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Evaluation of Sweet Potato (*Ipomoea batatus* (L.) Lam.) Germplasm Suitable for the Coastal Agroclimatic Situation of Sundarbans, West Bengal

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Abstract

Sweet Potato is an important tuber crop of rabi-summer season, suitable for the coastal agro-climatic situation of Sundarban due to its tolerance to salinity, to partial drought and to pest & diseases. However, due to lack of availability of location specific variety, the farmers of this region harvest far below the potential productivity of this crop which is around 15 – 17 t/ha. Hence it is imperative to replace the traditional undescribed germplasm with some superior genotypes through introduction and screening. With this objective thirteen genotypes (90/101, BCSP-7, Kamala Sundari, BCSP -10, h-200, TSP12/4, Pusa Safed, Samrat, Sree Bhadra, ST-14, Kishan, Sree Nandini, Sree Vardhini) were collected and evaluated at the Instructional Farm of Ramkrishna Ashram Krishi Vigyan Kendra, Nimpith, South 24 Parganas, West Bengal, for yield and qualitative parameters. Data were collected on sixteen growth and yield related traits and then subjected to statistical analysis. Five genotypes, namely Sree Nandini, Pusa Safed, H-200, Kamala Sundari and 90/101, recorded significantly higher value for the major yield contributing characters, i.e., tuber fresh weight, number of tuber/hill, tuber diameter, vine intermodal length and leaf area. The fresh tuber yield per hill was also high for these genotypes, which were 630.00g, 726.00g, 790.77g, 861.37g and 683.23g per hill, respectively. Though, Kamala Sundari recorded highest yield as well as β-carotene content, it showed poor storability. Considering all parameters, three genotypes, namely H-200, 90/101 and Pusa Safed proved tsuitable for the farmers of Sundarban region.

Key Words: Sweet potato, Sundarban, Salinity, Germplasm Screening, β –carotene

I. INTRODUCTION

Sweet potato (*Ipomoea batatas* (L.) Lam.) ranks fifth economically after rice, wheat, maize, and cassava, sixth in dry matter production, seventh in digestible energy production, and ninth in protein production in the developing countries (Stathers *et al*., 2005; Thottappilly and Loebenstein, 2009).

Sweet potato is adaptable to a broad range of agro-ecological conditions and fits into low-input agriculture. It is highly productive even under adverse farming conditions (Prakash, 1994). Sweet potato is drought tolerant and can be grown successfully in drought prone areas (Mukherjee, 2010). This crop could be grown successfully at a salinity level upto $EC_{(2)}$ 2.37 dS/m (Mondal *et al*., 2011).

Agriculture in Sundarban region during winter season faces three way hindrances like: i) late release of land for Winter crop due to poor surface and sub-surface drainage, ii) soil salinity and iii) poor irrigation facility as the ground water is saline. The farmers of this region have limited choice in crop selection during Winter season. In this situation, to get a success in agriculture, the crop should (a)

be short duration, (b) demand little or no irrigation and (c) tolerate soil salinity to some extent. Considering these aspects, sweet potato was selected by the local farmers, about fifteen years back. A profitable production in the less saline plots compelled the farmers to take this crop as a better alternative for winter season. In most of the cases the varieties used for cultivation were undescribed and traditional. Use of same variety for the past fifteen years resulted in declined yield, which is only 15-17 t/ha.

It was presumed that a systematic study on finding a cultivar suitable for this region may improve the productivity and production of this crop. Keeping this in mind the present experiment was formulated with thirteen diverse cultivars having good yield potential. Germplasm assemblage of sweet potato has been employed to study with the following objectives:

- Screening of the collected genotypes for yield, qualitative components and traits of interest.
- Determination of variable parameters based on morphological studies.
- Inter-relationship of character and their direct and indirect effects on tuber yield.

II. MATERIALS AND METHODS

Present investigation was carried out at the Instructional farm of Ramkrishna Ashram Krishi Vigyan Kendra, Nimpith. All the laboratory analysis was conducted in the Department of Horticulture, Institute of Agricultural Science, University of Calcutta. Thirteen genotypes of sweet potato were collected from two research stations namely CTCRI, RRS, Bhubaneswar and AICRP on tuber crops, BCKV, Kalyani, Nadia. The experiment was set-up in a completely randomized block design with 3 replications.

Genotypes collected form –

AICRP, Tuber crops, BCKV:	90/101, BCSP-7, Kamala Sundari, BCSP -10, H-200, TSP12/4
CTCRI, RC, Bhubaneswar :	Pusa Safed, Samrat, Sree Bhadra, ST-14, Kishan, Sree Nandini, Sree Vardhini

Data were recorded following 'Descriptors For Sweet Potato, CIP/AVRDC/IBPGR' (Huaman, 1991) on eleven qualitative traits namely vine colour, vine pigmentation, leaf shape, leaf margin, immature leaf colour, mature leaf colour, tuber shape, tuber surface defects, tuber skin colour, flesh colour, storage root formation and sixteen quantitative traits namely vine length (cm), vine internode length (cm), mature leaf length (cm), leaf area index (cm^2), tuber length (cm), tuber diameter (cm), no. of tuber / hill, average individual tuber fresh weight (g), tuber dry weight/100g. fresh tuber, % of reducing sugar, % of non-reducing sugar, % of total sugar, % of titrable acidity, vitamin-c (mg), β-carotene [vitamin-a (mg)], and tuber gross yield / hill.

Plot means were used for standard analysis. The statistical analysis for various experiments was executed in the Department of Horticulture, Institute of Agricultural Science, and University of Calcutta. Using the statistical package of GENRES (Version-2), field data were analyzed. Variability is measured in terms of grand mean, range, Phenotypic Coefficient of Variation and Genotypic Coefficient of Variation, Heritability, Genetic Advance and Genetic Advance as percentage of mean. The mean values for each genotype in each replication were used for statistical analysis. Analysis of variance was calculated as per Gomez and Gomez (1984).

III. RESULTS AND DISCUSSIONS

Eleven distinct germplasm qualifying characters (Table 1) clearly indicate that there is considerable variation for the leaf and tuber characters among the germplasms. Almost all germplasms are green leafed with two having purple coloured leaf. Also the variation in tuber colour is very much prominent with seven having purple skinned and two each of white, cream and orange skinned.

Analysis of variance (Table 2) based on sixteen quantitative characters shows that the accessions are significantly different for all the traits under study.

Mean performance of the genotypes for sixteen traits has been presented in Table 3. Highest tuber gross yield/hill was observed in Kamala Sundari (861.37g) followed by H-200 (790.77g). Number of tubers/hill, an important yield attributing trait, was observed highest in H-200 (9.20g) followed by Kamala Sundari (8.23g) and Pusa Safed (7.97g). Highest value for individual tuber fresh weight was recorded by 90/101 (124.13g) followed by Sree Vardhini (119.83g) and TSP12/4 (116.13g). Tuber length was observed maximum in TSP 12/4 (14.23g) followed by Sree Nandini (13.07g) and Sree Vardhini (12.97g) whereas tuber diameter was recorded highest in Sree Nandini (6.80g) followed by 90/101 (5.57g) and Pusa Safed (5.07g).

Tuber gross yield/hill showed maximum range (81.00-861.37) followed by vine length (47.23–202.33), leaf area index (6.97-39.73) and individual tuber fresh weight (36.93-124.13) (Table 4). The range was least for percentage of reducing sugar (0.71-1.23), while it was moderate for rest of the characters. GCV for all the characters was low to moderate (Table 4) except for β-carotene indicating comparatively less genetic variation among the genotypes for the concerned characters. Highest GCV was recorded for β-carotene (136.47) followed by percent non-reducing sugar (55.53) and tuber gross yield/hill (49.26). Rest of the characters recorded moderate values of genotypic and phenotypic coefficient of variation. Solankey *et al*. (2014) recorded highest PCV and GCV values for tuber yield per plant followed by starch content, fresh weight of tubers per plant and number of branches per plant which was supported by early work of Hossain *et al*. (2000); Tsegaye *et al*. (2007) and Thiyagu *et al*. (2013).

Burton (1952) suggested that genetic variability along with heritability should be considered for assessing the maximum and accurate effect of selection. Close correspondence between PCV and GCV estimates (Table 4) was reflected on the broad sense heritability estimates that were very high (more than 90%) for almost all the characters except for Vitamin C content (84.38). Jones *et al*. (1986) and Thiyagu *et al*. (2013) found that vine length, fresh weight of tubers, dry weight of tubers, root size and harvest index had high heritability. Vimala and Lakshmi (1990) reported high heritability estimates for tuber length, tuber weight, number of branches, tuber girth and vine weight. Mok *et al*. (1997) reported high heritability for number of storage roots per plant, storage root weight per plant, storage root dry matter content, root size and harvest index.

Genetic advance is the improvement in performance of the selected lines over the original population. Johanson *et al*. (1955) suggested that heritability in combination with genetic advance would be more reliable for predicting the effect of selection. Mean genetic advance estimated was highest for β-Carotene (280.93), whereas it was moderately high for percent non-reducing sugar (111.70) and tuber gross yield/hill (101.41). This indicates that these traits are controlled by additive gene action and offers the most effective criteria for selection. Moderate values of GA were recorded for leaf area index (96.34), vine length (92.05), vine internode length (88.85) and number of tuber/hill (81.23). Percent reducing sugar recorded lowest GA value (36.33) which reflects its governance through non additive genes either dominance or epistasis and improvement can be made by intercrossing the superior genotypes of the segregating population to develop multiple crosses and the desirable genes can be accumulated in the lines. Hossain *et al*. (2000) and Choudhary *et al*. (1999) reported high estimates of both heritability and genetic advance for number of roots per plant and root fresh yield per plant. These characters showed the preponderance of additive gene action and can be improve through selection.

Sankari *et al*. (2000) reported that high genetic advance was observed for vine length, vine girth, and yield of roots per vine.

In character association (Table 5), tuber yield per plant was positively correlated with as many as ten characters; however significant positive correlation was recorded by six traits namely number of tuber/hill, average individual tuber fresh weight, vine length, tuber diameter, tuber length and vine internode length. Tuber yield per plant was significantly negatively correlated with tuber dry weight. This suggests that selection of genotypes with high number of tuber/hill, tuber fresh weight, vine length, tuber diameter, tuber length and vine internodal length result in higher yield. Sweetness of tuber is negatively correlated with tuber length that means roundish shaped genotypes would be sweeter than long shaped genotypes. Early works of Hossain *et al*. (2000) and Chaudhary *et al*. (2000), indicated that tuber yield in sweet potato was highly and positively correlated with tuber diameter. Positive significant phenotypic correlation between fresh weight of tuber and number of tubers per plant was observed by Solankey *et al*. (2014).

Highest direct positive effect on tuber yield (Table 6) was exerted through individual tuber fresh weight followed by number of tuber/hill, leaf area, percent non-reducing sugar, tuber diameter, percent reducing sugar and vitamin-C content. It denotes that genotypes having higher values for these traits would result to higher yield. High direct negative effect on gross tuber yield per hill was recorded by mature leaf length followed by percent total sugar and percent titrable acidity. However, some of these characters exerted indirect positive effect on yield through other characters. Positive direct effects of number of tubers per plant on tuber yield were also observed by Alam *et al*. (1998), Parida *et al*. (1999) and Nedunzhiyan and Reddy, (2000). Jha (2011) observed that tuber yield was positively directly linked with number of tuber per plant, vine length, total soluble solid, neck length and diameter of tuber.

The thirteen genotypes under study were grouped into five clusters based on D^2 analysis. Cluster I consisted of maximum number of accessions (seven) while cluster II and III consisted of 2 genotypes in each (Table 7a). The cluster IV and V were single member. Cluster II was the most homogenous cluster with low intra-cluster value (68.33) while cluster I registered maximum heterogeneity (181.78) followed by cluster III (133.88) (Table 7b). The distance between clusters was maximum in between cluster III and IV (412.14) followed by cluster II and IV (311.12). Cluster V and II were mostly close to each other having lowest inter-cluster value (103.57) indicating close relationship among the genotypes (Samrat, Sree Vardhini and Sree Nandini) included in these two clusters.

The cluster means for different characters indicated considerable differences among the clusters for all characters (Table 7c). Cluster-IV recorded highest gross tuber yield per hill (726.00) followed by Cluster V, both are single membered cluster. Cluster V and IV also registered maximum values for yield attributing traits like number of tuber per hill, individual tuber fresh weight, tuber diameter and tuber yield. Cluster I having maximum number of genotypes registering itself third highest for gross tuber yield (551.82).

IV. CONCLUSION

From the study it is clear that the gross tuber yield per hill, the main criteria for selection of a genotype, is a resultant of different yield attributing characters of which maximum influence was exerted by tuber fresh weight, number of tuber/hill, tuber diameter, vine intermodal length and leaf area. So, genotypes having higher value for these traits as well as divergent to each other may be selected and recommended for commercial cultivation. Genotypes Sree Nandini, Pusa Safed (from Cluster V and IV

respectively), H-200, Kamala Sundari and 90/101 (from Cluster I) may be selected for further detailed study and commercial cultivation.

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Table 1: Distinct-Uniform-Stable characters of sweet potato genotypes for vine, leaf, tuber and flesh

S. No.	Variety	Vine colour	Vine pigmentation	Leaf shape	Leaf margin	Immature leaf colour	Mature leaf colour	Tuber shape	Tuber surface defects	Tuber skin colour	Flesh colour	Storage root formation
1	90/101	Green	Green	Lobed	Erect	Slightly purple	Yellow green	Round elliptic	Alligator like skin	Purple red	Pale yellow	Dispersed
2	BCSP-7	Green	Green	Triangular	Erect	Green with purple edge	Green with purple edge	elliptic	Alligator like skin	Purple red	White	Very dispersed
3	KAMALA SUNDARI	Green with few purple	Green with few purple	Triangular	Erect	Mostly purple	Green	Long elliptic	Veins	Orange	Dark orange	Open cluster
4	BCSP-10	Green	Green	Lobed	Serrated	Slightly purple	Green	elliptic	Alligator like skin	Purple red	Cream	Dispersed
5	H-200	Mostly purple	Mostly purple	Triangular	Erect	Slightly purple	Green with purple veins on lower surface	Round elliptic	Alligator like skin	Purple red	White	Dispersed
6	TSP12/4	Green	Green	Lobed	Serrated	Mostly purple	Green with purple edge	Long oblong	Veins	White	Dark orange	Very dispersed
7	PUSA SAFED	Green	Green	Lobed	Erect	Slightly purple	Green	Round elliptic	Longitudinal grooves	White	White	Very dispersed
8	SAMRAT	Green with few purple	Green with few purple	Triangular	Erect	Slightly purple	Green	Long irregular or curved	Veins	Cream	Cream	Open cluster
9	SREE BHADRA	Green	Green	Triangular	Erect	Slightly purple	Slightly purple	Round elliptic	Alligator like skin	Purple red	Cream	Very dispersed
10	ST-14	Purple	Purple	Triangular	Erect	Yellow green	Green	Round elliptic	Longitudinal grooves	Orange	Orange	Dispersed
11	KISHAN	Green	Green	Triangular	Erect	Green	Green with purple edge	Long oblong	Horizontal constrictions	Purple red	Cream	Dispersed
12	SREE NANDINI	Purple	Purple	Triangular	Erect	Yellow green	Green	elliptic	Veins	Cream	Cream	Dispersed
13	SREE VARDHINI	Green	Green	Cordate	Erect	Green with purple edge	Green	ovate	Alligator like skin	Purple red	White	Very dispersed

Table 2: ANOVA for sixteen characters of thirteen genotypes of sweet potato

SOURCE	DF	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	CH9	CH10	CH11	CH12	CH13	CH14	CH15	CH16
REP.	2	440.99	0.01	0.02	0.78	0.53	0.07	0.04	11.92	0.57	0.01	0.03	0.09	0.01	5.25	0.02	107.85
VAR.	12	8717.94**	16.84**	8.08**	420.87**	28.94**	5.45**	13.73**	2132.16**	183.26**	0.10**	0.34**	0.51**	0.08**	45.92**	52.40**	191395.11**
ERROR	24	232.75	0.01	0.04	0.22	0.06	0.02	0.04	15.40	0.29	0.00	0.00	0.01	0.00	2.67	0.02	82.45

* Significant at 5% level ** Significant at 1% level

Characters:

CH1: Vine length (cm)
CH2: Vine internode length (cm)
CH3: Mature leaf length (cm)
CH4: Leaf area index (cm^2)
CH5: Tuber length (cm)
CH 6: Tuber diameter (cm)
CH7: No. of tuber / hill
CH 8: Average individual tuber fresh weight (g)
CH9: Tuber dry weight/100g fresh tuber
CH10: % of reducing sugar
CH11: % of non-reducing sugar
CH12: % of total sugar
CH13: % of titrable acidity
CH14: Vitamin-C (mg)
CH15: β-Carotene [vitamin-A (mg)].
CH16: Tuber gross yield / hill.

Table 3: Mean performance of thirteen genotypes of sweet potato for sixteen characters

Genotype	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	CH9	CH10	CH11	CH12	CH13	CH14	CH15	CH16
90/101	147.10	7.00	8.60	37.93	6.80	5.57	5.53	124.13	14.30	0.80	1.04	1.91	0.26	20.01	2.66	683.23
BCSP-7	73.10	4.60	8.90	33.53	7.57	4.00	3.27	49.07	38.90	0.95	0.64	1.64	0.45	23.06	0.27	160.50
KAMALA SUNDARI	131.00	5.20	7.17	30.83	12.07	4.77	8.23	104.43	19.43	0.96	0.27	1.00	0.35	20.35	9.36	861.37
BCSP-10	181.00	5.73	8.90	28.50	5.10	1.77	5.53	109.97	44.33	1.12	0.73	1.92	0.37	15.56	2.50	605.43
H-200	60.57	6.17	5.07	11.60	9.03	4.80	9.20	85.93	23.40	0.71	1.03	1.82	0.74	23.60	0.67	790.77
TSP12/4	70.90	5.10	5.97	6.97	14.23	3.80	5.00	116.13	27.63	1.05	0.27	1.32	0.69	21.72	1.21	580.40
PUSA SAFED	202.33	12.40	6.27	15.63	8.57	5.07	7.97	91.17	26.30	1.20	0.35	1.61	0.33	17.92	0.53	726.00
SAMRAT	66.20	3.57	7.20	18.47	5.30	3.90	5.23	71.77	27.80	1.15	0.42	1.61	0.46	24.47	2.52	375.47
SREE BHADRA	55.43	4.17	9.30	39.27	6.23	3.03	2.40	75.50	27.70	1.05	1.08	2.17	0.49	18.44	1.44	181.07
ST-14	132.77	4.73	8.13	26.50	8.73	4.07	4.33	88.27	30.40	0.80	0.25	1.04	0.43	11.56	14.63	382.13
KISHAN	47.23	2.83	4.97	7.93	7.27	2.17	2.20	36.93	35.03	1.17	0.43	1.64	0.21	23.95	1.52	81.00
SREE NANDINI	152.90	5.90	10.03	39.73	13.07	6.80	6.20	101.40	26.23	1.23	1.03	2.23	0.35	15.00	1.71	630.00
SREE VARDHINI	166.67	3.90	8.43	32.00	12.97	4.37	5.07	119.83	25.87	0.74	0.31	1.06	0.21	18.28	0.80	607.03
CD (0.05)	25.70	0.19	0.33	0.78	0.42	0.26	0.32	6.61	0.90	0.08	0.13	0.16	0.08	2.75	0.26	15.30

Table 4: Variability analysis for sixteen characters of thirteen genotypes of sweet potato

Sl. No.	Characters	Grand mean	Range	GCV	PCV	Heritability (%)	GA as % of Mean
1	Vine length (cm)	114.40	47.23– 202.33	46.49	48.36	92.41	92.05
2	Vine internode length (cm)	5.49	2.83-12.40	43.18	43.23	99.77	88.85
3	Mature leaf length (cm)	7.61	4.97-10.03	21.51	21.67	98.56	43.99
4	Leaf area index (cm^2)	25.30	6.97-39.73	46.80	46.84	99.85	96.34
5	Tuber length (cm)	9.00	5.10-14.23	34.49	34.61	99.35	70.83
6	Tuber diameter (cm)	9.00	1.77-6.80	32.31	32.52	98.71	66.13
7	No. of tuber / hill	5.40	2.20-9.20	39.60	39.76	99.18	81.23
8	Average individual tuber fresh weight (g)	90.35	36.93-124.13	29.40	29.72	97.86	59.91
9	Tuber dry weight / 100g Fresh tuber	28.26	14.30-44.33	27.64	27.70	99.53	56.80
10	% of reducing sugar	1.00	0.71-1.23	18.17	18.72	94.22	36.33
11	% of non-reducing sugar	0.60	0.25-1.08	55.53	56.88	95.33	111.70
12	% of total sugar	1.61	1.00-2.23	25.28	25.93	95.08	50.78
13	% of titrable acidity	0.41	0.21-0.74	38.69	40.44	91.53	76.25
14	Vitamin-C (mg)	19.53	11.56-23.95	19.44	21.16	84.38	36.78
15	β-Carotene [vitamin-A(mg)]	3.06	0.27-14.63	136.47	136.56	99.87	280.93
16	Tuber gross yield / hill.	512.65	81.00-861.37	49.26	49.29	99.87	101.41

Table 5: Genotypic (G) and Phenotypic (P) Correlation coefficients between different pairs of characters

		CH2	CH3	CH4	CH5	CH6	CH7	CH8	CH9	CH10	CH11	CH12	CH13	CH14	CH15	CH16
CH1	G	0.63**	0.38*	0.35*	0.17	0.33*	0.43**	0.64**	-0.08	0.03	-0.14	-0.12	-0.53**	-0.71**	0.16	0.59**
	P	0.61**	0.35*	0.34*	0.16	0.33*	0.41**	0.61**	0.08	0.01	0.12	0.11	0.48**	0.60**	0.15	0.57**
CH2	G	-	-0.10	-0.07	0.02	0.43**	0.60**	0.32*	-0.25	0.15	0.05	0.14	-0.03	-0.25	-0.14	0.55**
	P		0.10	0.07	0.02	0.43**	0.59**	0.31*	-0.25	0.15	0.05	0.14	-0.03	-0.22	-0.14	0.55**
CH3	G	-	-	0.93**	-0.07	0.21	-0.28*	0.27*	0.11	0.03	0.39**	0.32*	-0.31*	-0.59**	0.09	-0.10
	P			0.92**	0.07	0.20	0.27*	0.27*	0.11	0.03	0.37*	0.31*	-0.29*	-0.54**	0.09	-0.10
CH4	G	-	-	-	0.06	0.32*	-0.15	0.27*	-0.14	-0.14	0.46**	0.28*	-0.39**	-0.49**	0.14	0.01
	P				0.06	0.32*	0.15	0.26*	-0.14	-0.14	0.45**	0.27*	-0.37*	-0.45**	0.14	0.01
CH5	G	-	-	-	-	0.50**	0.31*	0.46**	-0.36*	-0.14	-0.31*	-0.42**	0.12	-0.14	0.06	0.44**
	P					0.50**	0.31*	0.45**	-0.35*	-0.13	-0.30*	-0.41**	0.11	-0.12	0.06	0.44**
CH6	G	-	-	-	-	-	0.54**	0.39**	-0.70**	-0.16	0.22	0.06	0.00	-0.16	0.03	0.55**
	P						0.54**	0.39**	-0.70**	-0.16	0.22	0.06	-0.01	-0.15	0.03	0.55**
CH7	G	-	-	-	-	-	-	0.49**	-0.47**	-0.19	0.01	-0.13	0.25	-0.01	0.06	0.92**
	P	-	-	-	-	-	-	0.47**	-0.47*	-0.18	0.02	-0.12	0.24	-0.02	0.06	0.92**

									*							
CH8	**G**	-	-	-	-	-	-	-	**-0.47****	**-0.31***	**0.03**	**-0.16**	**-0.02**	**-0.45****	**0.11**	**0.78****
	P	-	-	-	-	-	-	-	-0.46**	-0.30*	0.02	-0.15	-0.01	-0.40**	0.11	0.77**
CH9	**G**	-	-	-	-	-	-	-	-	**0.38***	**-0.13**	**0.12**	**-0.01**	**-0.10**	**-0.12**	**-0.55****
	P	-	-	-	-	-	-	-	-	0.36*	0.13	0.11	0.01	0.09	-0.12	-0.55**
CH10	**G**	-	-	-	-	-	-	-	-	-	**-0.04**	**0.42****	**-0.17**	**0.03**	**-0.28***	**-0.25**
	P	-	-	-	-	-	-	-	-	-	0.06	0.38*	0.16	0.02	-0.27*	-0.25
CH11	**G**	-	-	-	-	-	-	-	-	-	-	**0.88****	**0.17**	**-0.01**	**-0.40****	**0.01**
	P	-	-	-	-	-	-	-	-	-	-	0.87**	0.16	0.01	-0.39**	0.01
CH12	**G**	-	-	-	-	-	-	-	-	-	-	-	**0.09**	**0.03**	**-0.56****	**-0.17**
	P	-	-	-	-	-	-	-	-	-	-	-	0.08	0.05	-0.54**	-0.16
CH13	**G**	-	-	-	-	-	-	-	-	-	-	-	-	**0.27***	**-0.08**	**0.11**
	P	-	-	-	-	-	-	-	-	-	-	-	-	0.22	-0.07	0.11
CH14	**G**	-	-	-	-	-	-	-	-	-	-	-	-	-	**-0.54****	**-0.19**
	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.50**	-0.17
CH15	**G**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.09**
	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.09

Table 6: Direct (diagonal bold) and indirect effect of fifteen characters on yield per plant

CH	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	CH9	CH10	CH11	CH12	CH13	CH14	CH15
CH1	**-0.06**	0.05	-0.20	0.14	0.01	0.05	0.23	0.44	-0.02	0.00	-0.03	0.02	0.05	-0.10	0.02
CH2	-0.04	**0.08**	0.05	-0.03	0.00	0.06	0.33	0.21	-0.07	0.02	0.01	-0.03	0.00	-0.04	-0.02
CH3	-0.02	-0.01	**-0.52**	0.36	0.00	0.03	-0.15	0.18	0.03	0.00	0.10	-0.06	0.03	-0.09	0.01
CH4	-0.02	-0.01	-0.48	**0.39**	0.00	0.05	-0.08	0.18	-0.04	-0.02	0.12	-0.05	0.04	-0.07	0.02
CH5	-0.01	0.00	0.04	-0.02	**0.04**	0.07	0.17	0.31	-0.11	-0.02	-0.08	0.08	-0.01	-0.02	0.01
CH6	-0.02	0.03	-0.11	0.12	0.02	**0.15**	0.30	0.27	-0.21	-0.02	0.06	-0.01	0.00	-0.02	0.00
CH7	-0.03	0.05	0.14	-0.06	0.01	0.08	**0.55**	0.33	-0.14	-0.03	0.00	0.02	-0.02	0.00	0.01
CH8	-0.04	0.02	-0.14	0.10	0.02	0.06	0.27	**0.68**	-0.14	-0.04	0.01	0.03	0.00	-0.07	0.02
CH9	0.01	-0.02	-0.05	-0.05	-0.01	-0.10	-0.26	-0.32	**0.30**	0.06	-0.03	-0.02	0.00	-0.01	-0.02
CH10	0.00	0.01	-0.01	-0.06	0.00	-0.02	-0.10	-0.21	0.11	**0.15**	-0.01	-0.08	0.02	0.00	-0.04
CH11	0.01	0.00	-0.20	0.18	-0.01	0.03	0.01	0.02	-0.04	-0.01	**0.26**	-0.17	-0.02	0.00	-0.05
CH12	0.01	0.01	-0.17	0.11	-0.01	0.01	-0.07	-0.11	0.04	0.06	0.23	**-0.19**	-0.01	0.00	-0.07
CH13	0.03	0.00	0.16	-0.15	0.00	0.00	0.14	-0.01	0.00	-0.03	0.05	-0.02	**-0.10**	0.04	-0.01
CH14	0.04	-0.02	0.31	-0.19	-0.01	-0.02	-0.01	-0.31	-0.03	0.00	0.00	-0.01	-0.03	**0.15**	-0.07
CH15	-0.01	-0.01	-0.05	0.05	0.00	0.00	0.03	0.08	-0.04	-0.04	-0.10	0.11	0.01	-0.08	**0.13**

Table 7a: Grouping of thirteen Sweet potato genotypes

Cluster	Number of genotypes	Genotypes/accessions
CLUSTER I	7	i) 90/101 ii) BCSP-7 iii) KAMALA SUNDARI iv) BCSP-10 v) H-200 vi) TSP12/4 vii) SREE BHADRA
CLUSTER II	2	i) SAMRAT ii) SREE VARDHINI
CLUSTER III	2	i) ST-14 ii) KISHAN
CLUSTER IV	1	PUSA SAFED
CLUSTER V	1	SREE NANDINI

Table 7b: Inter and Intra cluster distances for thirteen sweet potato genotypes

Cluster	I	II	III	IV	V
CLUSTER I	181.78	132.40	208.55	291.10	140.02
CLUSTER II		68.33	144.71	311.12	103.57
CLUSTER III			133.88	412.14	214.38
CLUSTER IV				0.00	262.54
CLUSTER V					0.00

Table 7c: Cluster wise mean values

Cluster	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	CH9	CH10	CH11	CH12	CH13	CH14	CH15	CH16
CLUSTER I	**102.73**	**5.42**	**7.70**	**26.95**	**8.72**	**3.96**	**5.60**	**95.02**	**27.96**	**0.95**	**0.72**	**1.68**	**0.48**	**20.39**	**2.59**	**551.82**
CLUSTER II	**116.43**	**3.73**	**7.82**	**25.23**	**9.13**	**4.13**	**5.15**	**95.80**	**26.83**	**0.95**	**0.36**	**1.33**	**0.34**	**21.37**	**1.66**	**491.25**
CLUSTER III	**90.00**	**3.78**	**6.55**	**17.22**	**8.00**	**3.12**	**3.27**	**62.60**	**32.72**	**0.99**	**0.34**	**1.34**	**0.32**	**17.76**	**8.07**	**231.57**
CLUSTER IV	**202.33**	**12.40**	**6.27**	**15.63**	**8.57**	**5.07**	**7.97**	**91.17**	**26.30**	**1.20**	**0.35**	**1.61**	**0.33**	**17.92**	**0.53**	**726.00**
CLUSTER V	**152.90**	**5.90**	**10.03**	**39.73**	**13.07**	**6.80**	**6.20**	**101.40**	**26.23**	**1.23**	**1.03**	**2.23**	**0.35**	**15.00**	**1.71**	**630.00**

