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Research Article

Genetic variability for different quantitative characters in sweet potato (*Ipomoea batatas* L.)

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Abstract
The study was initiated to generate genetic information on important yield contributing characters of sweet potato genotypes maintained in Chhattisgarh. Twenty eight sweet potatoes (*Ipomea batatas* L.) genotypes were evaluated to estimate the genetic variability for different characters. The experiment was conducted using a Randomized Complete Block Design with three replications. The genetic parameters for yield contributing characters of different sweet potato genotypes were studied. Analysis of variance showed significant variation among the genotypes for all tested characters. The highest tuber yield was recorded in genotype Indira Naveen (27.84 t/ha) which was followed by TSP-16-8 (25.42 t/ha), Indira Madhur (25.26 t/ha), Sree Bhadhara (24.81 t/ha) and Sree Rethana (24.48 t/ha). Diameter of tubers, vine length, vine internode length, the number of tubers per plant showed the highest genotypic and phenotypic variation. High heritability was observed for characters *viz*., dry matter of tubers followed by vine length, vine internode length, starch, TSS of tubers, tubers weight per plant, the number of tubers per plant, vine weight per plant, diameter of tubers, dry matter of foliage, length of tubers, harvest index, tubers yield. Variability in vine length, vine weight, dry matter of foliage, tuber weight per plant and tubers yield present in the genotypes could be used for the improvement of sweet potato.

Keywords: Sweet potato, Genetic variability, Heritability, Genetic advance, Tuber yield.

INTRODUCTION

Sweet potato (*Ipomea batatas* L.) is one of the most popular and extensively consumed tuber vegetable crops grown worldwide due to its acclimatization to a wide variety of environments, as well as its high nutritive value. In a Chhattisgarh, sweet potato is grown in both the rainy and summer season. It is one of the most important tuber crops of Chhattisgarh. Sweet potato commonly known as “Shakarkand” is one of the most popular and important tubers crops in India and abroad because of its yield potential and high calorific value. In Chhattisgarh, it is locally known as “Kalmal Kanda”, ‘Maati Kanda’ and ‘Kevat Kanda’. Sweet potato is mainly used for human consumption, animal feed and to a limited extent as a raw material for industrial purposes such as starch and alcohol production. Tubers are consumed in the form of boiled, fried and baked. Among other uses, the young leaves and shoots are sometimes eaten as greens. The minerals composition of root tubers is calcium 30 mg, magnesium 24 mg, potassium 373 mg, sodium 13 mg, phosphorus 49 mg, chlorine 85 mg, sulphur 26 mg and iron 0.8 mg/100 g. Sugar, primarily sucrose, glucose, fructose and maltose constitute 6-14 % of the dry matter content. Sweet potato tubers are rich in starch (20-28 %), carbohydrates (28.2%) and vitamins (Dhaliwal, 2017). Being rich in β-carotene, a

precursor of vitamin A, orange-fleshed sweet potatoes are becoming increasingly important as the cheapest source of antioxidants with several physiological characteristics, such as anti-oxidation, anti-cancer and liver injury safety, and are ideally suited as a bio-fortified crop to fight malnutrition in small-marginal farming communities. Among the major tuber crops cultivated in India, sweet potato ranks third next to potato and cassava in area and production. In India, it is grown in an area of 1.16 lakh ha and produces 11.86 lakh MT with productivity of 10.22 t/ha (Anonymous, 2020 a). Odisha is the leading state in the area and production of sweet potato, whereas, productivity is highest in Andhra Pradesh. In Chhattisgarh state, it is cultivated in an area of 4478 hectares area with a production of 48.15 thousand tonnes and productivity of 10.19 t/ha. (Anonymous, 2020 b). The yield of sweet potato in Chhattisgarh is not satisfactory enough in comparison with other sweet potato growing countries in India it is largely cultivated in Uttar Pradesh, Bihar, West Bengal, Orissa, Madhya Pradesh, Tamil Nadu, Kerala, Karnataka, and Andhra Pradesh (Hazra, 2015). Studies on genetic parameters provide information about the expected response of various traits to selection and help in developing optimum breeding procedures. Hence, the present study was planned to evaluate genetic variability parameters in sweet potato genotypes for tuber yield and yield contributing characters.

MATERIALS AND METHODS

The study was carried out during *kharif,* 2020-2021 at Instructional cum Research Farm of S.G. College of Agriculture and Research Station, Jagdalpur, Bastar (C.G.). The experimental material comprised of twenty eight genotypes (Indira Naveen, Indira Nandini, Indira Madhur, C.G. Shakarkand Priya, C.G. Shakarkand Narangi, Gouri, Sree Bhadhara, Sree Rethana, Bhu Kanti, Bhu Krishana, Bhu Sona, IGSP-KSKL-13-26, TSP-16-1, TSP-16-2, TSP-16-3, TSP-16-4, TSP-16-5, TSP-16-6, TSP-16-7, TSP-16-8, TSP-16-10, IGSP-26, IGSP-30, IGSP-34, SGCARS-1, SGCARS-5, SGCARS-17, SGCARS-38) of sweet potato. The experiment was laid out in a randomized block design with three replications at the spacing of 60 cm between rows and 20 cm between plants to plant. A net plot size of 2 x 1.8 m was kept for each genotype. All the recommended cultural practices were taken to grow a healthy crop. Data were recorded on five randomly selected plants for thirteen characters *viz.,* vine length (cm), vine internode length (cm), vine weight per plant (fresh weight) g, length of tubers (cm), the diameter of tubers (cm), TSS of tubers (%), starch content (%), dry matter of tubers (%), dry matter of foliage (%), the number of tubers per plant, tubers weight per plant (g), harvest index (%) and tuber yield (t/ha) were recorded. The data were analyzed to estimate genotypic and phenotypic co-efficient of variation using the formula given by Burton (1952), heritability in a broad sense by Burton and De Vane (1953) and the genetic advance was estimated by using the formula suggested by Johnson *et al.* (1955). The genetic variability parameters were determined using the software RStudio version 1.4.1717 © 2009-2021 package in genetic variability analysis for plant breeding research version 0.1.0.

RESULTS AND DISCUSSION

The analysis of variance for all the characters under study is presented in **Table 1**. ANOVA was worked out for tubers yield and its component characters indicated that the mean sum of squares due to genotypes were highly significant for all the characters under study. Significant mean sum of squares due to tubers yield and attributing characters revealed the existence of considerable variability in the genotypes studied for the improvement of various traits. These findings were closely associated with the reports of Sahu (2003), Anshebo *et al.* (2004), Teshome *et al.* (2004), Tirkey (2006), Chaurasia (2012), Mohanty (2013), Dash *et al.* (2014) and Bhadauriya *et al.* (2018) in sweet potato.

Table 1. Analysis of variance for tubers yield and its component characters in sweet potato

S. No.	Character	Mean sums of square		
		Replication	Treatment	Error
		Df: 2	Df: 27	Df: 54
1	Vine length	186.46	8591.04**	157.61
2	Vine internode length	1.04	6.94**	0.19
3	Vine weight per plant	9920.39	18282.32**	1143.10
4	Length of tubers	13.96	46.88**	3.23
5	Diameter of tubers	0.17	3.01**	0.20
6	TSS of tubers	0.29	5.67**	0.25
7	Starch content	0.04	61.55**	2.33
8	Dry matter of tubers	0.42	133.89**	1.16
9	Dry matter of foliage	760.96	542.73**	37.04
10	Number of tubers per plant	0.37	3.48**	0.19
11	Tubers weight per plant	1189.97	15366.18**	768.04
12	Harvest Index	25.42	257.67**	19.28
13	Tubers yield	67.36	67.58**	8.29

** Significant at 1 % level

The mean performance of genotypes is presented in **Table 2**. The tuber yield ranged from 12.22 to 27.84 t/ha with an overall average of 18.45 t/ha+. The highest tuber yield was recorded in the genotype Indira Naveen (27.84 t/ha) followed by TSP-16-8 (25.42 t/ha), Indira Madhur (25.26 t/ha), Sree Bhadhara (24.81 t/ha) and Sree Rethana (24.48 t/ha). Whereas, the lowest tuber yield was obtained in the genotype IGSP-30 (12.22 t/ha). Vine length variation was recorded from minimum in IGSP-30 and IGSP- 34 (67.22 cm) to maximum in

Table 2. Mean performance of tuber yield and its components in sweet potato

S. No.	Character/ Genotypes	VL	VIL	VWPP	LOT	DOT	TSS	Starch content	DMT	DMF	NTPP	TWPP	HI	TY
1	Indira Naveen	172.00	5.70	282.44	21.11	3.79	8.41	21.48	26.91	56.89	4.17	417.61	59.78	27.84
2	Indira Nandini	198.44	4.42	254.56	12.72	3.20	10.46	21.23	21.05	69.00	5.00	345.18	57.78	23.01
3	Indira Madhur	94.220	3.08	140.33	17.50	4.47	9.67	21.48	24.20	43.56	4.30	378.96	73.00	25.26
4	C.G. Shakarkand Priya	177.11	2.91	303.74	12.82	4.98	10.61	17.39	22.23	55.11	5.10	355.96	54.13	23.73
5	C.G. Shakarkand Narangi	131.11	3.40	332.33	16.22	2.75	8.22	16.04	22.14	42.56	4.25	334.62	50.45	22.31
6	Gouri	134.11	4.20	323.77	11.89	3.27	9.15	14.94	25.74	49.11	5.44	319.44	49.16	21.30
7	Sree Bhadhara	157.78	3.16	368.33	14.11	4.32	8.23	19.13	25.91	49.89	3.78	372.13	50.66	24.81
8	Sree Rethana	204.78	6.22	194.67	12.22	3.91	8.67	21.70	24.69	36.67	4.24	367.17	65.34	24.48
9	Bhu Kanti	228.67	4.63	413.44	19.44	3.22	11.48	18.37	20.90	54.56	3.23	303.62	42.35	20.24
10	Bhu Krishana	233.67	4.40	193.56	10.56	2.23	11.37	14.86	22.43	25.00	3.68	286.95	59.69	19.13
11	Bhu Sona	211.11	5.39	241.22	11.75	2.55	11.86	16.37	23.47	33.56	3.36	235.34	49.37	15.69
12	IGSP-KSKL-13-26	88.78	5.46	181.56	17.67	2.97	11.29	15.11	21.61	20.89	3.01	285.09	61.14	19.01
13	TSP-16-1	101.67	3.73	220.78	9.65	1.85	9.46	10.11	11.21	34.22	2.33	259.52	54.09	17.30
14	TSP-16-2	126.89	4.49	333.89	11.56	2.60	12.32	9.08	23.30	45.11	2.67	254.68	43.34	16.98
15	TSP-16-3	154.44	9.40	231.00	9.11	3.24	11.20	10.97	11.39	39.33	1.89	198.31	46.17	13.22
16	TSP-16-4	254.44	6.02	222.78	6.22	1.57	11.71	10.07	8.88	42.67	1.89	243.33	52.22	16.22
17	TSP-16-5	130.11	4.87	142.56	5.87	1.78	11.84	10.30	16.43	25.78	1.89	231.79	61.91	15.45
18	TSP-16-6	103.56	3.65	141.00	5.71	1.43	11.09	11.74	10.77	23.56	2.00	186.67	56.89	12.44
19	TSP-16-7	140.56	4.03	344.00	10.31	2.65	10.62	10.34	9.06	50.00	1.89	204.85	37.22	13.66
20	TSP-16-8	150.33	4.06	350.56	16.56	4.80	11.36	10.26	13.27	58.78	3.52	381.26	52.84	25.42
21	TSP-16-10	067.22	2.78	124.33	12.08	1.83	12.01	10.94	27.82	16.01	3.58	293.81	70.25	19.59
22	IGSP-26	126.67	3.41	276.00	11.44	3.41	9.51	8.67	8.95	37.70	2.67	198.90	42.05	13.92
23	IGSP-30	67.22	4.76	174.44	16.00	1.82	12.02	8.86	12.45	29.00	1.56	183.33	51.25	12.22
24	IGSP-34	67.22	2.52	339.44	12.44	1.96	11.74	10.55	26.14	56.00	2.33	186.73	35.09	12.45
25	SGCARS-1	105.11	2.14	262.22	6.83	2.11	9.57	8.15	25.45	54.00	2.22	195.15	42.68	13.01
26	SGCARS-5	195.22	2.89	210.11	12.67	1.74	11.06	11.08	28.11	40.08	3.33	204.67	49.26	13.64
27	SGCARS-17	214.67	6.63	292.66	11.56	3.04	7.71	8.33	10.59	62.75	2.89	226.00	43.00	15.07
28	SGCARS-38	126.22	4.49	272.67	15.44	3.01	11.48	11.64	23.36	44.11	3.44	286.93	51.61	19.13
Mean		148.69	4.39	256.01	12.55	2.88	10.50	13.54	19.59	42.71	3.20	276.36	52.24	18.45
SEM		4.18	0.14	11.27	0.60	0.18	0.17	0.51	0.36	2.65	0.14	9.24	1.46	0.96
SED		5.92	0.20	15.94	0.85	0.26	0.23	0.72	0.51	3.75	0.20	13.06	2.07	1.36
CD (p = 0.05 %)		11.87	0.41	31.95	1.70	0.52	0.47	1.44	1.02	7.52	0.41	26.19	4.15	2.72
CV (%)		8.44	9.87	13.21	14.33	19.03	4.71	11.26	5.50	18.63	13.49	10.03	8.41	15.61
Range	Minimum	67.22	2.14	124.33	5.71	1.43	7.71	8.15	8.88	16.01	1.56	183.33	35.09	12.22
	Maximum	254.44	9.4	413.44	21.11	4.98	12.32	21.7	28.11	69	5.44	417.61	73.00	27.84

VL – Vine length (cm), VIL – Vine internode length (cm), VWPP- Vine weight per plot (g), LOT- Length of tuber (cm), DOT – Diameter of tuber (cm), TSS- Total soluble solids (%), DMT – Dry matter of tuber (%), DMF- Dry matter of foliage (%), NTPP- Number of tubers per plant, TWPP- Tuber weight per plant (g), HI- Harvest index (%), TY- Tuber yield (t/ha).

TSP-16-4 (254.44 cm) with a mean of 148.69 cm. Vine internode length ranged from 2.14 cm (SGCARS-1) to 9.40 cm (TSP-16-3) with a mean of 4.39 cm and vine weight showed a high range of variation from 124.33 g (TSP-16-10) to a maximum of 413.44 g in Bhu Kanti with a mean of 256.01 g. Tuber length had a range of 5.71 cm (TSP-16-6) to 21.11 cm (Indira Naveen) with a mean of 12.55 cm and the diameter of tubers showed a high range of variation from 1.43 cm (TSP-16-6) to 4.98 cm (C.G. Shakarkand Priya) with a mean of 2.88 cm. TSS of tubers showed a range of variation from 7.71% (SGCARS-17) to 12.32 % (TSP-16-2) with a mean of 10.50% and starch content showed a high range of variation from minimum in SGCARS-1 (8.15%) to the maximum in Sree Rethana (21.70%) with a mean of 13.54%. Low dry matter content of tubers (%) recorded in TSP-16-4 (8.88%) to and maximum observed in SGCARS-5 (28.11%) with a mean of 19.59% and dry matter of foliage showed variation from minimum in TSP-16-10 (16.01%) to maximum in Indira Nandini (69.00%) with a mean of 42.71%. The number of tubers per plant recorded minimum in IGSP-30 (1.56) and maximum in Gouri (5.44) with a mean of 3.20, tubers weight per plant showed a high range of variation from 183.33 g (IGSP-30) to 417.61 g maximum in Indira Naveen with a mean of 276.36 g. Harvest index varied from 35.09 to 73.0 per cent with a mean of 52.24 per cent observed minimum in IGSP-34 (35.09%) and maximum in Indira Madhur (73.00%) and tubers yield showed a high range of variation from 12.22 t/ha in IGSP-30 and maximum in Indira Naveen i.e. 27.84 t/ha with a mean of 18.45 t/ha.

A wide range of variations for vine length, vine weight, dry matter of foliage, tubers weight per plant, tuber yield and harvest index. A similar finding was also reported by Choudhary *et al.* 2000 for tubers weight, harvest index and the number of tubers per plant in sweet potatoes. The range of variation was narrow for vine internode length, tubers length, tubers diameter, TSS of tubers, starch and the number of tubers per plant.

High magnitude of genotypic as well as phenotypic coefficient of variation was recorded for traits *viz*., the diameter of tubers (33.66% and 37.16%), vine length (35.66% and 36.65%) vine internode length (34.20% and 35.59%), the number of tubers per plant (32.72% and 35.40%), starch content (32.81% and 34.69%), dry matter of tubers (33.96% and 34.40%), length of tubers (30.38% and 33.59%), dry matter of foliage (30.40% and 33.57%), vine weight per plant (g) (29.52% and 32.34%), tubers yield (24.10 and 28.72%) and tubers weight per plant (25.24 and 27.16) suggesting the existence of considerable variability (**Table 3)**. High genotypic coefficient variation and phenotypic coefficient variation were also reported by Hossain *et al.* (2000) for the number of tubers per plant, tubers weight, tubers yield, Anshebo *et al.* (2004) for the number of tubers per plant, tubers weight, tubers girth, tubers length, Sharma (2004) for tuber yield in sweet potato.

A high magnitude of heritability was recorded for all the characters under study *viz*., dry matter of tubers (97.45%) followed by vine length (94.69%), vine internode length (92.33%), starch content (%) (89.46%), TSS of tubers (88.06%), tuber weight per plant (86.37%), the number of tubers per plant (85.43%), vine weight per plant (83.33%), the diameter of tubers (82.05%), dry matter of foliage (81.98%), length of tubers (81.80%), harvest index (80.48%) and tuber yield (70.45%).

Genetic advance as a percentage of mean was observed high for vine length (71.48%), dry matter of tubers

Table 3. Genetic parameters of variability for tubers yield and its components in sweet potato

S. No.	Characters	Coefficient of variation		H^2 (%)	GA as % of mean
		GCV (%)	PCV (%)		
1	Vine length	35.66	36.65	94.69	71.48
2	Vine internode length	34.20	35.59	92.33	67.70
3	Vine weight per plant	29.52	32.34	83.33	55.52
4	Length of tubers	30.38	33.59	81.80	56.61
5	Diameter of tubers	33.66	37.16	82.05	62.80
6	TSS of tubers	12.81	13.65	88.06	24.76
7	Starch content	32.81	34.69	89.46	63.92
8	Dry matter of tubers	33.96	34.40	97.45	69.05
9	Dry matter of foliage	30.40	33.57	81.98	56.70
10	Number of tubers per plant	32.72	35.40	85.43	62.31
11	Tubers weight per plant	25.24	27.16	86.37	48.32
12	Harvest Index	17.07	19.02	80.48	31.54
13	Tubers yield	24.10	28.72	70.45	41.67

(69.05%), vine inter node length (67.70%), starch content (63.92%), the diameter of tubers (62.80%), the number of tubers per plant (62.31%), dry matter of foliage (56.70%), length of tuber (56.61%), vine weight per plant (56.61%), tuber weight per plant (48.32%), tuber yield, (41.67%), harvest index (31.54%) and TSS of tubers (24.76%). The moderate and low genetic advance as a percentage was not observed for any of the characters under study. The high magnitude of genetic advance for the above traits showed that these characters are governed by additive genes and selection will be rewarding for the further improvement of such traits.

Heritability estimates along with genetic advances are more useful than the heritability value alone for selecting the best individual (**Table 3)**. High heritability coupled with high genetic advance was observed for all the traits *viz.,* tubers weight per plant, the number of tubers per plant, tubers yield (Hossain *et al.,* 2000; Teshome *et al.,* 2004), Vine length, vine weight per plant (Sahu, 2003; Bhadauriya *et al.,* 2018), the diameter of tubers, length of tubers (Anshebo *et al.,* 2004), vine inter node length, dry matter of foliage (Engida *et al.,* 2006), starch content, TSS of tubers, dry matter of tubers, harvest index and tubers yield indicating that most likely the heritability is due to additive gene effects and selection may be effective. Therefore, selection based on the phenotypic performance of these traits would be effective to select desirable plant types.

The study revealed sufficient genetic variability for quantitative traits among the sweet potato genotypes, which can be exploited for varietal improvement. Therefore, a gene pool can be generated by crossing the variety of interest which can be further used as source material to develop promising varieties in sweet potato suitable for the Chhattisgrah region with higher tuber yield and early bulking.

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