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Genetic Variation in Different Cultivars of Greater Yam (*Dioscorea alata*)

S. Alam, Euphemia Shylla, P. Bora and B.K. Saud

AICRP on Tuber Crops, Department of Horticulture, Assam Agricultural University,
Jorhat 785 013, Assam, India
Corresponding author: S. Alam, e-mail: salam5678@gmail.com
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Abstract

Assessment of 27 accessions of greater yam (*Dioscorea alata* L.), collected throughout north east India, was carried out during 2009-2010 at the Experimental Farm, Department of Horticulture, Assam Agricultural University. Observations were recorded for different morphological characters following International Plant Genetic Resources Institute's (IPGRI) descriptors for yam. Phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the characters indicating the influence of environment. High heritability (>90%) coupled with high genetic advance (>50%) was exhibited by total phenol, internode length, petiole length and days to emergence.

Key words: Greater yam, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), environmental coefficient of variation (ECV), heritability in broad sense (h^2_{bs}) expected genetic advance (GA)

Introduction

In north eastern parts of India, considerable variation exists in greater yam (*Dioscorea alata* L.) genotypes, which has not been properly evaluated. It is essential to have data on the extent and pattern of genetic variability present in a population of a given crop for future crop improvement programmes. Moreover, the success of any crop improvement program depends to a large extent on the amount of genetic variability present in the population. Characters contributing largely to the intra and inter-specific variability in greater yam are related to the shape, size, flesh colour of underground tubers, shape and colour of aerial tubers, position, shape, size and vein colour of the leaves, petiole colour, shoot growth rate, number of days for tubers to germinate, tuber quality parameters and cooking quality of tubers. Overall variability is required to be partitioned into heritable and non-heritable components for the estimation of genetic parameters such as genotypic and phenotypic coefficients of variation and heritability (Ariyo, 1987). Determination of genetic components will be helpful to the breeders in selecting suitable genotypes based on the simultaneous selection of two or more characters (Jain et al., 1988). The present study, therefore, was undertaken to evaluate the genetic diversity in greater yam.

Materials and Methods

The experiment was conducted under the agro-climatic condition of Jorhat, Assam in the Experimental Farm of the Department of Horticulture, Assam Agricultural University, Jorhat during 2009-2010. The materials for the present investigation comprised 27 cultivars of *Dioscorea alata* (L.) collected from different parts of north eastern regions of the country. The list of the materials and the sources from which they were collected are given in Table 1. Letter keys such as CV1, CV2, CV3 etc. were used to designate the respective cultivars as follows.

Table1. List of cultivars

Materials	Source	Materials	Source	Materials	Source
CV1	Assam	CV11	Assam	CV21	Nagaland
CV2	Arunachal Pradesh	CV12	Assam	CV22	Assam
CV3	Assam	CV13	Assam	CV23	Mizoram
CV4	Meghalaya	CV14	Assam	CV24	Manipur
CV5	Manipur	CV15	Assam	CV25	Assam
CV6	Mizoram	CV16	Assam	CV26	Mizoram
CV7	Assam	CV17	Assam	CV27	Tripura
CV8	Meghalaya	CV18	Assam		
CV9	Arunachal Pradesh	CV19	Assam		
CV10	Assam	CV20	Assam		

The field experiment was laid out in randomized block design (RBD) in two replications. The plot size was 3.6 m x 1.2 m with a spacing of 120 cm x 120 cm. Yam setts or cut pieces weighing 200-250 g each were planted in pits of size 45 cm x 45 cm x 60 cm. The collections were characterized and evaluated using plant descriptor published by IPGRI (International Plant Genetic Resource Institute, 1997). Starch, ash, ascorbic acid, total sugar, moisture, dry matter and total phenol were determined by the standard procedures.

Genetic variance (σ^2_g), phenotypic variance (σ^2_p), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV) and environmental coefficient of variation (ECV), were computed according to Burton and Devane (1953). Heritability in broad sense (h^2_{bs}) was calculated by the formula given by Hanson et al. (1956). Expected genetic advance (GA) of each character was calculated as described by Johnson et al. (1955).

Results and Discussion

The estimates of components of variance and related genetic parameters for growth and development characters are presented in Table 2 and those for biochemical and cooking time are presented in Table 3. The analysis of variance indicated significant difference for all the traits under study. A wide range of variability and coefficient of variation in this crop had also been observed for yield and its components by Lakshmi and Amma (1980).

The present study revealed high genotypic variances for vine length and tuber length indicating the presence of sufficient genetic variation in the material for these characters. However, the phenotypic variances for these characters were comparatively higher. These results are in partial agreement with those of Akoroda (1984) who reported high values of variance for leaf size and yield per plant in yellow yam. However, the genotypic and phenotypic variances do not give precise information but only gives an apparent idea about the genetic variability for the characters.

The estimates of genotypic and phenotypic coefficients of variation provide a better comparison of the characters for genetic variation. Among the characters considered in the present investigation, PCV was found to be higher than GCV indicating the influence of environment distinctly in the case of vine length and number of leaves for the expression of these characters which were partly supported by Lakshmi and Amma (1980) in greater yam, who observed high values of phenotypic coefficient of variation in the number of shoots, internode length and number of leaves which suggested that simple selection might not be effective for this trait. Kamalam et al. (1977) reported that in sweet potato, phenotypic coefficient of variation was higher than genotypic coefficient of variation for number of tubers. Nwankwo and Bassey (2013) also observed that in white guinea yam (*Dioscorea rotundata* Poir.) phenotypic coefficients of variation was higher than the genotypic coefficient of variation for petiole length, number of tubers, mean tuber weight and yield. Relatively high values of genotypic coefficient of variation were recorded for total phenol (66.27), total sugar (29.02), tuber length (28.93), tuber width (28.65), internode length (27.76) and petiole length (27.54). However, the reports available regarding the estimates of coefficient of variation are quite

Table 2. Estimates of components of variance and related genetic parameters for growth and development

Characters	Genetic parameters						
	σ^2_g	σ^2_p	GCV	PCV	ECV	$h^2_{(bs)}$	Exp. GA
Days to emergence(DAE)	24.84	25.50	24.66	24.99	4.03	97.4	50.14
*Vine length	332.27	959.93	13.76	23.39	18.92	34.61	16.68
Internode number	19.16	26.81	21.62	25.57	13.66	71.48	37.66
*Plant height	0.48	0.68	8.44	10.06	5.47	70.36	14.58
Internode length	25.23	25.63	27.76	27.97	3.47	98.46	56.75
First leaf emergence	24.34	24.68	20.97	21.12	2.49	98.6	42.91
Number of leaves (30 DAE)	23.16	49.35	22.32	32.57	23.72	46.94	31.49
Leaf length	6.14	14.58	11.74	18.10	13.77	42.13	15.70
Leaf width	2.68	3.22	11.62	12.72	5.16	83.51	21.88
Petiole length	6.96	7.40	27.54	28.41	6.97	93.98	55.00
Tuber length	124.76	143.74	28.93	31.06	11.28	86.80	55.52
Tuber width	34.02	45.46	28.65	33.12	16.61	74.85	51.06
Total weight of tubers	1.38	2.48	21.51	28.84	19.22	55.61	33.04
Yield of underground tuber/plant	66.50	119.58	21.51	28.85	19.21	55.61	33.04

*Vine length : Assessed at 20 days after emergence by taking the mean of three plants from both the replications.
*Plant height: Main stem height was measured in m from the base of the plant to the tip of the main climber with the help of measuring tape. The observations were recorded at the maturity stage.

Table 3. Estimates of components of variance and related genetic parameters for biochemical and cooking time

Characters	Genetic parameters						
	σ^2_g	σ^2_p	GCV	PCV	ECV	$h^2_{(bs)}$	Exp. GA
Starch content	27.64	27.81	7.85	7.87	0.61	99.4	16.12
Ash content	0.22	0.28	13.22	15.03	7.14	77.44	23.98
Ascorbic acid	1.21	1.21	13.18	13.47	2.76	95.8	26.59
Total sugar	4.18	4.46	29.02	30.00	7.60	93.58	57.83
Moisture	7.78	12.20	3.94	4.93	2.96	63.82	6.48
Dry matter	8.28	12.55	9.88	12.16	7.09	66	16.53
Total phenol	1.17	1.21	66.27	67.39	12.25	96.69	134.24
Cooking time to softness	19.84	27.16	21.18	24.78	12.86	73.06	37.30

contradictory. Lakshmi and Amma (1980) recorded the lowest value for both phenotypic and genotypic coefficients of variation in internode length of *Dioscorea alata*. Kamalam et al. (1977) also reported high degree of GCV for length of vine and number of shoots (>30%) in sweet potato. Comparatively higher degree of phenotypic and genotypic coefficients of variation displayed by total phenol, total sugar, internode length, petiole length, tuber length, tuber width, days to emergence, internode number, tuber weight and tuber yield offer better scope for selection in crop improvement programmes for these traits.

A fairly reliable idea of the relative amount of heritable variation in the population for a particular character can be obtained from the heritability estimates for the character concerned. In the present investigation, high estimates of heritability were observed for starch content (99.4), first leaf emergence (98.6), internode length (98.46), days to emergence (97.4), total phenols (96.6), ascorbic acid (95.8), petiole length (93.9) and total sugar (93.58), suggesting that selection should be effective for these characters as high heritability implies low influence of the environment. However, comparatively lower estimates of heritability were recorded for vine length

(34.61), leaf length (42.13) and number of leaves (46.94). Rishi et al. (1984) reported high estimates of heritability (over 50%) for leaf area and tuber yield per plant in *Dioscorea deltoidea*. Rai et al. (1986) also observed that tuber weight per plant was highly heritable. Other reports available regarding the estimates of heritability are quite contradictory. Lin (1983) reported high heritability (>65%) for yield. Akoroda (1984) observed high heritability (50%) for plant leafiness and number of tubers per hill in *Dioscorea cayensis*. Moreover, Saladaga and Hernandez (1981) reported that overall heritability estimates for yield was low (0.241). The contradiction in the results may be attributed to the difference in the materials used and different locations and environmental conditions in which the experiments were conducted. Since heritability is the proportion of the total variability that is ascribable to the genotype, it gives only an idea of the relative amount of the heritable variation to the total variation. Thus based on heritability estimates alone, no precise conclusions can be made.

Burton (1952) suggested that the genotypic coefficient of variation along with heritability in the broad sense was perhaps a better index of the extent of advance that can be expected from a given selection scheme. In the present study, very high heritability (>90%) was associated with high genotypic coefficient of variation (>50 %) for total phenol, total sugar, internode length, petiole length and days to emergence. Moderate estimates of heritability with genotypic coefficient of variation were recorded for internode number, tuber width, tuber weight and yield.

For reliable selection, high heritability of a character needs to be accompanied by high genetic advance (Johnson et al., 1955) because such characters are mostly controlled by additive gene action. In the present investigation very high heritability was found to be associated with high genetic advance for total phenol (96.69 and 134.24%), total sugar (93.58 and 57.83%), internode length (98.46 and 56.75%), petiole length (93.98 and 55%) and days to emergence (97.40 and 50.14%), suggesting predominance of additive genetic variance for these characters. High heritability (86.80) with high genetic advance (55.52) was recorded for tuber length whereas very high heritability (98.6) with moderate genetic advance (42.91) was recorded for first leaf emergence. Lakshmi and Amma (1980) reported high heritability (over 50%) combined with high genetic gains (over 30%) for number of branches, length of vine and tuber yield. Akoroda (1984) also reported that high estimates of heritability and genetic advance (over 50%) for plant leafiness in *Dioscorea cayensis*. These characters with high heritability coupled with high genetic advance can be subjected to phenotypic selection without progeny testing, thereby accumulating desirable additive genes.

Conclusion

Phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the characters indicating the influence of the environment. In the assessment of variability for both morphological and biochemical traits, high heritability coupled with high genetic advance was shown by total phenol (96.69 and 134.24%), total sugar (93.58 and 57.83%), internode length (98.46 and 56.75%), petiole length (93.98 and 55%) and days to emergence (97.40 and 50.14%) suggesting the predominance of additive genes. These characters can be subjected to phenotypic selection without progeny testing, thereby accumulating desirable additive genes rendering good scope for genetic improvement in the crop.

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