Correlation and Path Coefficient Studies for Plant Characters in Aqua Aroids, *Colocasia esculenta* L. Schott

K. K. Paul[1*], M. A. Bari[2] and S. C. Debnath[3]

[1]Govt Shahid Bulbul College, Pabna-6600, Bangladesh

[2]Institute of Biological Sciences, Rajshahi University, Rajshahi-6205, Bangladesh

[3]Atlantic Cool Climate Crop Research Centre, Agriculture and Agri-Food Canada, P.O. Box 39088, 308 Brookfield Road, NL A1E 5Y7, Canada

Abstract

The nature and extent of correlation and path coefficients of aqua edible aroid taro (*Colocasia esculenta* L., Panikachu) accessions were studied for plant height, petiole length, petiole breadth, leaf number, leaf length, leaf breadth, leaf area index, inflorescence length, peduncle length, spath length, spath breadth and yield per plant. The yield per plant showed significant and positive phenotypic correlation with petiole length (0.481), leaf length (0.576), leaf breadth (0.918), leaf number (0.620), inflorescence length (0.662), spath length (0.890) and spath breadth (0.992). The residual effect was 0.2205 which indicated that characters studied contributed 78% of yield per plant. At genotypic level, yield per plant expressed positive and significant correlation with plant height (0.560) and leaf number (0.600). The residual effect (0.424) indicated that about 58% yield was contributed by these characters.

Keywords: Genotypic correlation; Phenotypic correlation; Path coefficient; Aqua aroid; Panikachu (*Colocasia esculenta* L Schott.stoloniferous).

1. Introduction

Taro (*Colocasia esculenta* L.), also called Panikachu in Bangladesh, is an aqua aroid belonging to the family Araceae that contains 106 genera and more than 1500 species. While this underutilized crop is a staple food in Hawaii and Fiji, it is an important secondary food of some African and Asian countries. The plant is herbaceous, 1-2 m height and consists of a central corm (lying just below the soil surface) from which leaves and roots grow upwards and downwards, respectively and cormels, daughter corms and

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* *Corresponding author*: krshnnd@yahoo.com

runners (stolons) grow laterally. In Eddoe and Dasheen types of taro, the central corm represents the main stem structure of the plant. The sterile appendage is a distinguishing taxonomic characteristic between dasheen and eddoe types of taro. In eddoe types, the sterile appendage is longer than the male section of the spadix but in dasheen types, the appendage is shorter than the male section. In addition to being an important traditional food crop, aqua aroid is a significant export commodity in Fiji and Cook Islands. Few processed products are made from them, although *Colocasia* flour has been marketed successfully in Hawaii and India. In Bangladesh, aroid genera and species occur in different locations which can be categorized into edible, poisonous, medicinal and ornamental. They are rich in calcium, phosphorus, iron, vitamin C, thiamine riboflavin and niacin which are important constituents of human diet. Most of the araceae plants or plant parts (leaf, petiole, rhizome, corms, stolon, flowers, etc.) are used directly or indirectly in Bangladesh for animal and human beings in different ways. At the advent of modern agriculture introducing high yielding crop varieties in the country the underutilized crops like aqua aroids are pushed under the threat of extinction and their merits or potentialities were not evaluated nor their taxonomic position was properly determined. The degree of relationship and association of these components with yield can be measured by the correlation coefficient studies. An entirely different technique has been developed [1,2], which has effective for statistical in a system of correlated variables. Considering correlated responses, the present study therefore was undertaken to find out and establish suitable selection criteria for higher tuber yield through study of relationship between yield and yield components in aqua edible aroids. Association of yield contributing characters with yield is of great importance in selecting desirable genotypes. Path coefficient analysis on the other hand determines the direct and indirect contribution of the characters on yield. This will be helpful in effective selection for simultaneous improvement of the component characters towards yields.

2. Materials and Methods

2.1. *Plant materials*

Edible aroids accessions were collected from different aroid growing pockets in the country, such as Rajshahi, Satkhira, Jessore, Bogra, Joypurhat, Munshiganj and Joydebpur of Dhaka, Mymensingh and Barisal in Bangladesh. Collected 485 accessions are being maintained at the experimental farm of the Institute of Biological Sciences in 2005-2006 at Rajshahi University, Rajshahi-6205 during onset of rainy season. All recommended agricultural practices were followed.

2.2. *Experimental design*

The experiment was set up in a randomized complete block (RCB) design with three replications. In each experimental plot accessions are planted with row to row spacing 0.75 m   and plant to plant spacing was 0.60m. The plantlets were sown in March, 2006.

Two healthy accessions were planted per hill during plantation and finally a single healthy plant was maintained. When the vegetative growth is in climax the agro-morphological data were collected. When plant and vegetative growth is very stunted, leaves become yellowish, dry and dropping the quantitative parameters were observed and the data on plant height (PLH), petiole length (PEL), petiole breadth (PEB), leaf length (LEL), leaf breadth (LEB), leaf number (LEN), leaf area index (LAI), inflorescence length (IFL), peduncle length (PDL), spath length (SPL), spath breadth (SPB) and yield per plant (YPP) were recorded following descriptors of taro with necessary modifications [3].

2.3. *Statistical Analysis*

The collected data were analyzed following the biometrical techniques of analysis [4] based on mathematical model [5] and using the SPSS and MS Excel software. Mean and critical differences were worked out and the analysis of variance for each character under study was performed by F Test [6]. The critical differences were calculated to compare between any two mean values [7]. Genotypic variance (σ^2_g), phenotypic variance (σ^2_p), and environment variance (σ^2_e) and covariance were estimated following the methods as described by Singh and Chaudhary [8]. The path coefficient analysis was done by using formula was extended by solving a set of simultaneous equations [9].

3. Results and Discussion

3.1. *Correlation coefficients*

Correlation coefficient between all possible pairs of characters both at phenotypic (r_p), and genotypic (r_g) level were computed from the components of variances and covariance matrix to measure the nature and magnitude of mutual relationship between yield and its components characters. The relevant results are presented in Table 1.

3.1.1. *At phenotypic level*

Plant height exhibited highly strong negative and significant association with leaf breadth (-0.564), leaf number (-0.619), inflorescence number (-0.550), inflorescence length (-0.690), spath length (-0.900) and spath breadth (-0.810). Positive and significant correlation was found of petiole length with yield per plant (0.560). The positive and significant association of petiole breadth was observed with spath breadth (0.670) and yield per plant (0.481). The highly significant and positive association of leaf length was found with leaf breadth (0.990), leaf number (0.991), leaf area index (0.687), inflorescence length (0.860), peduncle length (0.995), spath length (0.487), spath breadth (0.610) and yield per plant (0.576). The leaf breadth exhibited highly significant and positive effects with leaf number (0.630), leaf area index (0.760), inflorescence number (0.707), inflorescence length (0.604), peduncle length (0.957), spath length (0.981), spath breadth 0.913) and yield per plant (0.998). Leaf number showed highly significant and

positive effects with leaf area index (0.680), inflorescence number (0.740), inflorescence length (0.987), peduncle length (0.630), spath length (0.728), spath breadth (0.922), corm weight (0.991) and yield per plant (0.620). Leaf area index exhibited highly significant and positive effects in phenotypic level with inflorescence length (0.712), peduncle length (0.505), spath length (0.850), spath breadth (0.600). Inflorescence number showed highly and significant positive effects with inflorescence length (0.638), peduncle length (0.598), spath length (0.650) and spath breadth (0.668). Inflorescence length exhibited highly significant and positive effect with peduncle length (0.866), spath length (0.890), spath breadth (0.854), and yield per plant (0.662). Peduncle length exhibited highly significant and positive correlation effects with spath length (0.684), spath breadth (0.642). Spath length exhibited highly significant and positive effects with spath breadth (0.760) and yield per plant (0.890). In phenotypic level spath breadth exhibited highly significant positive effects with yield per plant (0.992).

Table 1. Phenotypic (below the diagonal) and genotypic (above the diagonal) correlation coefficients of plant characters of cultivars in Panikachu, *colocasia esculenta* L. Schott (stoloniferous).

CHARACTER	PLH	PEL	PEB	LEL	LEB	LEN	LAI	IFN	IFL	PDL	SPL	SPB	YPP
PLH	1	0.300	0.020	0.177	0.406	0.323	0.174	0. 323	0.849¶	0.165	0.572*	0.540*	0.560*
PEL	0.109	1	-0.073	-0.118	0.079	-0.004	0.069	0.068	0.065	0.068	0.010	-0.020	0.024
PEB	0.121	0.289	1	0.003	0.073	-0.002	0.078	0.065	0.097	0.068	0.026	-0.910¶	0.478*
LEL	-0.344	0.263	0.005	1	-0.680¶	-0.670¶	-0.564*	0. 394	-0.760¶	-0.538*	-0.710¶	0.632¶	-0.278
LEB	-0.564*	0.079	0.051	0. 990	1	-0.640¶	0.530*	-0.296	-0.910¶	-0.419	-0.680¶	-0.685¶	-0.582¶
LEN	-0.619¶	-0.008	-0.010	0. 911¶	0.630¶	1	-0.993¶	-0.885¶	-0.650¶	-0.985¶	-0.890¶	-0.674¶	0.600¶
LAI	-0.104	0.047	0.048	0.687¶	0.760¶	0.680¶	1	-0.228	-0.750¶	-0.316	0.940¶	-0.640¶	-0.039
IFN	-0.550¶	0.066	0.068	0.425	0.707¶	0.740¶	0.392	1	-0.860¶	-0.216	-0.670¶	-0.690¶	-0.122
IFL	-0.690¶	0.024	0.057	0.860¶	0.604¶	0. 987¶	0.712¶	0.638¶	1	-0.637¶	-0.920¶	-0.911¶	-0.670¶
PDL	-0.160	0.068	0.066	0.995¶	0. 957¶	0.630¶	0.505*	0.598¶	0.866¶	1	-0.645¶	-0.657¶	-0.176
SPL	-0.900¶	0.001	0.019	0.487*	0.981¶	0.728¶	0.850¶	0.650¶	0.890¶	0.684¶	1	0.980¶	-0.985¶
SPB	-0.810¶	-0.021	0.670¶	0.610¶	0. 913¶	0.922¶	0.600¶	0.668¶	0.854¶	0.642¶	0.760¶	1	-0.902¶
YPP	-0.405	0.560*	0.481*	0.576¶	0. 918¶	0.620¶	0.272	0.319	0.662¶	0.429	0.890¶	0. 992¶	1

*Significant at 0.05 level; ¶significant at 0.01 level.

3.1.2. *At genotypic level*

Plant height showed highly strong and positive correlation with inflorescence length (0.849), spath length (0.572), spath breadth (0.540) and yield per plant (0.560). Negative and significant association was observed in petiole breadth with spath breadth (-0.910). Positive and significant association was only found with yield per plant (0.640). Leaf length showed the highest significant and negative attitude with leaf breadth (-0.680), leaf number (-0.670), leaf area index (-0.564), inflorescence length (-0.760), peduncle length (-0.538), spath length (-0.710). Highest significant and positive attitude was found with

spath breadth (0.632). Leaf breadth showed highly significant and negative attitude with leaf number (-0.640), inflorescence length (-0.910), spath length (-0.680), spath breadth (-0.685) and yield per plant (-0.582). Only significant and positive effects were also found with leaf area index (0.530). Leaf number exhibited highly negative and significant effects with leaf area index (–0.993), inflorescence number (-0.885), inflorescence length (-0.650), peduncle length (-0.985), spath length (-0.890) and spath breadth (-0.674). Only yield per plant (0.600) showed significant and positive effect with leaf number. Leaf area index also showed highly significant and negative effects with inflorescence length (-0.750) and spath breadth (-0.640). Significant and positive effect was also found with spath length (0.940). Inflorescence number exhibited negative and significant effects with inflorescence length (-0.860), spath length (-0.670), spath breadth (-0.690). Inflorescence length showed highly negative and significant effects with peduncle length (-0.637), spath length (-0.920), spath breadth (-0.911), corm weight (-0.700) and yield per plant (-0.670). Peduncle length showed significant and negative values with spath length (-0.645) and spath breadth (-0.657). Spath length showed highly significant and negative effects with corm weight (-0.843) and yield per plant (-0.985). Highly significant and positive correlation effects were also found with spath breadth (0.980). Spath breadth showed highly significant and negative effects with yield per plant (-0.902).

3.2. *Path analysis*

Path coefficient analysis was computed both at genotypic an phenotypic levels to measure the direct and indirect effects of yield contributing characters on the end product (yield per plant). The results are presented in Table 2.

3.2.1. *At phenotypic level*

Direct effect of plant height on yield per plant was high and positive (1.3978). Positive and high indirect effect was noticed through leaf length (0.2626), leaf breadth (0.8175), leaf number (0.2147) and inflorescence number (0.2833). Petiole length showed low positive effect on yield per plant (0.1079). Positive and indirect effects were observed through plant height (0.1789) on yield per plant. Petiole length exhibited high and positive effect on yield per plant (0.6978). Indirect and positive effects were also found through plant height (0.1524), leaf length (0.2007) and leaf breadth (0.1136). Petiole breadth showed indirect and positive effects through plant height (0.1691), petiole length (0.2017) and corm weight (0.2437). The leaf length exhibited high and positive direct effect on yield per plant (0.7633). The leaf length also showed indirect and positive effects through plant height (0.4804), petiole length (0.1835), leaf breadth (1.551), leaf number (0.3590), leaf area index (0.1932), inflorescence number (0.2189) and corm weight (0.3019). Leaf breadth showed positive and highest direct effect on yield per plant (1.4495). It also exhibited positive and indirect effects through plant height (0.7883), leaf length (0.8167), leaf number (0.2185), leaf area index (0.2137) and inflorescence number (0.3641). Leaf

number exhibited positive direct effect on yield per plant (0.3469). It also showed high and positive effects in major cases through plant height (0.8652), leaf length (0.7900), leaf breadth (0.9132), leaf area index (0.7669), inflorescence number (0.3871) and corm weight (0.6338). Leaf area index exhibited high and positive direct effect on yield per plant (0.2812). Indirect and positive attitudes of this trait were observed through plant height (0.1454), leaf length (0.5244), leaf breadth (1.1016), leaf number (0.3502), inflorescence number (0.2019) and corm weight (0.1394). Inflorescence number showed high and positive effects on yield per plant (0.5150). It also exhibited positive effects through plant height (0.7688), leaf length (0.3244), leaf breadth (1.0248), leaf number (0.2566), leaf area index (0.1102) and corm weight (0.1605). In the phenotypic level corm breadth followed by leaf breadth, plant height, and leaf length showed positive and highest direct effect toward yield per plant. The residual effect, 0.4235 indicated that about 58 % yield was contributed by these characters.

Table 2. Direct (diagonal bold) and indirect effects for yield of plant characters of cultivars in Panikachu in genotypic (G) and phenotypic (P) level.

Character		PLH	PEL	PEB	LEL	LEB	LEN	LAI	IFN	CRW	Corr YPP
PLH	G	0.5963	0.0324	0.0176	0.0334	0.1488	0.0093	0.0886	0.0862	0.0043	0.560*
	P	1.3978	0.0761	0.0087	0.2626	0.8175	0.2147	0.0292	0.2833	0.0563	-0.405
PEL	G	0.1789	0.1079	0.0647	0.0222	0.0287	0.0001	0.0352	0.0182	0.0007	0.024
	P	0.1524	0.6978	0.0207	0.2007	0.1136	0.0027	0.0133	0.0340	0.0070	0.560¶
PEB	G	0.0118	0.0079	0.8868	0.0006	0.0266	0.0001	0.0397	0.0174	0.0137	0.640¶
	P	0.1691	0.2017	0.0718	0.0036	0.0739	0.0035	0.0135	0.0350	0.2437	0.478*
LEL	G	0.1055	0.0127	0.0028	0.1884	0.2493	0.0193	0.2873	0.1052	0.0182	-0.298
	P	0.4804	0.1835	0.0003	0.7633	1.5510	0.3590	0.1932	02189	0.3019	0.576¶
LEB	G	0.2421	0.0085	0.0644	0.1281	0.3666	0.0184	0.2700	0.0790	0.0024	-0.582
	P	0.7883	0.0547	0.0037	0.8167	1.4495	0.2185	0.2137	0.3641	0.0377	0.998¶
LEN	G	0.1926	0.0004	0.0020	0.1263	0.2346	0.0288	0.5606	0.2363	0.0361	0.600¶
	P	0.8652	0.0055	0.0007	0.7900	0.9132	0.3469	0.7669	0.3871	0.6338	0.620¶
LAI	G	0.1037	0.0074	0.0692	0.1063	0.1943	0.2697	0.5095	0.0609	0.0319	-0.039
	P	0.1454	0.0329	0.0034	0.5244	1.1016	0.3502	0.2812	0.2019	0.1394	0.272
IFN	G	0.1926	0.0073	0.0576	0.0742	0.1085	0.0254	0.1162	0.2670	0.0090	-0.122
	P	0.7688	0.0461	0.0049	0.3244	1.0248	0.2566	0.1102	51.50	0.1605	0.319
CRW	G	0.0316	0.0010	0.1499	0.0422	0.0110	0.0128	0.2002	0.0296	0.0812	-0.080
	P	0.1230	0.0076	0.0273	0.3603	0.0855	0.3437	0.0613	0.1293	0.6396	0.256

G - residual effect = 0.2205; P - residual effect = 0. 4235; *significant at 0.05 level; ¶ significant at 0.01 level

3.2.2. *At genotypic level*

Plant height showed positive direct effect (0.5964) on yield per plant. Positive and indirect effects were noticed through leaf breadth (0.1488) on yield per plant. The direct effect of petiole breadth on yield per plant was high (0.8868). Leaf length showed positive and direct effect on yield per plant (0.1884). Positive and indirect effects were found through plant height (0.1055), leaf breadth (0.2493), leaf area index (0.2873) and inflorescence number (0.1052). Leaf breadth exhibited high and positive direct effect on yield per plant (0.3666). It showed indirect and positive effects through plant height (0.2421), leaf length (0.1281), leaf area index (0.2700). Leaf number also exhibited indirect and positive effects through plant height (0.1926), leaf length (1263), leaf breadth (0.2346), leaf area index (0.5606) and inflorescence number (0.2363). Leaf area index showed positive and direct effect on yield per plant (0.5095). It also exhibited positive and indirect effect through plant height (0.1037), leaf length (0.1063), leaf breadth (0.1943), leaf number (0.2697). Inflorescence number showed positive direct effect on yield per plant (0.2670). It also exhibited positive and indirect effects via plant height (0.1926), leaf breadth (0.1085), leaf number (0.0254), leaf area index (0.1162). In genotypic level relatively moderate to high direct effects were expressed by petiole breadth followed by plant height, LAI, leaf breath. Leaf number showed indirect effect via LAI toward yield per plant. The residual effect 0.2205 indicated that the characters studied contributed 78 % of the yield. In Panikachu, plant height, leaf length, leaf breadth, leaf number and LAI showed positive correlation with yield per plant of which leaf length, leaf breadth and leaf number showed significantly positive correlation with yield per plant in both genotypic and phenotypic level. Correlation study showed the wide spectrum of relationship in respect of yield per plant and the characters themselves. In genotypic level plant height, petiole breadth, LAI had relatively high direct effect than other characters but in phenotypic level plant height, petiole length, leaf length and leaf breadth play a significant role for increasing the yield per plant as well as important for selection. Residual effect in both cases indicates that there is a positive chance for selection for cultivars development.

Positive and highly significant correlation of tuber yield with plant leafiness, shoot height and vine dry weight in yellow yam was also observed by [10]. In taro, High positive correlation between plant height and size of corms, L/B ratio and size of corm were observed at genotypic level and yield was positively correlated with number of suckers per plant [11]. The characters such as mean weight of cormels/ plant, number of cormels / plant and LAI were positively and significantly correlated with yield [12]. Yield per plant was significantly and positively correlated with most of characters at both phenotypic and genotypic levels in tanier plants [13]. Yield per plant was significantly and positively correlated with most of character at both phenotypic and genotypic levels [14]. Cormel yield had positive and significant association with the length and girth of main sucker, number of cormels per plant and corm weight but it was negatively correlated with corm/cormel ratio [15]. Cormel number, cormel thickness, plant height, leaf length and leaf width had higher positive correlation with cormel yield whereas leaf number was negatively correlated with yield [16]. In arvi total yield per plant was

positively and significantly correlated with number of corms and cormels per plant and corm length [17].

Acknowledgement

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