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Genetic Variability Studies in F_1 Seedlings of Cassava (*Manihot esculenta* Crantz) based on Morphological Traits

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A B S T R A C T

Genetic improvement of cassava (*Manihot esculenta* Crantz) is to a certain extent limited by a poor knowledge of genetic variability. Estimation of variability is highly important and is always considered as the first step in any crop improvement programme. With this in view, the current study was planned to assess the variability in F_1 seedlings of crosses made between eight cassava genotypes in Line x Tester method. Analysis of variance revealed significant difference for all the agronomic traits studied. Majority of the characters like Plant Height(cm), Stem Girth(cm), Root Length(cm), Number of Roots, Girth Of Tuber(cm), exhibit moderate PCV, GCV values and Number of Tubers exhibits higher GCV and PCV values indicating greater variation for these traits and thus there is greater scope for further improvement by genetic manipulation. All the characters exhibited high broad sense heritability. High heritability coupled with high genetic advance as percent of mean for the characters suggesting that they can be improved through direct selection due to predominant additive variation. The estimation of descriptive statistics of different morphological traits studied in the present investigation revealed the existence of a high level of morphological variability among them, providing scope for improvement through hybridization and selection and need to constitute a pool of germplasm with adequate variability.

Introduction

Cassava (*Manihot esculenta* Crantz) is a perennial woody shrub with an edible root, which grows in tropical and subtropical areas of the world. Cassava originated from tropical America and was first introduced into Africa in the Congo basin by the Portuguese around 1558. Today, it is a dietary staple in much of tropical. It is rich in carbohydrates, calcium, vitamins B and C, and essential minerals. However, nutrient composition differs according to variety and age of the harvested crop, and soil conditions, climate, and other environmental factors during cultivation. The average yield of cassava worldwide is only 12– 13 tons/ha, but its potential yield under optimal conditions is almost seven times larger (80 tons/ha; FAO, 2013). According to FAO statistics (FAOSTAT, 2015), cassava world production raised to >263 million tons in 2013, a 27% increase in production during the last 10 years.

The potential for genetic improvement through creation of diversity within cultivars

of cassava has been demonstrated and considerable advances have been made in increasing its yield potential for different purposes (Akinwale *et al*., 2010). Selection for desirable traits is required to enhance cassava breeding (Asante and Dixon, 2006). However, the conventional means of breeding cassava which involves several field testing stages of large number of accessions is laborious, repetitive and takes a long time to achieve the expected results. A knowledge of which cultivars farmers prefer can facilitate the targeting of the breeding program for greater impact (Witcombe *et al.,* 2006). This involves for breeding strategy of using as one parent of a cross locally adapted cultivar that is also adopted on a wide scale. If this strategy is used properly, fewer crosses are needed (Witcombe and Virk, 2001). Such few but "smart or clever" crosses, involving carefully selected parents is an established concept used in many breeding programs to express greater genetic diversity and variability (Gyawali *et al*., 2002; Singh *et al*., 2001; Virk *et al*., 2003).

Materials and Methods

The experiment was conducted during2015-16 in ICAR- Central Tuber Crops Research Institute (CTCRI), Sreekariyam, Thiruvananthapuram, (8° 29 N, 76°57 E, 64 m altitude), Kerala, India. The soil of the research site is a well-drained acid Ultisol with pH 4.35.The field preparation was done as per the normal recommendations by proper weeding and providing irrigation facilities. Five high yielding varieties (lines)*viz.*, Sree Jaya, Sree Vijaya, VellayaniHraswa, CI 889 and 9S 75 and three varieties (testers) CR 54A3, IMS2-5 and CI 273 with resistance to cassava mosaic disease were selected and planted in a pollination block and crossed to produce fifteen F_1 combinations in Line x Tester method. The F_1 seeds were collected from the dried fruits of all the 15 cross combination. Seeds were sown in replication in poly bags and seedlings were maintained in nursery till the seedlings reach four leaf stage (40-45 days) and care has been taken with providing proper watering at timely interval. All the agronomic traits were recorded just before transplanting to the main field in all the F_1 seedlings produced out of seeds sown to raise the F_1 s to study the genetic variability with other traits.

Results and Discussion

The mean performances and other genetic parameters like phenotypic and genotypic co-efficient of variability (PCV and GCV), heritability (h^2), genetic advance (GA) and genetic advance as percent of mean (GAM) for the eight quantitative characters are presented in table 1. Mean performance of various genotypes for the eight characters under study indicated that wide range of variability was present among the genotypes. Significant differences were observed among all the genotypes for all the characters studied through analysis of variance. This indicated the presence of sufficient variability in the genetic material under study and it was good enough to carry out further analysis.

The character plant height was ranged from 19.7 to 30.9 cm with a grand mean value of 26.1 cm. The grand mean value of stem girth is 1.9 cm ranging from 1.46 to 2.4 cm. Number of leaves, from 8.78 to 12.00 with a mean value of 10.1. The mean root length is found as 12.1 cm with minimum and maximum values of 8.32 cm to 17.10 cm. Number of roots ranged from 6.33 to 11.8 with a mean value of 9.00.Number of tubers per plant was ranged from 0.08 to 0.4, with a mean value of 0.2, girth of the tuber ranged from 0.02 to 0.6 cm with a mean of 0.2 cm. The plant vigour scored to a mean of 3.7 with range values of 3.18 to 4.27.

The genetic variance and phenotypic variance of number of leaves and number of tubers are 10.85 and 13.10 respectively. In general, higher phenotypic co-efficient of variability values than that of genotypic co-efficient of variability values indicates the influence of environment on traits. But, smaller differences between PCV and GCV values are observed for all the characters under study, as they are less influenced by the environment indicating reliability of selection based on these traits. The character girth of tubers exhibits higher GCV and PCV (94.8% and 95.8%) values indicating that a greater amount of genetic variability is present, for this characters which provide greater scope for selection.

Table.1 Genetic variability components for different selected traits

Sl No.	Characters		Range		GV	PV	GCV	PCV	h^2	GA	GAM
		Mean	Min	Max			(%)	(%)	(%)		
1	Plant Height(cm)	26.1	30.9	19.7	1.71	30.52	5.0	21.2	5.6	0.6	2.5
2	Stem Girth(cm)	1.9	1.46	2.4	0.02	0.17	8.1	22.1	13.4	0.1	6.1
3	Number Of Leaves	10.1	8.78	12.0	10.85	13.10	15.3	17.6	19.8	22.1	24.3
4	Root Length(cm)	12.1	8.32	17.1	4.37	10.38	17.2	26.5	42.1	2.8	23.0
5	Number of Roots	9.0	6.33	11.8	1.33	5.22	12.7	25.3	25.4	1.2	13.2
6	Number of Tubers	0.2	0.08	0.4	10.85	13.10	14.9	19.5	82.8	6.2	21.2
7	Girth Of Tuber(cm)	0.2	0.02	0.6	0.04	0.04	94.8	95.8	88.4	0.4	83.7
8	Plant Vigour (1-5 Score)	3.7	3.18	4.27	0.10	0.43	8.6	17.5	23.9	0.3	8.6

GV = genetic variance; PV = phenotypic variance; GCV = genotypic coefficient of variance; PCV = phenotypic coefficient of variance; h^2 = broad sense heritability;
GAM is genetic advance as a % of mean.

Traits like plant height (5.0%, 21.2%), stem girth (8.1%, 22.1%), number of leaves (15.3%, 17.6%), root length(17.2%, 26.5%), number of roots (12.7%, 25.3%), number of tubers(14.9%, 19.5%), plant vigour (8.6%, 17.5%) exhibit moderate PCV, GCV values indicating that a moderate level of genetic variability is present in these characters. Girth of tuber has high PCV and GCV (94.8%, 95.8%) values indicating greater scope for improvement through this trail. This supports previous observations by Aina (2007), and Akinyale and Odiyi (2007) that the extent of environmental influence on any character is indicated by the magnitude of the difference between the phenotypic coefficient of variation and genotypic coefficient of variation values.

All the characters exhibited high broad sense heritability values viz., plant height (5.6%), stem girth (13.4%), number of leaves (19.8%), root length (42.1%), number of roots (25.4%), plant vigour (23.9%). Number of tubers (82.8%) and girth of tubers (88.4%) suggesting that the selection based on phenotypic performance of these traits would be more effective. the views of others such as Singh *et al*., (2001), Gyawali *et al*., (2002) and Virk *et al*., (2003) that the diversity used can constitute a gene pool with adequate

variability to provide suitable characters for cassava improvement. High genetic advance as percent of mean (GAM) is observed for the character, girth of tuber(83.7%). Plant height (2.5%), stem girth (6.1%) and plant vigour (8.6%) exhibit lower level and number of leaves (24.3%), root length (23.0%), number of roots (13.2%), and number of tubers (21.2%) exhibit moderate level of GAM.

High heritability coupled with high genetic advance as per cent of mean is observed for the characters like number of tubers and girth of tubers per plant indicating that these traits are under the strong influence of additive gene action and hence simple selection based on phenotypic performance of these traits would be more effective, Balashanmugam *et al*., (1980) reported that the tuber girth could be one of the most reliable indices for plant selection in cassava. High heritability and moderate GAM values is observed for the character root length indicating the influence of non-additive gene action and considerable influence of environment on the expression of these traits. This trait could be exploited through manifestation of dominance and epistatic components through heterosis studies for the upliftment of crop improvement.

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