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Correlates of Genetic and Phenotypic attributes of Taro [*Colocasia esculenta* (L.) Schott]

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ABSTRACT

An experiment was conducted with 40 Taro germplasm lines to study the genotypic variance, phenotypic variance, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (broad sense), genetic advance as percent of mean, correlation coefficient and path coefficient of different characters on tuber yield. The data collected over the genotypes and replications were analysed statistically for correlation studies revealed that tuber yield per plant had positive and significant correlation with number of leaves per plant, pseudostem girth, weight of corm per plant, pseudostem height, average weight of corm, number of corms per plant, number of suckers per plant, weight of cormel per plant, number of cormels per plant and number of days to maturity both at genotypic and phenotypic level suggested that selection based on these traits would ultimately improve the tuber yield per plant. Path coefficient analysis revealed that weight of corm per plant had maximum positive direct effect on tuber yield per plant followed by weight of cormel per plant at genotypic and phenotypic level. Therefore emphasis should be given on weight of corm per plant, weight of cormel per plant and number of leaves per plant, while selecting a good genotype for enhancing the yield of Taro.

1. Introduction

Taro [*Colocasia esculenta* (L.) Schott] is an ancient crop belonging to the monocotyledonous family Araceae whose members are known as aroids (Henry, 2001 and Van Wyk, 2005). It is thought to have originated in North Eastern India and Asia (Kuruvilla and Singh, 1981; Hanson and Imamuddin, 1983 and, Ivancic, 1992). Taro is a highly polymorphic vegetatively propagated and predominantly allogamous species characterized by protogyny (Purseglove, 1972). There are eight recognized variants within *Colocasia esculenta*, of which two are commonly cultivated i) *Colocasia esculenta* (L.) Schott var. *esculenta* which possesses a large cylindrical central corm and only few cormels; agronomically it is referred to as the dasheen type of taro and ii) *Colocasia esculenta* (L.) Schott var. antiquorum which has a small globular central corm with several relatively large cormels arising from the corm; agronomically this variety is referred to as the eddoe type of taro (O'Sullivan *et al.*, 1996; Purseglove, 1972 and Lebot and Aradhya, 1991). The first task that the breeders need to attempt is to build up as large collection of germplasm as possible. A comprehensive knowledge of the available variability within the breeding material of a crop species for desired characters enables the breeders to identify most potential genotype. The study of correlation of character will help in simultaneous selection for more than one character. Path coefficient analysis helps for sorting out the total correlations into direct and indirect effects and useful in selecting high yielding genotypes.

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Table 1. Genetic parameters for yield and its attributing characters in Taro

Sl.No.	Character	Mean ± SE(m)	Range		Variance (σ^2)			Coefficient of variability (%)		Heritability (%)	Genetic advance	Genetic advance as % of mean
			Min.	Max	Phenotypic(σ^2p)	Genotypic (σ^2g)	Environmental(σ^2e)	PCV	GCV			
1	**Days to 50% plant emergence**	11.91±0.73	6.33	19.33	11.45	9.86	1.59	28.41	26.36	86.00	6.00	50.39
2	**Pseudostem height**	65.87±4.04	46.55	93.41	215.07	166.04	49.03	22.26	19.56	77.00	23.32	35.41
3	**Pseudostem girth**	32.68±2.44	18.05	47.90	57.91	40.10	17.81	23.29	19.38	69.00	10.86	33.22
4	**Number of suckers per plant**	3.54±0.42	1.91	7.11	1.80	1.27	0.53	37.95	31.84	70.00	1.95	55.04
5	**Number of leaves per plant**	13.49±1.00	9.07	20.20	10.61	7.61	3.01	24.15	20.44	72.00	4.81	35.65
6	**Leaf length**	22.01±1.73	13.54	31.95	29.97	21.01	8.96	24.87	20.82	70.00	7.91	35.92
7	**Leaf breadth**	20.02±1.50	11.99	29.82	25.28	18.51	6.76	25.11	21.49	73.00	7.59	37.88
8	**Number of days to maturity**	174.18±5.20	151.33	201.33	177.12	96.01	81.11	7.64	5.63	54.00	14.86	8.53
9	**Number of corms per plant**	1.71±0.16	1.00	2.87	0.26	0.19	0.08	30.00	25.31	71.00	0.75	43.98
10	**Weight of corm per plant**	151.01±15.54	37.33	356.33	7933.11	7208.89	724.22	58.98	56.22	91.00	166.73	110.41
11	**Average weight of corm**	83.91±5.23	29.64	152.63	1177.04	1094.83	82.22	40.89	39.43	93.00	0.93	78.34
12	**Number of cormels per plant**	7.57±0.83	2.40	15.87	8.81	6.73	2.08	39.21	34.27	76.00	0.76	61.70
13	**Weight of cormels per plant**	84.99±8.39	30.11	188.08	903.46	692.51	210.95	35.37	30.96	77.00	0.77	55.84
14	**Average weight of cormel**	12.64±1.40	4.06	41.98	47.83	41.97	5.85	54.70	51.24	88.00	0.88	98.89
15	**Dry matter content**	40.84±1.49	31.32	52.55	33.13	26.46	6.67	14.09	12.60	80.00	0.799	23.19
16	**Starch content**	7.11±0.298	2.78	12.83	6.57	6.30	0.27	36.06	35.32	96.00	0.96	71.27
17	**Tuber yield per plant**	236.00±18.153	67.44	417.67	9135.84	8147.25	988.59	40.50	38.25	89.00	0.89	74.40

Table 2. Phenotypic (rp) and genotypic (rg) correlation of coefficients among seventeen characters in Taro

S. No	Character		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	Days to 50% plant emergence	rp	**1.000**	-0.188*	-0.201*	-0.272**	-0.254**	-0.062	-0.042	-0.039	-0.114	-0.328**	-0.367**	0.147	0.178	-0.012	-0.019	-0.048	-0.249**
		rg	**1.000**	-0.223*	-0.244**	-0.313**	-0.357**	-0.104	-0.059	-0.048	-0.174	-0.381**	-0.398**	0.157	0.210*	0.016	-0.035	-0.055	-0.297*
2.	Pseudostem height	r_p		**1.000**	0.706**	0.384**	0.673**	-0.053	-0.107	0.036	0.675**	0.707**	0.574**	0.251**	0.223*	-0.064	-0.015	-0.233*	0.729
		r_g		**1.000**	0.854**	0.510**	0.903**	-0.017	-0.074	0.165	0.920**	0.852**	0.685**	0.346**	0.332**	-0.046	-0.001	-0.273**	0.899**
3.	Pseudostem girth	r_p			**1.000**	0.456**	0.635**	-0.028	-0.055	0.233*	0.623**	0.756**	0.645**	0.157	0.190*	-0.037	-0.065	-0.081	0.764**
		r_g			**1.000**	0.711**	0.874**	0.062	-0.021	0.332**	0.881**	0.940**	0.791**	0.230**	0.303**	-0.026	-0.081	-0.109	0.973**
4.	Number of suckers per plant	r_p				**1.000**	0.476**	0.060	0.000	0.299**	0.322**	0.561**	0.530**	0.089	0.026	-0.012	-0.032	0.140	0.531**
		r_g				**1.000**	0.673**	0.098	0.035	0.461**	0.535**	0.730**	0.652**	0.172	0.100	-0.029	-0.069	0.179	0.716**
5.	Number of leaves per plant	r_p					**1.000**	0.071	0.020	0.169	0.623**	0.756**	0.678**	0.259**	0.236**	-0.056	0.062	-0.145	0.779**
		r_g					**1.000**	0.105	0.007	0.284**	0.903**	0.949**	0.814**	0.362**	0.309**	-0.084	0.062	-0.178	0.983**
6.	Leaf length	r_p						**1.000**	0.830**	0.109	0.034	0.170	0.270**	-0.035	-0.005	0.032	0.204*	0.080	0.156
		r_g						**1.000**	1.051**	0.228*	0.102	0.244**	0.315**	-0.058	-0.043	0.033	0.233**	0.099	0.217**
7.	Leaf breadth	r_p							**1.000**	0.124	0.028	0.140	0.222*	-0.028	0.003	0.024	0.110	0.024	0.132
		r_g							**1.000**	0.235**	0.002	0.132	0.229**	-0.017	-0.013	-0.007	0.143	0.026	0.120
8.	Number of days to maturity	r_p								**1.000**	0.159	0.137	0.074	0.309**	0.207*	-0.106	-0.109	0.087	0.192*
		r_g								**1.000**	0.205**	0.143	0.059	0.443**	0.384**	-0.106	-0.295**	0.114	0.246**
9.	Number of corms per plant	r_p									**1.000**	0.770**	0.421**	0.298**	0.244**	-0.090	-0.015	-0.109	0.794**
		r_g									**1.000**	0.787**	0.574**	0.327**	0.268**	-0.107	-0.024	-0.140	0.818**
10.	Weight of corm per plant	r_p										**1.000**	0.882**	0.092	0.056	-0.059	0.121	-0.101	0.949**
		r_g										**1.000**	0.948**	0.089	0.055	-0.063	0.134	-0.112	0.957**
11.	Average weight of corm	r_p											**1.000**	-0.072	-0.021	0.039	0.226*	-0.076	0.816**
		r_g											**1.000**	-0.057	-0.002	0.037	0.260**	-0.084	0.891**
12.	Number of cormels per plant	r_p												**1.000**	0.604**	-0.532**	-0.215*	-0.173	0.276**
		r_g												**1.000**	0.588**	-0.554**	-0.245**	-0.218**	0.255**
13.	Weight of cormels per plant	r_p													**1.000**	0.236**	-0.045	-0.202*	0.367**
		r_g													**1.000**	0.253**	-0.051	-0.244**	0.343**
14.	Average weight of cormel	r_p														**1.000**	0.175	0.025	0.019
		r_g														**1.000**	0.187**	0.027	0.015
15.	Dry matter content	r_p															**1.000**	0.221*	0.099
		r_g															**1.000**	0.289**	0.111

16.	Starch content	r_p																**1.000**	-0.158
		r_g																**1.000**	-0.177
17.	Tuber yield per plant	r_p																	**1.000**
		r_g																	**1.000**

*** & ** Significant at 5% and 1% level of significance**

2. Materials and Methods

The experiment was laid out in Randomized Block Design with three replications at Vegetable Farm College of Horticulture and Forestry, Pasighat Central Agricultural University, Imphal, Manipur in2011-12. Observations were recorded on five randomly tagged plants in each genotype on days to 50% emergence, pseudostem height (cm), pseudostem girth (cm), number of suckers per plant, number of leaves per plant, leaf length (cm), leaf breadth (cm) were recorded at maximum vegetative growth stage *i.e.* 120 days after planting and Number of days from planting of tuber to emergence of 50 percent sprouts above soil surface was counted in each genotype and expressed as days to 50% plant emergence, number of days to maturity, number of corms per plant, weight of corm per plant (g), average weight of corm (g), number of cormels per plant, weight of cormel per plant (g), average weight of cormel (g), dry matter content (%), starch content (%), total tuber yield per plant (g).The data collected on five randomly selected plants in each genotype for all the 17 characters under study were subjected to statistical analysis by using Statistical Package for Agricultural Research (SPAR 2.0) and Indostat for elucidating the information on genetic variation existing for tuber yield and its different component.

3. Results and Discussion

The analysis of variance indicated highly significant differences among the genotypes for all the characters under study. Phenotypic coefficient of variation was higher in magnitude than the genotypic coefficient of variation in respect to all the characters. The characters *viz,* weight of corm per plant, average weight of cormel, average weight of corm, tuber yield per plant, starch content, number of cormels per plant, number of suckers per plant and weight of cormel per plant showed high PCV and GCV whereas, number of days to maturity showed low PCV and GCV. The phenotypic variance for all the traits under study was higher in magnitudethan corresponding genotypic variance, which indicated that the environment plays considerable role in the expression of these traits. Genotypic and phenotypic variances were high for tuber yield per plant (8147.25 and 9135.84) followed by weight of corm per plant (7208.89 and 7933.11), average weight of corm (1094.83 and 1177.04), weight of cormel per plant (692.51 and 903.46), pseudostem height (166.04 and 215.07) and number of days to maturity (96.01 and 177.12) suggested scope of selection for these traits. The phenotypic and genotypic correlations of various characters were subjected to path analysis for partitioning the values in to direct and indirect effects by considering tuber yield per plant as the dependent variable and other characters as independent variable. The results are presented in Tables 3. The weight of corm per plant was predominant to influence tuber yield per plant at genotypic (0.941) and phenotypic (0.932)levels followed by weight of cormels per plant (0.292, 0.314, respectively). The other traits like days to 50% plant emergence, pseudostem height, pseudostem girth, number of suckers per plant, number of leaves per plant, leaf length, leaf breadth, number of days to maturity, number of corms per plant, average weight of corm, number of cormels per plant, average weight of cormel per plant, dry matter content and starch content showed negligible direct effect towards tuber yield per plant at both the levels. It is observed that weight of corm per plant besides having high direct positive influence towards tuber yield per plant also influenced this trait indirectly through weight of cormels per plant at both genotypic (0.016) and phenotypic (0.018) levels. Similarly, weight of cormels per plant had positive direct effect on tuber yield per plant due to maximum indirect contributions of weight of corm per plant (0.052, 0.052) at both the levels

The genotypic correlation was higher than the phenotypic correlation in almost all cases indicating the high heritable nature of the characters. Tuber yield per plant showed positive and significant association with number of leaves per plant, pseudostem girth, weight of corm per plant, pseudostem height, average weight of corm, number of corms per plant, number of suckers per plant, weight of cormel per plant, number of cormels per plant and number of days to maturity indicated that the selection based on these traits would be effective to improve rhizome yield per plant. Negative association of tuber yield per plant with days to 50% plant emergence and starch content suggested that tuber yield per plant, days to 50% plant emergence and starch content could not be improved simultaneously through selection. So, independent selection for these traits could be made to obtain improved population. Heritability (broad sense) coupled with genetic advance as per cent of mean were high for weight of corm per plant, average weight of cormel, average weight of corm, tuber yield per plant, starch content, number of cormels per plant, weight of cormel per plant, number of suckers per plant, days to 50% plant emergence, number of corms per plant, leaf breadth, leaf length, number of leaves per plant, pseudostem height, pseudostem girth and dry matter content suggesting role of additive genes in the expression of these character which could be effectively improved upon selection. The character number of days to maturity showed moderate heritability with low mean thereby indicated that expression of this trait may be due to non-additive gene action and direct selection for improvement of this trait may not be rewarding.

Table 3. Direct (diagonal) and indirect effects of yield components on tuber yield per plant at phenotypic and genotypic levels in taro Residual effect = 0.002 and 0.004 at phenotypic and genotypic level, respectively.

Sl, No.	Character		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Correlation with yield
1	Days to 50% plant emergence	P	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.305	0.000	0.000	0.056	0.000	0.000	0.000	-0.249**
		G	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.358	0.000	0.000	0.061	0.000	0.000	0.000	-0.297**
2	Pseudostem height	P	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.659	0.000	0.000	0.070	0.000	0.000	0.000	0.729**
		G	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.802	0.000	0.000	0.097	0.000	0.000	0.000	0.899**
3	Pseudostem girth	P	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.704	0.000	0.000	0.060	0.000	0.000	0.000	0.764**
		G	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.885	0.000	0.000	0.088	0.000	0.000	0.000	0.973**
4	Number of suckers per plant	P	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.523	0.000	0.000	0.008	0.000	0.000	0.000	0.531**
		G	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.687	0.000	0.000	0.029	0.000	0.000	0.000	0.716**
5	Number of leaves per plant	P	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.705	0.000	0.000	0.074	0.000	0.000	0.000	0.779**
		G	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.892	0.000	0.000	0.090	0.000	0.000	0.000	0.983**
6	Leaf length	P	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.158	0.000	0.000	-0.002	0.000	0.000	0.000	0.156
		G	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.230	0.000	0.000	-0.012	0.000	0.000	0.000	0.217*
7	Leaf breadth	P	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.133	0.000	0.000	-0.001	0.000	0.000	0.000	0.132
		G	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.124	0.000	0.000	-0.004	0.000	0.000	0.000	0.120
8	Number of days to maturity	P	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.127	0.000	0.000	0.065	0.000	0.000	0.000	0.192*
		G	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.134	0.000	0.000	0.112	0.000	0.000	0.000	0.246**
9	Number of corms per plant	P	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.718	0.000	0.000	0.077	0.000	0.000	0.000	0.794**
		G	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.740	0.000	0.000	0.078	0.000	0.000	0.000	0.818**
10	Weight of corm per plant	P	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.932**	0.000	0.000	0.018	0.000	0.000	0.000	0.949**
		G	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.941**	0.000	0.000	0.016	0.000	0.000	0.000	0.957**
11	Average weight of corm	P	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.822	**0.000**	0.000	-0.007	0.000	0.000	0.000	0.816**
		G	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.892	**0.000**	0.000	-0.001	0.000	0.000	0.000	0.891**
12	Number of cormels per plant	P	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.086	0.000	**0.000**	0.190	0.000	0.000	0.000	0.276**
		G	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.084	0.000	**0.000**	0.171	0.000	0.000	0.000	0.255**
13	Weight of Cormels per plant	P	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.052	0.000	0.000	**0.314**	0.000	0.000	0.000	0.367**
		G	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.052	0.000	0.000	**0.292**	0.000	0.000	0.000	0.343**
14	Average weight of cormels	P	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.055	0.000	0.000	0.074	**0.000**	0.000	0.000	0.019
		G	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.059	0.000	0.000	0.074	**0.000**	0.000	0.000	0.015
15	Dry matter content	P	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.113	0.000	0.000	-0.014	0.000	**0.000**	0.000	0.099
		G	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.126	0.000	0.000	-0.015	0.000	**0.000**	0.000	0.111
16	Starch content	P	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.094	0.000	0.000	-0.063	0.000	0.000	**0.000**	-0.158
		G	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.106	0.000	0.000	-0.071	0.000	0.000	**0.000**	-0.177

Path coefficient analysis revealed that weight of corm per plant had the highest positive direct effect on tuber yield per plant followed by weight of cormel per plant at both genotypic and phenotypic level. The present findings suggested that the yield related traits contributed maximum indirect effects mainly through weight of corm and cormel per plant. Hence, it would be worthwhile to lay stress on these two characters in selection programmes for increasing the tuber yield per plant in taro.

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