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Genetic Variability, Heritability and Genetic Advance for Growth, Yield and Quality Parameters among Orange-Fleshed Sweet Potato [*Ipomoea batatas* (L.) Lam.] Genotypes

Pallavi Wani[1*], Ambresh[2] and Shantappa T.[3]
[1]M.Sc. Scholar, Department of Vegetable Science,
University of Horticultural Science, Bagalkote (Karnataka), India.
[2]Assistant Professor, Department of Vegetable Science,
University of Horticultural Science, Bagalkote (Karnataka), India.
[3]Associate Director of Research and Extension Centre,
RHREC, Dharwad (Karnataka), India.

(Corresponding author: Pallavi Wani)*
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ABSTRACT: Sweet potato (*Ipomoea batatas* (L.) Lam.) is the one of most important food crop in the world. In other countries, sweet potato is used as a staple food crop because of it's easy propagation, rich in nutrient content and high yield under varied climatic conditions. Orange fleshed sweet potato (OFSP), in particular case produces storage roots that are rich in β-carotene, a precursor of Vitamin A. Therefore, OFSP is a promising genotype to address the Vitamin A deficiency needs of women & children and to prevent malnutrition in poverty & tribal areas. The current study was undertaken to estimate the genetic variability, heritability and genetic advance for growth, yield and quality parameters among sixteen genotypes of orange fleshed sweet potato (*Ipomoea batatas* L. Lam.). In a randomized block design with three replications during *rabi* 2020-21 at Regional Horticultural Research and Extension centre (RHREC), (Kumbapur Form), Dharwad. Analysis of variance revealed that highly significant differences among the genotypes were observed for all the characters under study. The PCV was higher than GCV for all the characters. High (> 20 %) genotypic coefficient of variation (GCV) and phenotypic coefficient variation (PCV) were observed for number of leaves per vine at 60 and 120 DAP, leaf area at 60, 90 and 120 DAP, mean weight of tuber, yield of tuber per vine, yield of tuber per plot, yield of tuber per hectare. It indicates the existence of broad genetic base, which would be useful for further selection. High heritability (> 60 %) coupled with high genetic advance as per cent over mean (> 20 %) were recorded for the characters such as, vine length, number of leaves per vine, leaf area, inter- nodal length, total number of tubers per vine, girth of tuber, weight of tuber, yield of tuber per vine, yield of tuber per plot, yield of tuber per hectare, starch content, dry matter percentage and beta carotene content indicates the prevalence of additive gene action for these traits. Thus, there is ample scope for improving these characters through direct selection in crop improvement programme.

Keywords: Orange Fleshed Sweet Potato genotypes, Variability, Heritability, Genotypic coefficient, Phenotypic coefficient of variation.

INTRODUCTION

Sweet potato [*Ipomoea batatas* (L.) Lam.] belongs to family Convolvulaceae having its chromosome number 2n=6x=90. It is originated from South America. It is herbaceous perennial vine but cultivated as annual and it is vegetatively propagated by vine cuttings taken from freshly harvested vines grown in secondary nursery. Sweet potato is a cross pollinated and highly heterozygous crop resulting in large variability for crop improvement, knowledge on genetic diversity helps the breeder in choosing desirable parents for use in the breeding program. The diverse genotypes can be crossed to produce superior high yielding hybrids possessing resistance to various biotic and abiotic stresses. This family includes about 55 genera and more than 1000 species. The amount of variability that is present in the genetic material of any crop is very important for breeding of elite varieties. This is useful for selecting, identifying promising variants for developing hybrids or varieties directly or through recombinant breeding. Genetic variation for any character is a basic requirement for its improvement by use of systematic breeding activities Genetic analysis reveals the genetic nature of the inheritance of tuber yield and yield components which is required to design efficient sweet potato improvement breeding strategy. Therefore, this research was conducted with the objective to assess the extent and nature of genetic variability and heritability among the orange fleshed sweet potato genotypes (Jones *et al.,* 1986).

Studies on high heritability and genetic advance in per cent mean for growth, yield and quality traits among sweet potato [*Ipomoea batatas* (L.) Lam.] genotypes indicated that yield per plot followed by β-carotene content, non-reducing sugars, yield per plant, leaf area, length of vine, length of petiole, number of tuberous roots per plant, number of branches per plant, ash content, tuber width, internodal length, total sugars, reducing sugars, and tuber girth exhibited high value of PCV and GCV (Narasimhamurthy *et al*., 2018).

Sharavati *et al*. (2018) noted on analysis of variance shows the presence of genetic variation among yield and growth parameters. High heritability along with higher genetic advance was observed for several growth parameters such as vine length, number of leaves per vine, inter nodal length, vine girth, chlorophyll content, leaf area, tuber length, tuber girth, weight of tuber, dry weight of vine, tuber yield per vine, total tuber yield per plot and marketable yield per hectare.

Tripathi *et al*. (2016) conducted research on twenty nine genotypes of sweet potato [*Ipomoea batatas* (L.) Lam.] and observed that the higher phenotypic and genotypic coefficients of variation were recorded for a traits such as leaf area followed by yield per plant and leaves per vine. They also said that high heritability along with high genetic advance were estimates for leaf area (98 % and 68 %) followed by dry matter (97 % and 22.64 %) and yield per plant (78 % and 35 %).

An experiment was conducted on genetic variability in twenty four potato genotypes in order to find out the genetic variability. The phenotypic (PCV) and genotypic (GCV) coefficient of variation computed ranged from 0.90 to 46.43 per cent and 0.75 to 40.0 per cent respectively. Shoot dry mass weight, average number of tubers, average tuber weight, unmarketable tuber yield, small size tuber and large size tubers exhibited high value of phenotypic and genotypic coefficients of variation along with high heritability (Seid *et al*., 2020).

Mekonnen *et al*. (2021) conducted an experiment to determine the variability for yield and yield related traits in twenty four orange fleshed sweet potato [*Ipomoea batatas* (L.) Lam.] genotypes. High heritability along with high genetic advances as a percent of mean were observed for marketable root yield, skin color of root, beta carotene content of tuber, harvest index, vine length, vine inter-node length and above ground fresh weight. And these several characters are governed by additive gene action and for such traits selection would be feasible.

MATERIALS AND METHODS

The experiment was conducted from September, 2020 to March, 2021 at Regional Horticultural Research and Extension Centre (RHREC), Kumbapur, Dharwad. The site is located in the agro climatic zone-8 (Northern Transition Zone) of Karnataka state. Dharwad is geographically located at 15°26′ North latitude, 76°27′ East longitude and at an altitude of 678 m above mean sea level. The soil was a medium sandy loam. Well matured healthy and disease-free cuttings of sixteen genotypes of sweet potatoes were collected from AICRP on Tuber crops, Dharwad, UHS, Bagalkote have been taken for investigation. The research experiment was laid out in a randomized complete block design (RCBD) with three replications. The treatments in each replication were allotted randomly by using random number table. Sweet potato cuttings which have 2-3 buds were planted in each replication at 60 cm × 20 cm spacing within the 3 m × 3 m plot size. All other recommended cultural practices and irrigation were applies as per needed. Plots were kept free from weeds by regular hand weeding. Five plants of each genotype from each replication were used for observations.

Statistical analysis. Analysis of variance was carried out as per the procedure given by Panse and Sukhatme (1957). Phenotypic and genotypic coefficients of variation were computed according to Burton and Devane (1953). Heritability in broad sense was estimated as per Weber and Moorthy (1952). Genetic advance was estimated as per the formula proposed by Johnson *et al.* (1955). The range of genetic advance as per cent of mean was classified as low (< 10 %), moderate (10–20 %) and high (> 20%) as recommended by Johnson *et al.* (1955).

RESULTS AND DISCUSSION

Analysis of Variance. The analysis of variance for different quantitative and qualitative characters among sixteen genotypes of orange fleshed sweet potato genotypes was represented in Table 2 and 3. The analysis of variance indicated significantly higher amount of variability among the genotypes for all the characters studied *viz*., vine length, number of branches per vine, number of leaves per vine, inter nodal length, leaf area, number of tuber per vine, tuber length, tuber girth, tuber weight, total tuber yield per vine, total tuber yield per plot, total yield per hectare, starch content, beta-carotene, and dry matter content indicates the presence of sufficient amount of variability in all the characters under study. These findings are in line with earlier reports of Sharavati *et al*. (2018), Narasimhamurthy *et al*. (2018) in orange fleshed sweet potato and Gehan *et al*. (2019); Seid *et al*. (2020); Mekonnen *et al*. (2021).

Phenotypic and genotypic coefficient of variation (PCV and GCV). Higher magnitude of PCV and GCV (> 20 %) were observed in the present investigation. High (> 20 %) magnitude of GCV and PCV were observed for leaf area and number of leaves per vine both at 60 DAP, 90 DAP and 120 DAP respectively and mean weight of tuber, tuber yield per vine, tuber yield per plot, total tuber yield per hectare. Indicating wider range of variability exhibited in these traits. Similar results were also obtained by Badu *et al.* (2017) for leaf area in orange fleshed sweet potato. Singh *et al.* (2015) for number of leaves per vine in sweet potato Prarthana *et al*. (2015); Tripura *et al*. (2016); Panigrahi *et al*. (2017); Sharavati *et al*. (2018). It indicates the presence of high variability in the genotypes for selection. The differences between PCV and GCV values were minimum for most of the traits studied and indicating that, traits under study were less influenced by environment. Hence, these characters can be relied upon and selection can be practiced for further improvement.

The moderate phenotypic and genotypic coefficient of variations recorded for other growth parameters like vine length, number of leaves per vine and internodal length at 60 DAP, 90 DAP and 120 DAP respectively, it indicates that the apparent variation is not only due to genotypes but also due to little influence of environment on the expression of character. Similar opinion was expressed by other researchers like Rangare and Rangare (2013); Singh *et al.* (2015); Darshan *et al*. (2017); Sharavati *et al*. (2018); Gehan *et al*. (2019).

Heritability. High heritability (> 60 %) coupled with high genetic advance (> 20 %) as per cent of mean were recorded for growth parameters such as vine length at 60 and 90 DAP, leaf area, number of leaves and intermodal length at 60, 90 and 120 DAP respectively, total number of tubers per vine, length of tuber, girth of tuber, mean weight of tuber, yield of tuber per vine, yield of tuber per plot, total yield of tuber per hectare. These results suggested that the inheritance of such traits governed mainly by additive gene effects hence selection based on phenotypic performance may performed useful. As high heritability accompanied with high genetic advance as per cent mean indicates the prevalence of additive gene action, selection would be most effective. Similar results were noticed in earlier studies by Prarthana *et al*. (2015) for vine length, inter-nodal length, number of leaves and leaf area index in sweet potato, Badu *et al.* (2017) for vine length, number of leaves, intermodal length Ramachandra and Srinivasa (2017), for leaf area in sweet potato. For vine length, number of leaves, inter-nodal length results were similar to Sharavati *et al.* (2018) in sweet potato. Narasimhamurthy *et al*. (2018) for vine length and leaf area in orange fleshed sweet potato. Thus, there is an ample scope for improving these characters by direct selection. Similar results were also reported by Madawal *et al*. (2015); Badu *et al.* (2017); Nasiruddin *et al*. (2017); Ramachandra and Srinivasa (2017); Sharavati *et al*. (2018) for traits such as number of tubers per vine, length of tuber, girth of tuber, mean weight of tuber, yield of tuber per vine, yield of tuber per plot, yield of tuber per hectare in sweet potato. For tuber yield per vine, tuber yield per plot, results were similar to Tripathi *et al.* (2016); Narasimhamurthy *et al*. (2018). The research findings of Gehan *et al.* (2019); Prajapati *et al.* (2020); Seid *et al*. (2020) was similar for number of tubers per plant.

Table 1: Analysis of variance (mean sum of squares) for growth parameters in orange fleshed sweet potato genotypes.

Sr. No.	Source of variation/characters	Replication	Genotypes	Error	S.Em±	CD @ 5%
	Degrees of freedom	2	15	30		
A	Growth parameters					
1.	Vine length (cm) at 60 DAP	255.87	1096.36*	172.13	7.57	21.87
2.	Vine length (cm) at 90 DAP	282.80	1574.51*	203.94	8.24	23.81
3.	Vine length (cm) at 120 DAP	423.52	1229.40*	366.06	11.04	31.9
4.	Leaf area (cm^2) at 60 DAP	367262.09	2947601.11*	111174.23	192.50	555.99
5.	Leaf area (cm^2) at 90 DAP	28821.18	34626000.04*	165514.82	234.88	678.39
6.	Leaf area (cm^2) at 120 DAP	619507.00	7019614.08*	237667.58	281.46	812.92
7.	Inter nodal length (cm) at 60 DAP	0.37	0.94*	0.11	0.19	0.56
8.	Inter nodal length (cm) at 90 DAP	0.25	0.91*	0.08	0.17	0.49
9.	Inter nodal length (cm) at 120 DAP	0.20	0.86*	0.09	0.18	0.52
10.	Number of leaves per vine at 60 DAP	216.74	2678.75*	153.29	7.14	20.64
11.	Number of leaves per vine at 90 DAP	233.16	2463.16*	315.40	10.25	29.61
12.	Number of leaves per vine at 120 DAP	324.01	7002.10*	495.26	12.84	37.10
13.	Number of branches per vine at 90 DAP	0.19	0.43*	0.07	0.15	0.46
14.	Number of branches per vine at 120 DAP	0.55	0.93*	0.17	0.24	0.69

***** Significant @ 5 % DAP: Days after planting

Table 2: Analysis of variance (mean sum of squares) for yield and quality parameters in orange fleshed sweet potato genotypes.

Sr. No.	Source of variation/ characters	Replication	Genotypes	Error	S.Em±	CD @ 5%
	Degrees of freedom	**2**	**15**	**30**		
B	**Yield parameters**					
1.	Number of tubers per vine	0.19	0.99*	0.06	0.15	0.43
2.	Tuber length (cm)	4.00	4.98*	1.30	0.65	1.90
3.	Tuber girth (cm)	0.89	19.52*	2.204	0.85	2.47
4.	Mean weight of tuber (g)	702.42	17151.27*	282.86	9.71	28.04
5.	Tuber yield per vine (kg)	9319.50	176725.19*	3612.13	34.69	100.21
6.	Tuber yield per plot (kg/plot)	6.72	120.50*	2.89	0.98	2.83
7.	Tuber yield per hectare (t/ha)	8.30	148.77*	3.57	1.09	3.15
C	**Quality parameters**					
8.	Starch content (%)	0.84	32.83*	0.27	0.30	0.87
9.	Dry matter content (%)	0.18	27.99*	0.29	0.31	0.90
10.	Beta-carotene (mg/100g)	0.10	21.20*	0.04	0.12	0.37

* Significant @ 5 %

Table 3: Estimates of range, mean, components of variance, heritability and genetic advance for growth attributes in orange fleshed sweet potato genotypes.

Sr. No.	Character	Range	Mean	GV	PV	GCV (%)	PCV (%)	h^2 (%)	GA	GAM %
A	**Growth parameter**									
1.	Vine length (cm) 60 DAP	96.33-178.20	132.16	303.03	361.63	13.14	14.36	83.80	32.82	24.79
2.	Vine length (cm) 90 DAP	130.46-218.93	172.12	471.78	546.02	12.60	13.56	86.40	41.59	24.14
3.	Vine length (cm) 120 DAP	175.06-252.46	201.23	278.81	411.08	7.95	9.66	67.82	28.32	13.50
4.	Number of leaves per vine 60 DAP	69.73-175.60	122.05	841.81	892.91	23.77	24.48	94.28	58.03	47.54
5.	Number of leaves per vine 90 DAP	101.13-210.53	161.37	715.92	821.05	16.58	17.75	87.20	51.46	31.89
6.	Number of leaves per vine 120 DAP	134.93-307.40	210.19	2168.94	2334.03	22.15	22.98	92.93	92.48	43.99
7.	Leaf area (cm^2) 60 DAP	2098.54-5510.95	3509.09	945475.62	982533.70	27.70	28.24	96.23	1964.91	55.99
8.	Leaf area (cm^2) 90DAP	3338.3-6838.83	4718.17	1099028.40	1154200.01	22.21	22.77	95.22	2107.34	44.66
9.	Leaf area (cm^2) 120 DAP	4208.17-9852.56	6023.11	2260648.83	2339871.36	24.96	25.39	96.61	3044.41	50.54
10.	Number of branches per vine 90 DAP	3.20-4.66	3.82	0.1202	0.14	9.06	9.97	82.47	0.64	16.95
11.	Number of branches per vine 120 DAP	4.83-6.60	5.51	0.2516	0.31	9.09	10.10	81.09	0.93	16.87
12.	Inter nodal length (cm) 60 DAP	2.55-4.25	3.35	0.27	0.31	15.70	16.73	88.01	1.01	30.34
13.	Inter nodal length (cm) 90 DAP	2.69-4.37	3.63	0.27	0.30	14.47	15.21	90.53	1.03	28.36
14.	Inter nodal length (cm) 120 DAP	2.79-4.70	4.00	0.25	0.28	12.61	13.40	88.59	0.97	24.46

GV- Genotypic variance; **PCV**- Phenotypic co-efficient of variation; **GAM**- Genetic advance as percent over mean
PV - Phenotypic variance; **GCV**- Genotypic co- efficient of variation; **GA**- Genetic advance; **DAP**- Days after planting

Table 4: Estimates of range, mean, components of variance, heritability and genetic advance for yield attributes in orange fleshed sweet potato genotypes.

Sr. No.	Character	Range	Mean	GV	PV	GCV (%)	PCV (%)	h^2 (%)	GA	GAM %
B	**Yield parameter**									
1.	Number of tubers per vine	2.73-4.60	3.23	0.30	0.33	17.80	17.80	93.02	1.10	34.12
2.	Tuber length (cm)	10.94-15.60	12.49	1.22	1.66	8.86	10.31	73.87	1.96	15.69
3.	Tuber girth (cm)	12.54-21.26	16.39	5.77	6.50	14.65	15.55	88.71	4.66	28.43
4.	Mean weight of tuber (g)	106.19-315.27	176.11	5622.80	5717.09	42.57	42.93	98.35	153.19	86.98
5.	Tuber yield per vine (kg)	205-1027.86	536.73	57704.35	58908.39	44.75	45.21	97.96	489.76	91.24
6.	Tuber yield per plot (kg/plot)	10.11-33.64	17.74	39.20	40.16	35.28	35.71	97.60	12.74	71.80
7.	Tuber yield per hectare (t/ha)	11.24-37.38	19.71	48.39	49.59	35.28	35.71	97.60	14.15	71.80

GV- Genotypic variance
PV - Phenotypic variance
GA-Genetic advance
PCV- Phenotypic co-efficient of variation
GCV- Genotypic co- efficient of variation
GAM-Genetic advance as percent mean

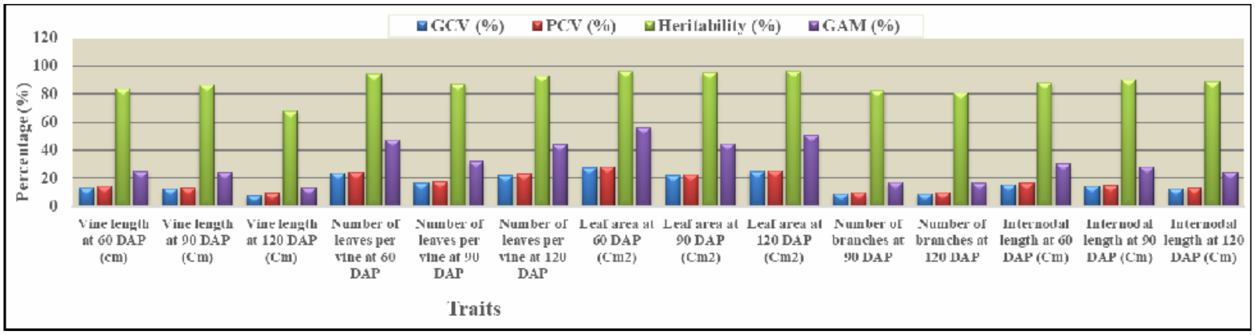

Fig. 1. GCV, PCV, heritability and GAM for growth parameters in orange fleshed Sweet potato genotypes.

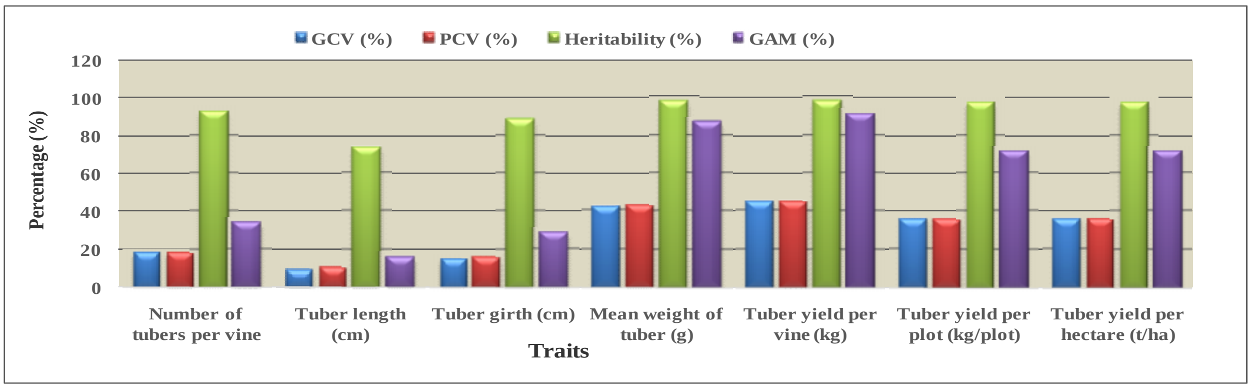

Fig. 2. GCV, PCV, heritability and GAM for yield attributing characters in orange fleshed Sweet potato genotypes.

Plate 1. Variability for tuber characters in sweet potato.

Plate 2. Variability for tuber characters in sweet potato.

CONCLUSIONS

In conclusion, analysis of variance showed the presence of highly significant differences among the tested genotypes for the characters considered which indicates the existence of notable genetic variability among the genotypes for all the characters studied *viz*., vine length, number of branches per vine, number of leaves per vine, inter nodal length, leaf area, number of tuber per vine, tuber length, tuber girth, tuber weight, total tuber yield per vine, total tuber yield per plot, total yield per hectare, starch content, beta-carotene, and dry matter content indicates the presence of sufficient amount of variability in all the characters under study.

FUTURE SCOPE

— Wide range of variability was present for all the characters studied. Hence, attention needs to be given for these traits during selection for improvement of tuber yield.

— The genotypes included under the investigations may be evaluated at different agro-climatic zones of Karnataka to identify the most suitable genotype showing stability in performance for desirable characters.

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Conflict of Interest. None.

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