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To study in genetic variability and genetic divergence using non-hierarchical D^2 analysis in taro (*Colocasia esculenta* L. var. Antiquorum)

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Abstract
The variability, heritability and genetic advance for quantitative characters, estimate of correlation coefficients among the important economic traits and to find out the direct and indirect effect of yield components on yield by path coefficient analysis and genetic divergence. Experimental materials for the study consisted 27 genotypes including two checks (NDC-1, NDC-2). The experiment was conducted in Randomized Block Design with three replications. Recommended cultural practices including spacing for planting were adopted for healthy crop. Observations were recorded on sixteen quantitative characters *viz.*, days taken for sprouting, length of leaf (cm), width of leaf (cm), height of plant (cm), girth of plant (cm), petiole length (cm), number of cormels per plant, weight of cormels per plant (gm), length of corms (cm), girth of corms (cm), weight of corms per plant (gm), size of corm (cm^2), yield per plant (gm), yield tonne per hectare, calcium oxalate content (mg), dry matter (%).higher genetic advance in percent of mean were recorded for yield per plant, weight of cormels per plant, petiole length, plant height. While, it was observed lower in girth of plant, girth of corm and length of corm indicates possibility of obtaining higher selection response for improvement in respect of these trait. The genotype NDC-86, NDC-26, NDC-18, NDC-6 and NDC-5 found best for yield over the check (NDC-2) in this experiment and may be exploit as a new variety of taro.

Keywords: Taro, variability, yield

Introduction

Tuber crops, the third most important food crop constitute staple and or important subsidiary food for about a fifth of people of the world considering the adaptability and suitability to the varied climate, more attentions need to be focused on tuber crops. Among tuber crops, Taro (*Colocasia esculenta* var. antiquorum) is one of the oldest and most important tuber crop. It is also known as eddoes type taro, arvi and ghuian. It is grown mostly as staple or subsistence crop throughout the tropics and subtropics. Although this crops is not treated as economically important and was often considered as poor man's crop. Which is most extensively consumed low income by the group in the rural areas. However, in the recent part, economic importance of this crop has region up considerably and therefore the availability of quality planting materials has become an important agenda for taro crops growers.

Colocasia belongs to the monocotyledonous family Araceae whose members are known as aroids (Henry, 2001 and Van Wyk, 2005) [8]. Taro is one of the most important edible species under the genus *Colocasia* and usually they are polyploidy, but mostly found triploid in nature with chromosome no. 2n=3x=42.

India to Southern Asia is the centre of origin of *colocasia* from where it has traveled east to all the Island of Occeania, Phillipines, China and Japan. Although, India is known as native of taro. Africa ranks first in area and production of *Colocasia* followed by Asia. In India, it is mainly cultivated in Eastern and Southern States. Faizabad, Varanasi, Sitapur, Sultanpur and some parts of Jhansi.

The corms and cormels are mostly used as vegetables or as subsidiary food after roasting, baking or boiling. Young leaves and petioles are widely consumed as vegetable. The corms and cormels are rich in starch which contains 17-25 per cent amylase. Its flour is considered as a good baby food because its starch is easily digestible. It helps in constipation problems and supplements of iron (Onwueme, 1999) [6].

The nutritive value of *colocasia* per 100g of adible corms and cormels are moisture 73.1g, carbohydrate 21.1g, protien 3.1g, fat 0.1g, β-carotene 24 µg, thiamine 0.09mg, riboflavin 0.03mg, calcium 40mg, and iron 1.7mg which can be used as supplements of these nutrients.

The variability available in population could be partitioned into heritable and non-heritable components with the aids of genetic parameters such as genotypic coefficient of variation, heritability and genetic advance which also serve as basis of selection. The magnitude of genetic variability forms the basis for selection. The success of any breeding programme depends on the nature and amount of genetic variability available in the breeding material. The extent of transmission of quantitative characters from parents to the off-spring depends upon the heritability of the particular character. The heritability value does not much significance as it fails to account for the magnitude of absolute variability. It is therefore, necessary to utilize heritability along with genetic advance while advocating for selection. Selection and hybridization approaches are followed to bring about the improvement in quantitative parameters. Although correlation are helpful in determining the components of complicated traits like yield, but they do not provide exact picture of the relative importance of direct and indirect influences of each of the component characters towards this trait. Path coefficient analysis developed by Wright (1921) [9], is a standardized partial regression analysis which specifies the relative importance and measures the direct influence of one variable upon another through the partitioning of the correlation coefficient into direct and indirect effects (Dewey and Lu, 1959) [1].

The assessment of genetic divergence existing in the germplasm collection is very important for success of breeding programme leading to development of high yielding varieties of crop plant because optimum magnitude of parental diversity is required for selecting superior variety.

Materials and Methods

The study was designed to work out the status of association of different yield traits and direct and indirect effects of these different traits on yield per plant among 27 taro (Colocasia esculenta L. var. Antiquorum) genotypes at field experiment under present investigation was conducted during summer season 2016 (April, 2016 to October, 2016) at the Main Experiment Station, Vegetable Science, N. D. University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) India. The experimental materials of studies comprised of 27 taro (Colocasia esculenta L. var. Antiquorum) genotypes including two check varieties viz., NDC-1 and NDC-2. The experiment was conducted in Randomized Block Design with three replications.

Geographically, this place is located between 24.47^0 and 26.56^0 N latitude, 82.12^0 and 83.98^0 E longitude at an elevation of about 113 m above from mean sea level in the gangetic plains of eastern U.P. This area falls in sub-tropical climatic zone. The soil type is sandy loam. The annual rainfall is about 1270 mm. The climate of district Faizabad is semi-arid with hot summer and cold winter. The lab experiment as conducted in this university.

Observations were recorded on fifteen quantitative characters viz., days to sprouting, length of leaf (cm), width of leaf (cm), plant height (cm), girth of plant (cm), petiole length (cm), number of cormels per plant, weight of cormels per plant (gm), length of corms (cm), girth of corms (cm), weight of corms per plant (gm), size of corm (cm2), calcium oxalate content (mg), dry matter (%) and yield per plant (gm). The genetic divergence in 50 genotypes was estimated by Mahalanobis (1936) [4] 'D2' statistic and generalized distance as suggested by Rao 1952). The ten quantitative characters were included for this analysis.

Results and Discussions

The genetic divergence was estimated according to Mahalanobi's D^2 statistics as described by Rao (1952). The clustering pattern of the twenty seven genotypes was grouped into six different non-overlapping clusters (Table-1). Cluster I had highest number of genotypes (9) followed by cluster II (7), cluster VI (5), cluster III (3), cluster IV (2),and cluster V recorded only one genotypes which indicates that these genotypes have their own identity and there no similarity with other genotypes.

The estimates of intra and inter-cluster distances represented by D^2 values are given in (table-4.9).The intra-cluster distance showing totally till since the value of the cluster V were zero which suggested that number of these one cluster are genetically very low diverse to cluster VI while maximum was recorded to 622.04 for the cluster V

Table 1: Clustering pattern of twenty seven genotypes of *colocasia* on the basis of Mahalanobis D^2 statistics

Cluster number	No. of genotypes	Genotypes
I	9	NDC-10,NDC-63,NDC-9,NDC-11,NDC-17,NDC-6,NDC-13, NDC-15,NDC-21
II	7	NDC-42,NDC-24,NDC-41,NDC-8,NDC-14,NDC-20,NDC-23
III	3	NDC-32,NDC-34,NDC-16
IV	2	NDC-1(C), NDC-2(C)
V	1	NDC-7
VI	5	NDC-18,NDC-26,NDC-86,NDC-19,NDC-5

Table 1.1: Inter and intra - cluster D^2 value for six clusters in *colocasia* germplasm**.**

Cluster number	I	II	III	IV	V	VI
I	299.24	450.84	566.23	678.64	1083.33	1371.44
II		261.55	552.29	856.39	1421.56	1620.19
III			276.76	701.07	1084.56	734.87
IV				189.30	982.34	1412.55
V					0.00	1686.86
VI						622.04

The maximum inter-cluster distance was observed between clusters V and VI (1686.86). Which suggested that members of these two clusters are genetically very diverse to each other. The inter-cluster values between cluster II and cluster VI (1620.19), cluster II to V (1421.56), cluster IV to VI (1412.55), cluster I to VI (1371.44) and cluster III to V (1084.56) were very high. The minimum inter-cluster D^2 value was recorded in case of cluster I and cluster II (450.84). The higher inter-cluster distance indicated greater genetic divergence between the genotypes of those clusters while, lower inter-cluster values between the clusters suggested that

the genotypes of the clusters were not much genetically diverse from each other.
The intra- clusters means for sixteen characters in *colocasia* had given in (table-2.).
A perusal of (Table-2.) showed that clusters means for different traits indicated considerable differences between the clusters. The entire cluster from cluster I to VI had in general medium mean performance for most of the characters, exhibiting extreme cluster means for none of the characters under study. Cluster V showed maximum mean values for the day to sprouting (25.07), number of cormels (25.76), weight of cormels (458.18), corm length (11.12), yield per plant (554.11), yield tonne per

Table 2: Intra-cluster means for sixteen character in *Colocasia*

Characters Cluster	Days to Sprouting	Length of Leaf (cm)	Width of Leaf (cm)	Plant Height (cm)	Girth of Plant (cm)	Petiole Length (cm)	Number of Cormels/Plant	Weight of Cormels/Plant
I	24.49	49.02	38.54	86.71	16.59	21.32	17.24	380.03
II	21.86	52.59	40.85	95.50	16.76	24.41	14.04	241.51
III	24.61	44.57	38.48	92.54	16.41	22.78	13.59	269.85
IV	16.66	35.80	27.53	67.16	15.27	11.69	13.58	288.30
V	25.07	38.62	30.37	84.61	16.13	14.29	25.76	458.18
VI	24.01	45.47	36.81	84.27	17.14	19.45	15.40	316.17

Table 2: contd**.**

Characters Cluster	Length of Corm (cm)	Girth of Corm (cm)	Weight of Corms/Plant (g)	Size of Corm (cm²)	Calcium oxalate mg/100g	Dry Matter (%)	Yield t/ha	Yield/Plant (g)
I	10.59	19.98	91.24	213.53	0.36	22.96	19.83	447.73
II	10.96	20.48	88.88	231.20	0.60	22.10	14.57	331.05
III	10.15	19.37	105.31	201.75	0.70	22.79	15.93	369.15
IV	10.92	21.85	89.08	247.16	0.56	22.01	17.43	392.09
V	11.12	20.40	97.76	212.61	1.65	20.74	24.63	554.11
VI	10.30	20.36	143.31	214.73	0.55	22.82	22.26	502.77

hectare (24.63), and calcium oxalate (1.65). Cluster II showed maximum mean values for the leaf length (52.59), leaf width (40.85), plant height (95.50), and petiole length (24.41). Cluster IV showed maximum mean values for the corm girth (21.85), and corm size (247.16). Cluster VI showed maximum mean values for the girth of plant (17.14) and weight of corms per plant (143.31). Cluster I showed maximum mean value for dry matter (22.96).

Highest contribution per cent towards genetic divergence was exhibited by corm weight (43.59), Calcium oxalate (14.25), petiole length (10.83), weight of cormels per plant (10.83), yield per plant (8.26) which showed highly significant contribution towards total genetic divergence. The character such as plant height (5.98), leaf length (3.13), day to sprouting (1.71), width of leaf (1.14) and size of corm (.28), yield tonne per hectare (0.01), dry matter (0.01), girth of corm (0.01), girth of plant (0.01), length of corm (0.01) exhibited minimum contribution towards total genetic divergence.

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Table 3: Per cent contribution of sixteen characters towards total genetic divergence in colocasia**.**

S. No.	Source	Per cent contribution
1	Days to Sprouting	1.71
2	Length of Leaf (cm)	3.13
3	Width of Leaf (cm)	1.14
4	Plant Height (cm)	5.98
5	Girth of Plant (cm)	0.01
6	Petiole Length (cm)	10.83
7	Number of Cormels/Plant	0.01
8	Weight of Cormels/Plant	10.83
9	Length of Corm (cm)	0.01
10	Girth of Corm (cm)	0.01
11	Weight of Corms/Plant (g)	43.59
12	Size of Corm (cm²)	0.28
13	Yield/Plant (g)	8.26
14	Yield t/ha	0.01
15	Calcium oxalate mg/100g	14.25
16	Dry Matter (%)	0.01

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