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Character association and their direct and indirect relationship between yield and its contributing traits in taro (*Colocasia esculenta* L. *var.* Antiquorum)

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Abstract
Twenty seven genotypes including two check varieties (NDC-1 and NDC-2) of taro (*Colocasia esculenta* L. *var.* Antiquorum) were assessed to work out the association of different yield traits, direct and indirect effects of their various attributes on yield per plant. The yield per plant had shown significant and positive correlation at phenotypic level with weight of cormels per plant (0.695), number of cormels per plant (0.595), weight of corms per plant (0.451), day to sprouting (0.293). However, this character had negative and significant association with plant height (-0.364), petiole length (-0.303), leaf width (-0.287), leaf length (-0.296). Among other traits days to sprouting had positive and significant association with number of cormel per plant (0.343), yield per plant (0.293), weight of cormels per plant (0.285), at phenotypic level. At phenotypic level weight of cormels per plants (0.543) followed by weight of corm per plant (0.499), number of cormels per plant (0.217), length of leaf (0.183), and petiole length (0.072) exerted high positive direct effect on total yield per plant. Length of leaves had negative and significant association with yield per plant (-0.296) which was mainly due to indirect effects by weight of cormels per plant (-0.130) and width of leaf (-0.121). Petiole length *via* indirect effects of weight of cormels per plant (-0.149) and plant height (-0.101) was showed negative and significant association with yield per plant (-0.303).

Keywords: taro (*Colocasia esculenta* L. *var.* antiquorum), character association, path coefficient analysis and yield per plant

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.

Tropical root and tuber crops have been instrumental in filling the hungry stomach of millions of small holder operators since ages. In any places, they served as the alternate food source for livelihood security. Today when the over ground food crops are facing the production challenge due to a likely vegetative impact of climate change hopes are now being pinned on root and tuber crops since they are less likely to suffer from such impact.

Colocasia belongs to the monocotyledonous family Araceae whose members are known as aroids (Van Wyk, 2005) [5]. 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) [2]. 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 corms are acrid due to presence of calcium oxalate crystals. However, it has got a very good potential as an important tuber crop because of its higher yield potential and better keeping quality. In addition to this, it has got very good medicinal values too. Various parts of the plant are also used in traditional medicine practice (Tsitsiringos, 2002) [4]. The juice of the leaves is used against colic and constipation, the acrid juice extracted from leaf stalk is astringent and styptic. The corm is mild lucrative and diuretic. It is generally used against piles, constipation and dropsy in the form of gruel. The ash of the corm is used as antihelminthic, mixed with honey, and it is applied in the aphthus condition of the mouth.

Correlation coefficient measure the mutual relationship between two or more variables. Correlation coefficient between a pair of characters is either positive or negative and it may be high or low. Estimation of correlation coefficient among the yield contributing variables is necessary to understand the direction of selection and to maximize yield in the shortest period of time. Genetic correlations indicate the relative importance of characters on which greater emphasis should be made in selection for yield. Path coefficient analysis which determines the cause and effect relationship has been found useful in splitting the correlation coefficient into its direct and indirect effects contributing to yield. 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) [6], 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. 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 (cm^2), calcium oxalate content (mg), dry matter (%) and yield per plant (gm). The correlations between different characters at genotypic and phenotypic levels were worked out between characters as suggested by Searle (1961) [3]. Path coefficient analysis was done according to the formula given by Dewey and Lu (1959) [1].

Results and Discussions

Estimate of phenotypic and genotypic correlation coefficient between different characters given in (Table-1 and 2). Yield per plant had shown significant and positive correlation at phenotypic level with weight of cormels per plant (0.695), number of cormels per plant (0.595), weight of corms per plant (0.451), day to sprouting (0.293). However, this character had negative and significant association with plant height (-0.364), petiole length (-0.303), leaf width (-0.287), leaf length (-0.296). Similar finding have been reported by Mehata *et al*. (2003) [7], Dwivedi and Sen (1999) [8]. Among other traits days to sprouting had positive and significant association with number of cormel per plant (0.343), yield per plant (0.293), weight of cormels per plant (0.285), at phenotypic level. Length of leaf exhibited positive and significant association with width of leaf (0.950), plant height (0.447), girth of plant (0.249), and petiole length (0.476), negative and significant association with yield per plant (-0.296), number of cormels (-0.222), and calcium oxalate (-0.233), at phenotypic level The estimates of correlation coefficients at phenotypic level revealed that width of leaf had positive and significant association with plant height (0.442), girth of plant (0.309), petiole length (0.485), negative and significant association with number of cormels per plant (-0.255), weight of cormels per plant (-0.260), length of corm (-0.259), size of corm (-0.252), yield per plant (-0.287). Plant height exhibited significant positive correlation with girth of plant (0.310), petiole length (0.602), at phenotypic level. Negative and significant association correlation coefficient with weight of cormels per plant (-0.221), length of corm (-0.291), girth of corm (-0.385), size of corm (-0.322), yield per plant (-0.364). The estimates of correlation coefficients at phenotypic level revealed that plant girth had negative significant correlation with length of corm (-0.266), and size of corm (-0.308). Petiole length had negative significant association with number of cormels per plant (-0.258), weight of cormels per plant (-0.274), length of corm (-0.256), girth of corm (-0.472), size of corm (-0.462), yield per plant (-0.303), calcium oxalate (-0.377), at phenotypic level. Number of cormels per plant had significant positive association with weight of cormels per plant (0.740), yield per plant (0.595), calcium oxalate (0.334). The estimates of correlation coefficients at phenotypic level revealed that weight of cormels per plant had positive significant association with yield per plant (0.695). The estimates of correlation coefficients at phenotypic level revealed that corms length had positive and significant association with girth of corms (0.597) and size of corm (0.707). Girth of corm had significant positive association with corm size (0.726) and also the estimates of correlation coefficients at phenotypic level revealed corms weight per plant with yield per plant (0.451).

Table 1: Estimates of Phenotypic correlations coefficient among fifteen characters in taro (*Colocasia esculenta* L. *var.* Antiquorum)

Characters	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	Length of Corm (cm)	Girth of Corm (cm)	Weight of Corms/Plant (g)	Size of Corm (cm^2)	Ca Oxalate mg/100g	Dry Matter (%)	Yield /Plant
Days to Sprouting	0.004	0.023	-0.047	0.091	-0.083	0.343	0.285	0.071	-0.068	0.172	-0.097	0.142	0.159	0.293**
Length of Leaf (cm)		0.950	0.447	0.249	0.476	-0.222	-0.240	-0.119	-0.150	-0.194	-0.144	-0.233	0.141	-0.296**
Width of Leaf (cm)			0.442	0.309	0.485	-0.255	-0.260	-0.259	-0.212	-0.116	-0.252	-0.203	0.154	-0.287**
Plant Height (cm)				0.310	0.602	-0.169	-0.221	-0.291	-0.385	-0.197	-0.322	0.002	-0.092	-0.364**
Girth of Plant (cm)					0.212	-0.039	0.062	-0.266	-0.152	0.143	-0.308	0.001	0.094	-0.091
Petiole Length (cm)						-0.258	-0.274	-0.256	-0.472	-0.162	-0.462	-0.377	-0.073	-0.303**
Number of Cormels/Plant							0.740	0.116	0.043	-0.089	0.015	0.334	-0.113	0.595**
Weight of Cormels/Plant								0.069	0.112	0.044	0.043	-0.018	0.061	0.695**
Length of Corm (cm)									0.597	0.051	0.707	0.203	0.035	0.128
Girth of Corm (cm)										0.218	0.726	0.201	0.128	0.140
Weight of Corms/Plant (g)											0.100	-0.016	0.156	0.451**
Size of Corm (cm^2)												0.166	0.015	0.066
Ca Oxalate mg/100g													-0.176	0.084
Dry Matter (%)														0.124

*, ** Significant at 5% and 1 % probability levels.

Table 2: Estimates of genotypic correlations coefficient among fifteen characters in taro (*Colocasia esculenta* L. *var.* Antiquorum)

Characters	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	Length of Corm (cm)	Girth of Corm (cm)	Weight of Corms/Plant (g)	Size of Corm (cm^2)	Calcium Oxalate mg/100g	Dry Matter (%)	Yield/Plant (g)
Days to Sprouting	-0.004	0.020	-0.017	0.035	-0.105	0.413	0.320	0.084	-0.189	0.185	-0.062	0.148	0.218	0.318
Length of Leaf (cm)		0.961	0.486	0.425	0.504	-0.232	-0.246	-0.164	-0.345	-0.210	-0.213	-0.265	0.191	-0.315
Width of Leaf (cm)			0.494	0.486	0.526	-0.267	-0.274	-0.347	-0.470	-0.126	-0.351	-0.245	0.223	-0.3162
Plant Height (cm)				0.533	0.644	-0.226	-0.231	-0.382	-0.680	-0.203	-0.437	0.011	-0.108	-0.381
Girth of Plant (cm)					0.240	-0.021	0.077	-0.379	-0.034	0.242	-0.273	0.025	0.176	-0.156
Petiole Length (cm)						-0.265	-0.279	-0.283	-0.780	-0.160	-0.530	-0.390	-0.093	-0.312
Number of Cormels/Plant							0.831	0.210	0.093	-0.084	0.022	0.378	-0.145	-0.058
Weight of Cormels/Plant								0.034	0.153	0.029	0.026	-0.014	0.105	0.697
Length of Corm (cm)									0.521	-0.100	0.773	0.234	-0.103	0.065
Girth of Corm (cm)										0.164	0.997	0.274	-0.063	0.126
Weight of Corms/Plant (g)											0.045	-0.024	0.213	0.445
Size of Corm (cm^2)												0.198	0.064	0.040
Calcium Oxalate mg/100g													-0.337	0.092
Dry Matter (%)														0.188

Table 3: Direct and indirect effect of fifteen characters on yield per plant (gm) at genotypic level in taro (*Colocasia esculenta* L. *var.* Antiquorum)

Characters	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	Length of Corm (cm)	Girth of Corm (cm)	Weight of Corms/Plant (g)	Size of Corm (cm^2)	Calcium Oxalate mg/100g	Dry Matter (%)	Yield/Plant (g)
Days to Sprouting	-0.183	-0.003	-0.013	-0.001	-0.016	-0.002	0.293	0.064	-0.025	0.023	0.123	-0.008	0.013	0.052	0.318
Length of Leaf (cm)	0.001	0.751	-0.632	0.017	-0.195	0.008	-0.165	-0.049	0.049	0.042	-0.139	-0.027	-0.023	0.046	-0.315
Width of Leaf (cm)	-0.004	0.722	-0.657	0.017	-0.223	0.009	-0.190	-0.055	0.104	0.057	-0.084	-0.044	-0.021	0.054	-0.316
Plant Height (cm)	0.003	0.365	-0.325	0.034	-0.245	0.011	-0.160	-0.046	0.114	0.083	-0.135	-0.055	0.001	-0.026	-0.382
Girth of Plant (cm)	-0.006	0.319	-0.319	0.018	-0.460	0.004	0.015	0.015	0.113	0.004	0.161	-0.035	0.002	0.042	-0.156
Petiole Length (cm)	0.019	0.379	-0.346	0.022	-0.110	0.017	-0.188	-0.056	0.085	0.095	-0.106	-0.067	-0.033	-0.022	-0.312
Number of Cormels / Plant	-0.075	-0.174	0.176	-0.008	0.010	-0.004	0.711	0.166	-0.063	-0.011	-0.056	0.003	0.032	-0.035	-0.058
Weight of Cormels/Plant	-0.058	-0.185	0.180	-0.008	-0.035	-0.005	0.591	0.200	-0.010	-0.019	0.019	0.003	-0.0012\	0.025	0.697
Length of Corm (cm)	-0.015	-0.123	0.228	-0.013	0.174	-0.005	0.149	0.007	-0.300	-0.063	-0.066	0.098	0.020	-0.025	0.065
Girth of Corm (cm)	0.035	-0.259	0.309	-0.023	0.016	-0.013	0.066	0.031	-0.156	-0.122	0.109	0.126	0.023	-0.015	0.126
Weight of Corms/Plant (g)	-0.034	-0.157	0.083	-0.007	-0.111	-0.003	-0.060	0.006	0.030	-0.020	0.663	0.006	-0.002	0.051	0.445
Size of Corm (cm^2)	0.011	-0.160	0.231	-0.015	0.125	-0.009	0.015	0.005	-0.232	-0.121	0.030	0.127	0.017	0.015	0.040
Calcium Oxalate mg/100g	-0.027	-0.199	0.161	0.000	-0.012	-0.007	0.268	-0.003	-0.070	-0.033	-0.016	0.025	0.085	-0.081	0.092
Dry Matter (%)	-0.034	0.143	-0.146	-0.004	-0.081	-0.002	-0.103	0.021	0.031	0.008	0.141	0.008	-0.029	0.241	0.188

R Square = 0.8999, Residual Effect = 0.3164

Table 4: Direct and indirect effect of fifteen characters on yield per plant (gm) at phenotypic level in taro (*Colocasia esculenta* L. *var.* Antiquorum)

Characters	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	Length of Corm (cm)	Girth of Corm (cm)	Weight of Corms/Plant (g)	Size of Corm (cm^2)	Calcium Oxalate mg/100g	Dry Matter (%)	Yield/plant (g)
Days to Sprouting	-0.052	0.001	-0.003	0.008	-0.017	-0.006	0.074	0.155	0.003	0.007	0.086	0.007	0.017	0.013	0.293**
Length of Leaf (cm)	0.000	0.183	-0.121	-0.075	-0.047	0.034	-0.048	-0.130	-0.005	0.016	-0.097	0.010	-0.029	0.012	-0.296**
Width of Leaf (cm)	-0.001	0.174	-0.127	-0.074	-0.058	0.035	-0.055	-0.141	-0.010	0.023	-0.058	0.018	-0.025	0.013	-0.287**
Plant Height (cm)	0.002	0.082	-0.056	-0.168	-0.058	0.043	-0.037	-0.120	-0.011	0.042	-0.098	0.023	0.000	-0.008	-0.364**
Girth of Plant (cm)	-0.005	0.046	-0.039	-0.052	-0.188	0.015	-0.008	0.034	-0.011	0.017	0.072	0.022	0.000	0.008	-0.091
Petiole Length (cm)	0.004	0.087	-0.062	-0.101	-0.040	0.072	-0.056	-0.149	-0.010	0.052	-0.081	0.032	-0.046	-0.006	-0.303**
Number of Cormels/Plant	-0.018	-0.041	0.032	0.028	0.007	-0.019	0.217	0.401	0.005	-0.005	-0.045	-0.001	0.041	-0.009	0.595**
Weight of Cormels/Plant	-0.015	-0.044	0.033	0.037	-0.012	-0.020	0.160	0.543	0.003	-0.012	0.022	-0.003	-0.002	0.005	0.695**
Length of Corm (cm)	-0.004	-0.022	0.033	0.049	0.050	-0.018	0.025	0.037	0.039	-0.065	0.025	-0,0496	0.025	0.003	0.128
Girth of Corm (cm)	0.004	-0.027	0.027	0.065	0.029	-0.034	0.009	0.061	0.024	-0.109	0.109	-0.051	0.025	0.011	0.140
Weight of Corms/Plant (g)	-0.009	-0.036	0.015	0.033	-0.027	-0.012	-0.019	0.024	0.002	-0.024	0.499	-0.007	-0.002	0.013	0.451**
Size of Corm (cm^2)	0.005	-0.026	0.032	0.054	0.058	-0.033	0.003	0.023	0.028	-0.079	0.050	-0.070	0.020	0.001	0.066
Ca. Oxalate mg/100g	-0.007	-0.043	0.026	0.000	0.000	-0.027	0.072	-0.010	0.008	-0.022	-0.008	-0.012	0.122	-0.015	0.084
Dry Matter (%)	-0.008	0.026	-0.020	0.015	-0.018	-0.005	-0.025	0.033	0.001	-0.014	0.078	-0.001	-0.022	0.082	0.124

The path coefficient analysis was carried out from phenotypic and genotypic correlation coefficients to resolve direct and indirect effect of different characters on yield per plant as presented in (Table- 3 and 4). At phenotypic level weight of cormels per plants (0.543) followed by weight of corm per plant (0.499), number of cormels per plant (0.217), length of leaf (0.183), and petiole length (0.072) exerted high positive direct effect on total yield per plant. Path coefficient analysis for various morphological and quality traits were studied by Mehta *et al*. (2003) [7] and Devi *et al.* (2013) [9]. The direct effect of other three characters was too low to be consequence which was constant and not contributed their role for increasing the yield. However, plant height (-0.168), width of leaf (-0.127), day to sprouting (-0.052) exerted high negative direct effect on yield per plant. Length of leaves had negative and significant association with yield per plant (-0.296) which was mainly due to indirect effects by weight of cormels per plant (-0.130) and width of leaf (-0.121). Petiole length *via* indirect effects of weight of cormels per plant (-0.149) and plant height (-0.101) was showed negative and significant association with yield per plant (-0.303).

References

1. Dewey DR, Lu KH. A correlation and path analysis of the components of crested wheat grass seed production. Agron J. 1959; 51:515-518.
2. Onwueme IC. Taro Cultivation in Asia and the Pacific. FAO PAR publication 1996/16. Bangkok, Thailand, 1999.
3. Searle. Genotypic and environmental variance and covariance in an upland cotton crops of interspecific origin; Agron. J. 1961; 50:633-636.
4. Tsitsiringos VK. Financial engineering, E-commerce and Supply Chain. Kluwer Academic Publishers, The Netherlands, 2002.
5. Van Wyk BE. Food Plants of the world: Identification, culinary Uses and Nutritional Value. Briza Publications, Pretoria, South Africa, 2005.
6. Wright S. The method of path coefficient. Ann. Math. Stat. 1921; 15:161-215.
7. Mehta JL, Bendale VW, Bhawe SG, Saindane AK, Pethe UB. Correlation and path coefficient analysis in taro. J Root Crops. 2003; 29(2):32-35.
8. Dwivedi AK, Sen H. Correlation and path analysis in taro (*Colocasia esculenta var*. Antiquorum). J Root Crops. 1999; 2(1):51-54.
9. Devi HS, Singh V, Duwey RK, Chauhan VBS. Assessment of genetic diversity in taro (*Colocasia esculent* L.) National conference on: Tuber crops (other then potato) for sustainable agri. And livelihood security in climate change scenario AAU. Jorhat on dated. 2013; 29:53-54.