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Article

Morphological characterization of Sapota (*Manilkara zapota)* germplasm

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Abstract: An experiment was conducted to evaluate the morphological characterization of five germplasm of Sapota namely BAU Sapota-1, BAU Sapota-2, BAU Sapota-3, Deshi Sapota and Vietnam Sapota. Randomized complete block design with three replications was performed for investigating the morphology of Sapota. Results indicate that the tallest plant was Deshi Sapota and the shortest plant was BAU Sapota-2. Also, the highest stem circumference was found in Deshi Sapota which was 52.25 cm. The maximum spreaded plant both in north-south and east-west direction was found in BAU Sapota-1 which was 1.62 and 1.53 m, respectively. Maximum shoot girth was found in BAU Sapota-3 and BAU Sapota-1 plants showed the most vigorous growth whereas BAU Sapota-3 had the longest shoot length. Results revealed that significant difference ($p<0.01$) present in leaf length, lamina length and petiole length among the variety of Sapota. Higher numbers of flower per shoot was found in BAU Sapota-3 whereas the highest fruit setting time was observed in Deshi Sapota. The BAU Sapota-3 produced the heaviest fruit while the lightest fruit was recorded in BAU Sapota-2. The longest fruit length, highest moisture content and maximum total soluble solids were found in BAU Sapota-3. Correlation coefficient study indicated that plant height, leaf length and fruit length had positive and highly significant association with stem circumference, leaf lamina length, % moisture and fruit yield, respectively. In respect of path analysis, plant height, tree growth, leaf length, fruit setting time, fruit fresh weight, % moisture content and total soluble solids positively affected on fruits per plant indicating its importance as a selection parameter.

Keywords: sapota; morphology; correlation coefficients; path coefficients

1. Introduction

Sapota (*Manilkara zapota*) commonly known as chiku which is mainly cultivated in India due to its fruit value as well as in South-East Mexico, Vietnam, Guatemala and other countries. It is commercially grown for the production of chickle which is a gum like substance obtained from latex and is mainly used for preparation of chewing gum. It belongs to the family Sapotaceae. It is also called by other names, such as chikku, Sapota plum, sapodilla or prickly pear. In fruits, peel can also be eaten along with pulp since it is rich in nutritive value than the pulp alone (Gupta *et al.,* 1981). Latex from Sapota tree is used in the manufacture of chewing gum in Tropical America. The pulp of Sapota when ripe is soft, granular and very sweet. Sapota is an energy rich fruit with high total soluble solids (20-22%) and good source of digestible sugar and has an appreciable amount of protein, fat, fiber and minerals like calcium, phosphorous, iron (Shanmugavelu and Srinivasan, 1973). The cultivation of Sapota has attracted many farmers on account of its hardy nature and better adaptability to diverse soil and climatic conditions. Though the area under cultivating Sapota is increasing day by day but this increasing trend failed to meet up the expected level of production in this country due to absence of number of good choice varieties. So, characterization is an important aspect for documentation of the performance of the

studied cultivars which subsequently will help to introduce, select and improve existing Sapota varieties. That's why this research was undertaken to study the morphological characteristics of plant, leaf, flower, fruit and seed of Sapota under different parameters.

2. Materials and Methods

This study was carried out to investigate the morphological characteristics of Sapota germplasm at germplasm centre of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and the duration of the study was April 2012 to April 2013. Five germplasm namely BAU Sapota-1, BAU Sapota-2, BAU Sapota-3, Deshi Sapota and Vietnam Sapota were taken for this study (Figure 1). The experiment was laid out in randomized complete block design (RCBD) with single factor experiment. Five treatments were used in this study and three replications were followed by each treatment. For this study, the mature leaves, fruits, flowers and seeds were collected randomly from the selected plants. Five plants from each of the selected germplasm were taken under study in field for recording their physical characteristics like plant height, stem circumference, tree spread, plant shoot girth and number of leaves per shoot and tree growth. Ten leaves, flowers, fruits and seeds from each of the selected germplasm were taken in the laboratory for recording their physical characteristics like leaf shape, leaf color, leaf margin, leaf apex, leaf length, leaf breadth, leaf lamina length, and leaf petiole length, flower type, flower color, number of flower per shoot, flower opening time and fruit setting time, fruit shape, fruit color, fruit smoothness, fruit sweetness, fruit pulp color, cavity of fruit, fruit length, fruit breadth, fruit fresh weight, % moisture content, total soluble solids and fruit yield per tree, seed length, and seed color. The leaf color was estimated by Royal Horticultural Society (RHS) color chart and the total soluble solids (TSS) content of Sapota pulp was measured by Refractometer. Also, the dry weight was estimated by transferring the cut pieces and air dried Sapota to an oven maintained at constant temperature of 78^0 C for about 72 hours. Analysis of variance was performed using MSTAT-C software and LSD test were also performed. Also, genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PVC) were estimated according to Burton and DeVane (1953), heritability in broad sense (h^2_b), genetic advance (GA) were calculated following Hanson *et al.* (1956) correlation coefficients were estimated according to Al-Jibouri *et al.* (1958) and path coefficient analysis was done following Dewy and Lu (1959).

3. Results and Discussion

3.1. Plant characteristics

Result showed that significant difference ($p<0.01$) present in case of all plant characteristics except tree spread east-west which was also significantly different at $p<0.05$ (Table 1). Results indicates that plant height, stem circumference, tree spread N-S and E-W, plant shoot length, plant shoot girth, number of leaves/shoot and tree growth ranges varied from 3.80-5.50 m, 35.10-52.25 cm, 1.12-1.62 m (N-W) and 1.19-1.53 m (E-W), 19.90-22.07 cm, 2.64-3.57 cm, 10.13-13.80 and 3.64-7.29 m^3, respectively (Table 1). Also, higher phenotypic coefficient of variation (PCV) was found in case of all the parameters of plant characteristics than genotypic coefficient of variation (GCV) (Table 2) and which indicated marked influence of environment on the expression of these characters. The study of heritability indicates that the character of plant height, stem circumference, tree spread (N-S direction), plant shoot length, plant shoot girth, number of leaves per shoot, tree growth were highly heritable. The analysis of genetic advance in percentage of mean showed that the characters like plant height, stem circumference, plant shoot girth, number of leaves per shoot and tree growth had more than 20% expected genetic advance under selection (Table 2). Tree spread and shoot length had minimum genetic advance in percentage of mean. These characters had also least phenotypic and genotypic coefficient of variation indicating they are less important in selection. Among these characters tree growth, stem circumference, plant height and plant shoot girth had high phenotypic and genotypic coefficient of variation which was associated with high heritability and suggests that selection for these character would be effective. Goenaga and Jenkins (2012) also reported similar variation of Sapota grown on Ultisol and Oxisol soils at Corozal and Isabela. They found significant differences and higher results in maximum characters of plant morphology and yield attributes of Sapota at Isabela. Similarly, three selected white Sapota (*Casimiro aedulis*) were evaluated by Abo-El-Ez *et al*. (2013).

Table 1. Plant characteristics in respect of plant height, stem circumference, tree spread, plant shoot length, plant shoot girth and number of leaves per shoot and tree growth.

Variety	Plant height (m)	Stem Circumference (cm)	Tree spread (m)		Plant shoot length (cm)	Plant shoot girth (cm)	Number of leaves/ shoot	Tree growth (m^3)
			N-S	E-W				
BAU Sapota-1	4.20	35.10	1.62	1.53	20.97	2.95	13.63	7.29
BAU Sapota-2	3.80	39.67	1.43	1.38	20.20	2.64	13.03	5.25
BAU Sapota-3	4.60	42.62	1.35	1.29	22.07	3.57	13.80	5.61
Deshi Sapota	5.50	52.25	1.38	1.23	21.60	2.90	12.07	6.53
Vietnam Sapota	3.90	38.42	1.12	1.19	19.90	2.68	10.13	3.64
$LSD_{0.05}$	0.367	2.555	0.198	0.215	1.276	0.342	1.188	0.450
$LSD_{0.01}$	0.535	3.721	0.288	0.313	1.859	0.498	1.731	0.655
Range	3.80-5.50	35.10-52.25	1.12-1.62	1.19-1.53	19.90-22.7	2.64-3.57	10.13-13.80	3.64-7.29
Mean ± SE	4.40 ±0.31	41.61±0.92	1.38 ±0.04	1.32 ±0.35	20.95 ±0.24	2.95 ±0.68	12.53 ±0.43	5.66±0.62
Level of significance	**	**	**	*	**	**	**	**
CV (%)	4.44	3.26	7.56	8.60	3.24	6.12	5.03	4.22

N-S = North-South, E-W = East-West, **indicates significant at $p<0.01$, * indicates significant at $p<0.05$.

Table 2. Estimation of genotypic variance (GV), phenotypic variance (PV), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), Broad sense heritability (H^2_b), Genetic advance (GA) of plant characters of five Sapota germplasm.

Characters	Plant height (m)	Stem Circumference (cm)	Tree spread (m)		Plant shoot length (cm)	Plant shoot girth (cm)	Number of leaves/ shoot	Tree growth (m^3)
			N-S	E-W				
GV	0.46	42.02	0.03	0.01	0.68	0.13	2.13	1.90
PV	0.50	43.86	0.04	0.02	1.14	0.16	2.53	1.95
GCV (%)	15.45	15.58	12.55	7.55	3.94	12.23	11.65	24.34
PCV (%)	16.08	15.92	14.49	10.68	5.10	13.57	12.69	24.70
H^2_b (%)	92.41	95.80	75.00	50.00	59.65	81.25	84.19	97.08
GA	1.35	13.07	0.03	0.14	2.08	0.66	2.76	2.80
GA (%)	30.60	31.41	2.24	10.89	9.97	22.71	22.00	49.40

N-S = North-South, E-W = East-West.

Table 3. Qualitative characteristics of five Sapota germplasm.

Variety	Leaf			Flower color	Fruit				Seed color
	Shape	Color	Apex		Shape	Skin color	Sweetness	Color of pulp	
BAU Sapota-1	Elliptical	Dark green (RHS 137A)	Emarginate	Greenish White	Round	Brown RHS 199A	Sweet	Orange	Black
BAU Sapota-2	Elliptical	Dark green (RHS 136A)	Acute	Off White	Round	Yellow RHS 167A	Sweet	Yellow orange	Brown
BAU Sapota-3	Elliptical	Green (RHS 136A)	Emarginate	Greenish White	Long oval	Brown RHS 199c	Medium Sweet	Orange red	Brown
Deshi Sapota	Ovate	Dark green (RHS 137A)	Emarginate	Off White	Round	Brown RHS N 99c	Very sweet	Orange red	Light Brown
Vietnam Sapota	oblong-lanceolate	Dark green (RHS 137A)	Acute	Off White	Round	Brown RHS 199A	Very sweet	Yellow orange	Black

RHS= Royal Horticulture Society Color Chart

Table 4. Quantitative characteristics of five Sapota germplasm.

Variety	Leaf			Number of flowers/ shoot	Fruit setting time (days)	Fruit				Fruit yield/ tree (kg)
	Length (cm)	Lamina length (cm)	Petiole length (cm)			Length (cm)	Fresh weight (g)	%Moisture	Total soluble solids (^{0}Brix)	
BAU Sapota-1	13.97	12.26	1.96	9.80	25.66	5.18	79.8	72.77	23.87	7.30
BAU Sapota-2	14.82	12.25	2.57	7.00	25.00	5.43	68.14	75.02	25.51	6.70
BAU Sapota-3	15.77	12.67	3.17	11.20	24.00	6.81	80.28	77.67	28.86	13.50
Deshi Sapota	13.16	10.75	2.47	11.00	25.76	5.04	74.14	71.21	28.69	9.50
Vietnam Sapota	10.82	9.53	1.29	7.40	24.57	5.10	73.73	71.15	27.00	6.20
$LSD_{0.05}$	1.429	1.055	0.188	0.927	1.122	0.702	4.540	2.671	1.805	0.639
$LSD_{0.01}$	2.082	1.537	0.274	1.350	1.635	1.023	6.613	3.891	2.629	0.930
Range	10.82-15.77	9.53-12.67	1.29-3.17	7.00-11.20	24.00-25.76	5.04-6.81	68.14-80.28	71.15-77.67	23.87-28.86	6.20-13.50
Mean± SE	13.71±0.84	11.49±0.59	2.28±0.31	9.28±0.88	25.00±0.33	5.51±0.33	75.22±2.24	73.56±1.24	26.79±0.95	8.64±1.34
Level of sign.	**	**	**	**	*	**	**	**	**	**
CV (%)	5.54	4.88	4.40	5.38	2.39	6.77	3.21	1.93	3.59	3.93

**indicates significant at p<0.01, * indicates significant at p<0.05.

Table 5. Estimation of genotypic variance (GV), phenotypic variance (PV), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), Broad sense heritability (H^2_b), Genetic advance (GA) of leaf, flower and fruit characters of five Sapota germplasm.

Characters	Leaf			Number of flowers/ shoot	Fruit setting time (days)	Fruit				Fruit yield/ tree (kg)
	Length (cm)	Lamina length (cm)	Petiole length (cm)			Length (cm)	Fresh weight (g)	% Moisture	Total soluble solids (^{0}Brix)	
GV	3.36	1.30	0.48	3.28	0.43	0.50	23.08	7.28	4.73	8.93
PV	3.93	2.60	0.52	3.52	0.79	0.64	28.90	9.29	5.65	9.04
GCV (%)	13.36	9.93	30.27	19.52	2.63	12.88	6.39	3.67	8.12	34.59
PCV (%)	14.47	14.03	31.70	20.22	3.55	14.55	7.15	4.14	8.87	34.81
H^2_b (%)	85.36	50.13	91.19	93.13	54.85	78.37	79.87	78.35	83.74	98.73
GA	3.49	1.66	1.36	3.60	1.00	1.29	8.85	4.92	4.10	6.12
GA (%)	25.44	14.49	59.55	38.80	4.01	23.49	11.76	6.69	15.30	70.79

Table 6. Estimation of genotypic (r_g) and phenotypic (r_p) correlation coefficients between fruit yield/plant and its contributing character in Sapota.

Characters		SC (cm)	TG (m^3)	LL (cm)	LM (cm)	NS	FS (days)	FL (cm)	FW (g)	MC	TSS (^{0}Brix)	FY (Kg)
PH (m)	r_g	0.877*	0.482	0.069	-0.093	0.845	0.301	0.005	0.244	-0.207	0.595	0.555
	r_p	0.887*	0.492	0.103	-0.057	0.860	0.352	0.040	0.283	-0.162	0.617	0.554
SC (cm)	r_g		0.152	0.008	-0.232	0.545	0.169	-0.033	-0.165	-0.182	0.756	0.441
	r_p		0.167	0.033	-0.201	0.556	0.214	-0.001	-0.136	-0.146	0.773	0.439
TG (m^3)	r_g			0.486	0.561	0.687	0.631	-0.058	0.423	0.023	-0.318	0.242
	r_p			0.501	0.575	0.691	0.647	-0.033	0.440	0.047	-0.294	0.244
LL (cm)	r_g				0.927*	0.314	-0.301	0.650	0.171	0.816	-0.029	0.627
	r_p				0.961**	0.338	-0.190	0.700	0.230	0.863	0.020	0.624
LM (cm)	r_g					0.236	-0.212	0.545	0.246	0.752	-0.304	0.474
	r_p					0.256	-0.100	0.600	0.297	0.802	-0.241	0.467
NS	r_g						0.180	0.273	0.682	0.063	0.383	0.730
	r_p						0.221	0.308	0.704	0.099	0.404	0.723
FS (days)	r_g							-0.936*	-0.271	-0.820	-0.560	-0.477
	r_p							-0.772	-0.149	-0.655	-0.430	-0.455
FL (cm)	r_g								0.407	0.858	0.387	0.876*
	r_p								0.471	0.916*	0.440	0.883*
FW (g)	r_g									0.170	-0.001	0.584
	r_p									0.239	0.051	0.582
MC	r_g										0.113	0.677
	r_p										0.176	0.667
TSS (^{0}Brix)	r_g											0.679
	r_p											0.671

**indicates significant at p<0.01, * indicates significant at p<0.05. PH = Plant height, SC = Stem circumference, TG = Tree growth, LL= Leaf length, LM = Leaf lamina length, NS = Number of flowers per shoot, FS =Fruit setting time, FL = Fruit length, FW = Fruit fresh weight, MC = % moisture content, TSS = Total soluble solids, FY = Fruit yield per tree.

Table 7. Path coefficient of fruit yield per plant and yield contributing characters among five Sapota germplasm.

Characters	PH	SC (cm)	TG (m^3)	LL (cm)	LM (cm)	NS	FS (days)	FL (cm)	FW (g)	MC	TSS (^{0}Brix)	FY (kg)
PH (m)	**0.849**	-0.664	0.682	0.071	0.095	-0.282	-0.003	-0.015	0.189	-0.278	0.612	0.554
SC (cm)	0.019	**-0.749**	0.2232	0.023	0.335	-0.829	0.016	0.0004	-0.091	-0.250	0.742	0.439
TG (m^3)	0.566	-0.121	**0.958**	0.344	-0.959	-0.031	-0.076	0.012	0.294	0.081	-0.252	0.244
LL cm)	0.118	-0.025	0.694	**0.686**	-0.600	-0.504	-0.146	-0.263	0.153	0.483	0.026	0.624
LM (cm)	-0.065	0.151	0.798	0.650	**-0.952**	-0.395	-0.146	-0.226	0.198	0.37	-0.221	0.467
NS	0.988	-0.416	0.958	0.232	-0.441	**-0.824**	-0.0511	-0.115	0.469	0.170	0.421	0.723
FS (days)	-0.026	-0.082	-0.705	-0.674	0.633	0.511	**0.149**	0.277	-0.244	-0.511	0.052	-0.455
FL (cm)	0.046	0.0007	-0.046	0.479	-0.999	-0.459	-0.100	**-0.376**	0.314	0.574	0.428	0.853
FW (g)	0.325	0.102	0.610	0.158	-0.494	-0.050	-0.054	-0.177	**0.667**	0.411	0.085	0.582
MC	-0.186	0.109	0.065	0.593	-0.335	-0.148	-0.131	-0.345	0.159	**0.926**	0.166	0.667
TSS (^{0}Brix)	0.736	-0.581	-0.366	0.019	0.385	-0.656	0.008	-0.168	0.059	0.299	**0.956**	0.671

PH=Plant height, SC=Stem circumference, TG=Tree growth, LL=Leaf length, LM=Leaf lamina length, NS=Number of flowers per shoot, FS=Fruit setting time, FL=Fruit length, FW=Fruit fresh weight, MC= % moisture content, FY=Fruit yield per tree, TSS=Total soluble solids, Residual effect: 0.0001409 and Bold figure indicates direct effect.

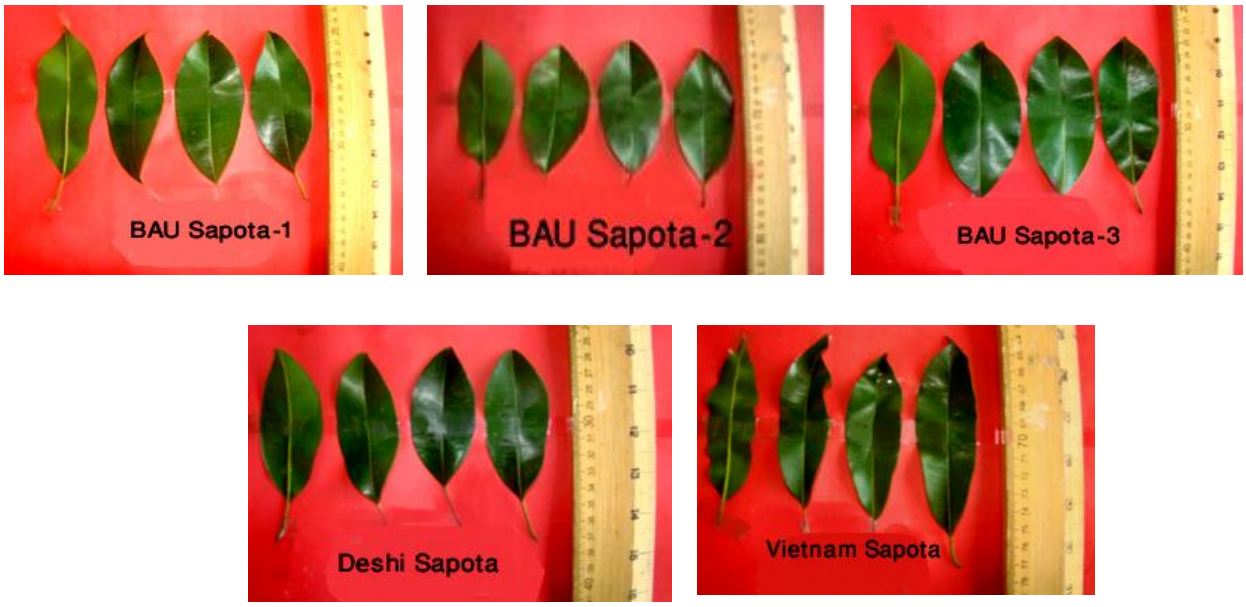

Figure 1. Leaf of different Sapota germplasm.

Figure 2. Vertical and horizontal differences in Sapota germplasm.

3.2. Leaf characteristics

Quantitative characteristics of Sapota germplasms in respect of leaf length, leaf lamina length and leaf petiole length. Considering all kinds of leaf length highest length value was found in case of BAU Sapota-3 than others. Results indicate that mean leaf length, leaf lamina length and leaf petiole length were 13.71±0.84, 11.49±0.59 and 2.28±0.31, respectively and significant different ($p<0.01$) present among the leaf lengths (Table 4). Table 3 reveals that the leaf shape of the BAU Sapota-1, BAU Sapota-2 and BAU Sapota-3 were elliptic shaped and rest Deshi Sapota and Vietnam Sapota of the were found as ovate and oblong-lanceolate shape leaves, respectively. The dark green leaves were found in BAU Sapota-1, BAU Sapota-2, Deshi Sapota and Vietnam Sapota. Green leaf was found in BAU Sapota-3. The apex of leaves of BAU Sapota-1, BAU Sapota-3 and Deshi Sapota were emarginated whereas it was acute shaped in BAU Sapota-2 and Vietnam Sapota. PCV were slightly higher than GCV in case of leaf length, leaf lamina length and leaf petiole length (Table 5).

3.3. Flower characteristics

Research result indicates that greenish white flowers present in BAU Sapota-1 and BAU Sapota-3 whereas off white flowers color were found in case of BAU Sapota-2, Deshi Sapota and Vietnam Sapota (Table 3). The plants of BAU Sapota-3 showed the highest number of flowers (11.20) which was followed by the Deshi Sapota and BAU Sapota-1 (11.00, 9.80, respectively) and significantly ($p<0.01$) differed from each (Table 4). PCV were slightly higher than GCV in case of number of flowers per shoot indicating the presence of environmental influence on the expression of these characters (Table 5).

3.4. Fruit characteristics

Through studying qualitative characteristics of five Sapota, it was found that fruits shape were in round and long oval and skin color was found Brown RHS 199c in BAU Sapota-3 and DESHI Sapota whereas BAU Sapota-1 and Vietnam Sapota was found Brown RHS 199A in color. Regarding sweetness of Sapota, accessions Vietnam Sapota and Deshi Sapota were tasted very sweet and BAU Sapota-1 and BAU Sapota-2 tasted sweet whereas BAU Sapota-3 was found medium sweet to taste. Orange red pulp color was found in case of BAU SapotA-3 and Deshi Sapota whereas yellow orange color found in BAU Sapota-2 and Vietnam Sapota beside these only BAU Sapota-1 showed orange colors (Table 3). Table 4 reveals that the plants of Deshi Sapota showed the longest fruit setting time which was 25.76 days and the shortest fruit setting time was observed in BAU Sapota-3 which was 24 days. It also described that the longest fruit length, highest fresh weight, highest moisture content, highest total soluble solids and highest fruit yield were found in BAU Sapota-3 than others and mean values were 5.51±0.33, 75.22±2.24, 73.56±1.24, 26.79±0.95 and 8.64±1.34, respectively (Table 4). PCV was also found higher than GCV in respect of all the fruit characteristics of Sapota and fruit setting time, fruit fresh weight, % moisture content, total soluble solids had minimum genetic advance in percentage of mean and highly heritable (Table 5). Similar findings was also observed by Shirol *et al*. (2009) who reported that significantly higher number and weight of fruits tree-1 in Virudhnagar while significantly higher individual fruit weight was also noticed in Cricket Ball (Udupi), Arabhavi. Shirol *et al*. (2006) also elucidated that Virudhnagar and Singapore were better yielder followed by Guthi and Cricket Ball (ARSA) whereas Cvs. Murabba, Mohangootee and Cricket Ball (Udupi) were found to be medium to poor yielder due to different agro-climatic condition. Again, Dinesh and Reddy (2000) also found that fruit weight was the maximum in Krishna Rao and least in Pilipatti whereas TSS was highest in Kirtibarti (big) and Pakala Oval. The average number of seeds per fruit was least in Guruvayya, Gavaraiah and Pakala Oval under Bangalore (Karnataka, India) conditions.

3.5. Seed characteristics

Among the Sapota germplasms, BAU Sapota-1 and Vietnam Sapota were in black color whereas brown color seed was found in BAU Sapota-2 and BAU Sapota-3 and (Figure 2). Deshi Sapota showed light brown in color only (Figure 2).

3.6. Correlation coefficient

Mutual relationship present between fruit yield per tree and its contributing characters which shown in Table 6 and reveals that in most cases the genotypic correlation coefficient were higher than the phenotypic correlation coefficient. It also indicates that strong inherent relation between the traits but suppressing effect of the environment modifies the phenotypic expression of these characters through reducing phenotypic coefficient values. It suggests that the fruit yield per tree would be increased through increasing of these characters. Plant height, leaf length, fruit setting time and fruit length had significant effect on stem circumference, leaf lamina length, fruit length, % moisture content, fruit yield, respectively and are the primary yield components. Plant height, stem circumferences, tree growth, leaf length, leaf lamina length, number of flowers per shoot, fruit setting time, fruit weight, %moisture content and total soluble solids were positively correlated with fruit yield but the values were non-significant ($p>0.05$). Among the yield contributing characters plant height had negative association with leaf lamina length and % moisture content.

Leaf length had significant effect on leaf lamina length but negatively associated with fruit setting time. Fruit setting time had significant negative effect on fruit length and negatively correlated with fruit weight, % moisture content, total soluble solids and fruit yield. Fruit length showed significant effect both in % moisture content and fruit yield per tree. Therefore, % moisture content and fruit yield per tree will be increased with the increase of fruit length. This trail also has positive association with total soluble solids and fruit fresh weight. Genotypic correlation coefficients between these fruit yield and yield contributing characters were generally higher than phenotypic correlation coefficients between them. The correlation coefficients of plant height stem circumferences, leaf length, leaf lamina length, number of flowers per shoot, fruit weight, % moisture content

and total soluble solids were higher at phenotypic level but they were low at genotypic level. This revealed that environmental effect enhanced the correlation between them to become higher at phenotypic level. The study of correlation among yield and yield contributing traits suggests that plant height, stem circumference, tree growth, leaf length, leaf lamina length, number of flowers per shoot, fruit length, fruit weight, % moisture content and total soluble solids were the most important characters which possessed positive association with fruit yield per tree. Therefore, these characters could be utilized in breeding program to improve varieties for higher yield.

3.7. Path coefficient analysis

Path analysis was performed to investigate the causes and effects of chain relationships of different yield contributing characters with yield. Table 7 implies that the plant height, tree growth, leaf length, fruit setting time, fruit fresh weight, %moisture content and total soluble solid had positive and direct effect on fruit yield. The character stem circumference, leaf lamina length, number of flowers per shoot and fruit length had negative direct effect on fruit yield. It was also found that considerably the highest positive direct effect on fruit yield was exhibited by tree growth followed by total soluble solids, % moisture content, plant height, leaf length, fruit fresh weight and fruit setting time. Although tree growth exhibited high and positive direct effects on fruit yield and its correlation with fruit yield was in minimum. Indirectly negative effect of tree growth and stem circumference reduced the correlation of the character with fruit yield.

4. Conclusions

Results suggest that BAU Sapota-3 is the best for fruit production among the 5 Sapota germplasms. A wide variability exists among the collected Sapota and that variability could be used for future breeding program of Sapota in Bangladesh. This variability can also be used for selection of superior germplasm for cultivation at farmer's level as well as future breeding program of Sapota in Bangladesh. Further collection of Sapota germplasm should be continued for getting more variability in respect of desired traits. Morphological characterization has been done in this research work but in future molecular and nutritional studies would be done.

Conflict of interest

None to declare.

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