable taste.

Mean varietal yields of 208-5, B-2, B-1 and 208-15 over 5 fruiting seasons were 20.07, 20.02,18.21 and 17.88 t/ha/yr respectively. Yield of Bangkok Giant, was not significantly ($p=0.05$) different to 208-5 and B-2.

The variety 208-15 was found to be suitable for dual-purpose variety due to its quality parameters. Environmental Index or the numerical grading of the environments of cropping seasons was significantly ($p=0.05$) co-related to the fruit yields of promising varieties of tested seasons. This indicates that all these 4 varieties showed a good adaptability to different environmental conditions. Therefore, these 4 varieties could be recommended for cultivation.

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