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Accession Characterization and Genetic Variability Studies in *Colocasia esculenta* L. Schott

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Abstract

Accessions of *Colocasia esculenta* L. Schott. cultivars collected from thirteen aroid growing districts were studied for determining their genetic variability under the agromorphological purviews. Plant height, petiole length, petiole breadth, leaf number, leaf length, leaf breadth, LAI, inflorescence length, peduncle length, spathe length, spathe breadth, corm length, corm breadth, cormel number, cormel length, cormel breadth, corm weight, cormel weight, total fresh weight, total dry weight, yield per plant were taken in this study for nature and extent of variability analysis of edible cultivars of *Colocasia esculenta* L. Schott. Presence of significant differences together with wide ranges of variation in most cultivars indicates wide range of variability existed among the accession as well as local cultivars of this edible aroid. Genotypic variances and coefficient of variation for most of the characters were remarkably higher than their corresponding environmental variances which also indicate the existence of variation in genotypic origin.

Key words: Characterization, *Mukhikachu,* Variability, Corm, Cormel, *Colocasia esculenta.*

Introduction

Colocasia esculenta L. Schott commonly known as Mukhikachu belongs to Araceae family is an important vegetable in Bangladesh and it contributes a considerable part of the total supply of bulky vegetables particularly during August and September (Ahmed and Rashid, 1975). It also compares favorably in nutritional value with other root crops such as cassava, yam, sweet potato (Plucknett *et al.*, 1970). In Bangladesh very little research works on this edible aroids had been done. Here it is absolutely an under utilized crop and not yet accepted as a general crop of the farmers. The world's rapid population growth is demanding increased production and greater diversification of crops. Roots and tubers can play a major role in addressing this issue, including edible aroids which in many countries are treated just as a vegetable. Germplasm characterization and evaluation address the existing genetic variability that acts as a supporting backbone for providing basic information towards improving the crop plant. Genetic variability is an essential prerequisite for crop improvement program for obtaining high yielding varieties. Therefore, knowledge of characterization and genetic variability is useful in formulation of effective selection strategy in breeding program. The main objectives of this finding for characterization and evaluation of collected *Colocasia esculenta* L. Schott edible accessions and to analyze its genetic diversity through study of using morpho-agronomic traits. It also estimate the variation through in depth study on gross morphological characters. The phenotypic and genotypic variability present in different characters, contributing to corm yield of edible cultivars.

Materials and Methods

Plant materials

Colocasia esculenta L. Schott accessions were collected from different aroid growing areas such as such as Arani, Godagari and Meher chandi of Rajshahi, Tala of Satkhira, Churamonkati and Chougacha of Jessore, Santhahar of Bogra, Panchbibi of Joypurhat, Munshiganj and Joydebpur of Dhaka, Madhupur of Mymensingh and sadar upozilla of Barisal in Bangladesh from 2005-2006. Selected plantlets and plants parts (plantlets, corm, cormels and setts) were used for propagating materials. This investigation was conducted at the experimental farm of the Institute of Biological Sciences research field at Rajshahi University, Rajshahi during 2005-2008. The land in which the experiment was carried out was medium high. The soil was part of Level Barind

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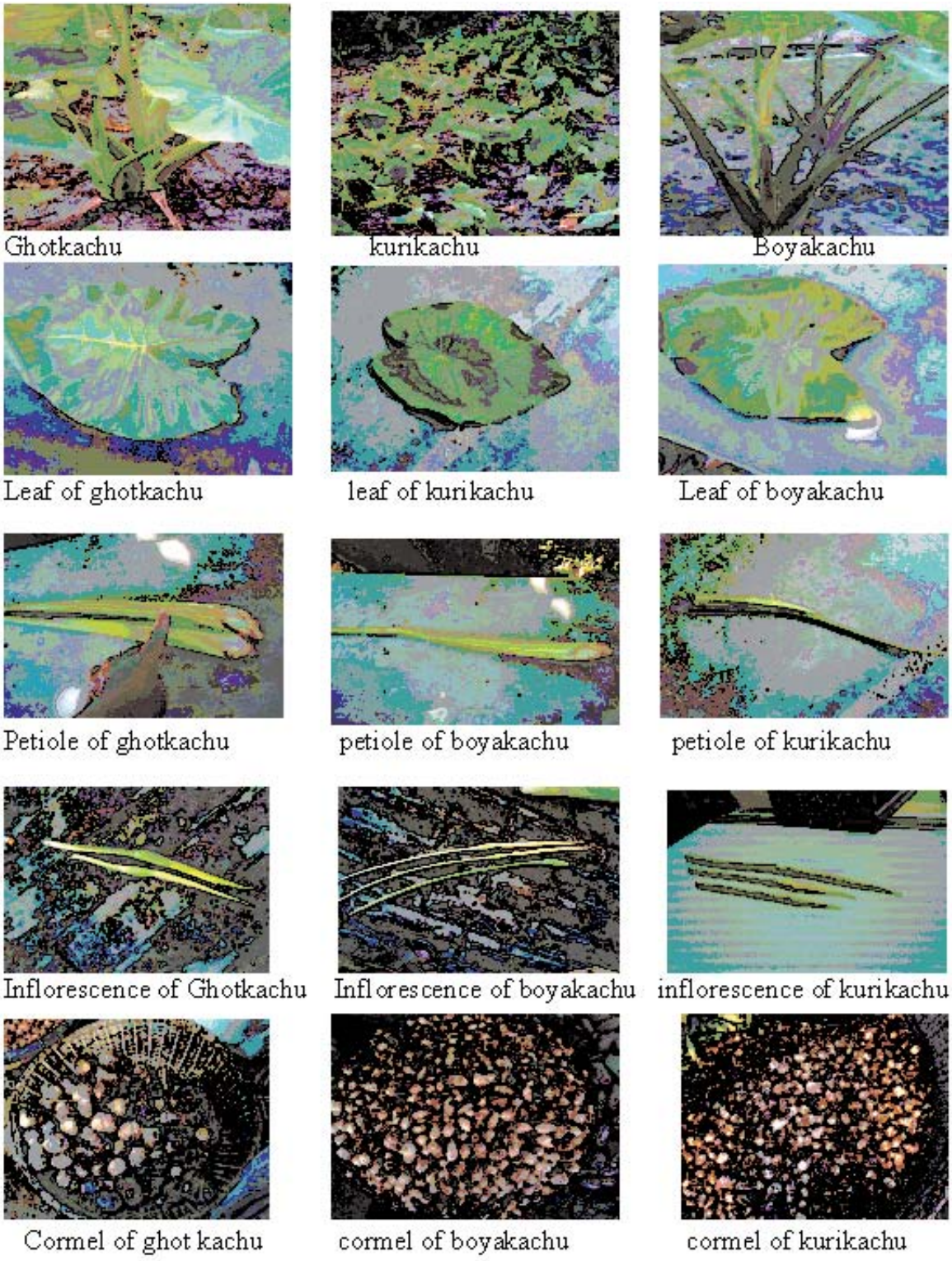

Fig: Variation showing plant parts of *C. esculenta* L.

agroecological zone marked by sandy loam with PH 6.5. All recommended agricultural practices were followed.

Experimental design

The experiment was set up in a Randomized Complete Block (RCB) design with three replications. In each experimental plot plant propagules were planted with row to row spacing 0.75 m and plant to plant spacing was 0.60 cm was maintained. The collected propagules are designated, districts with first three letters (dha=Dhaka) and number on basis of collected accessions. Two healthy propagules were planted per hill during plantation and finally a single healthy plant was maintained.

Data recording

The agro-morphological data of Plant height (PLH), Petiole length (PEL), Petiole breadth (PEB), Leaf length (LEL), Leaf breadth (LEB), Leaf Number (LEN), Corm length (CRL): Corm breadth (CRB), Cormel length (COL), Cormel breadth (COB), Cormel number (CON), Cormel weight (COW), Corm weight (CRW), Sucker number (SUN) and Yield per plant (YPP) were collected and recorded following descriptors of Taro with necessary modifications (IPGR I, 1999).

Statistical analysis

The collected data were analyzed following the biometrical techniques of analysis developed by Mather (1949) based on mathematical model of Fisher *et al.* (1932) using the SPSS and excel software. Mean and Critical differences were worked out by the method of analysis of variance used for randomized block design. The data analysis was done after Cochran and Cox, (1960). Critical differences were calculated to compare between any two means following Panse and Suhatme, (1978) and Singh and Chaudhary (1977). Coefficient of variability at phenotypic, genotypic and environmental levels were computed following Johnson *et al.* (1955) and Burton and De Vane (1953).

Results and Discussions

A total of 447 accessions of edible *Colocasia esculenta* L. Schott were collected from Bangladesh (Table I). For the description of edible aroid accessions ranges, means of quantitative and qualitative characters were considered. The quantitative characters are plant height, petiole length, petiole breadth, leaf numbers, leaf length, leaf breadth, inflorescence length, peduncle length, corm length, corm breadth, cormel length, cormel breadth were presented in Table II. The qualitative characters such as colour of leaf, petiole, nature of inflorescence, growing condition, corm flesh colour and leaf lamina type were considered. Collected accessions were grouped on their agro morphological quantitative and qualitative characters for selecting suitable accessions of the cultivars of edible aroids in Bangladesh were presented in Table III.

Quantitative characterization

C. esculenta L. Schott plants were very short type and only attained 65.7 cm in height followed by Muk -2 (41.1 cm). Leaf length was observed in Muk-1 (26.23 cm) followed by in Muk--2 (19.60 cm).The minimum leaf length was found in Muk -3 (15.08 cm). Among the edible cultivar leaf breadth was highest in Muk-1 (16.35 cm) followed by Muk-2 (11.23 cm). Minimum leaf breadth was found in muk-3 (8.48 cm). The length of petiole was highest in Muk-1 (43.17 cm). Petiole length is lowest in Muk-3 (19.67 cm). Petiole breadth was highest in Muk- 1(4.26cm) followed by 2.44 cm in Muk-2, which are similar to Muk-3. Highest inflorescence length was found in Muk-2 (15.00 cm) followed by Muk-1 (13.77 cm). Muk-3 has the lowest inflorescence (12.17 cm). Highest peduncle length was found in Muk-1 (10.37 cm) followed by Muk-3 (10.28 cm). The lowest peduncle length was found in Muk-2 (9.82 cm). Highest corm length was found in Muk-3 (10.03 cm) followed by Muk-2 (7.57cm). Among the cultivars highest corm breadth was observed in Muk-3 (19.47 cm) followed by Muk-2 (12.32 cm). Lowest corm breadth was found in Muk-1 (5.58 cm). Highest cormel length was found in Muk-2 (4.70 cm) followed by Muk-3 (4.43 cm). Lowest cormel length was found in Muk-1 (2.23cm). Cormel breadth was highest in Muk-3 (9.87 cm) followed by Muk-2 (8.62 cm). Lowest cormel breadth was found Muk-1(5.35 cm). Some wild type genotypes such as indigenous, ornamental, medicinal aroid plants has long stolons, small elongated corms, continuous growth and predominantly high concentration of calcium oxalate that causes acridity as a result they are non edible.

Qualitative characterization

Leaf colour varied from whitish yellow to very dark purple, depending on the genotype. Leaf petioles and laminas do not always have the same colour. The basic colour of the

Table I :Collection of accessions from different aroid growing districts in Bangladesh.

Accession no	Major grops	Nos of Collections	% of groups in collection		Growing conditions	colour of corm flesh	Palatibility of cooked starch	Plant uses	Place of collection/ district
			Cultivated	wild					
Dha-1.1-1.32	Muk (Mukhikachu)	32	30.47	-	Upland	White	Acceptable	Food	Dhaka (Dha)
Gaz-1.33-1.66	Muk (Mukhikachu)	34	25.0	-	Upland	brown	Acceptable	Food	Gazipur (Gaz)
Mun-1.67-1.83	Muk (Mukhikachu)	17+3	18.68	3.29 Med.	Upland	White	Acceptable	Food, med	Munshiganj (Mun)
Tan-1.84-1.108	Muk (Mukhikachu)	25	24.50	-	Upland	White	Acceptable	Food, med	Tangail (Tan)
Sat-1.109-1.150	Muk (Mukhikachu)	42	24.85	3.55 wild	Upland	yellow	Acceptable	Food, med	Satkhira (Sat)
Khu-1.151-1.183	Muk (Mukhikachu)	25+8	19.37	6.20 Ornamental	Upland	White	Acceptable	Food, med	Khulna (Khu)
Jes-1.184-1.225	Muk (Mukhikachu)	42	22.95	-	Upland	Yellow	Acceptable	Food, med	Jessore (Jes)
Raj-1.227-1.250	Muk (Mukhikachu)	39	19.69	3.03 wild	Upland	White	Good	Food	Rajshahi (Raj)
Joy-1.251-1.281	Muk (Mukhikachu)	25	16.44	-	Upland	White	Acceptable	Food	Joypurhat (Joy)
Bog-1.282-1.323	Muk (Mukhikachu)	42	33.87	-	Upland	White	Good	Food	Bogra (Bog)
Nao-1.324-1.358	Muk (Mukhikachu)	35	25.00	-	Upland	Yellow	Acceptable	Food, med	Naogaon (Nao)
Kus-1.359-1.393	Muk (Mukhikachu)	35	20.83	-	Upland	White	Acceptable	Food, med	Kustia (Kus)
Bar-1.394-1.436	Muk (Mukhikachu)	43	24.02	-	Upland	Brown	Acceptable	Food	Barisal (Bar)
Total=447									

Table II: Mean performance of yield contributing characters of three cultivars in mukhikachu (*Colocasia esculenta*.LSchott.)

Culvars	PLH cm	PEL cm	PEB cm	LEL cm	LEB cm	LEN cm	LAI cm	IFL cm	PDL cm	SPL cm	SPB cm	CRL cm	CRB cm	CRW cm	CON cm	COW cm	COL cm	COB cm	YPP g
Muk-1	65.7	43.17	4.26	26.20	16.35	7.00	0.016	13.77	10.37	9.90	3.30	5.90	5.58	118.2	3.83	65.8	2.23	5.35	182
Muk-2	41.1	29.77	2.44	19.60	11.23	6.60	0.017	15.00	9.82	13.37	3.20	7.57	12.32	136.8	6.80	92.3	4.70	8.62	229
Muk-3	30.3	19.67	2.36	15.08	8.48	4.97	0.018	12.17	10.28	9.03	3.25	10.03	19.47	186	10.97	218.3	4.43	9.87	401
Mean	45.9	30.87	3.00	20.29	12.01	6.18	0.0173	13.64	10.15	10.76	3.24	7.83	12.45	147	7.2	125.49	3.78	7.94	270.7
±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±
S.E.	1.73	1.14	0.099	0.544	0.386	0.151	0.0004	0.246	0.131	0.240	0.0654	0.234	0.642	4.36	0.456	8.86	0.161	0.247	11.9
SD	16.38	10.85	0. 945	5.16	3.66	1.429	0.0038	2.33	1.24	2.27	0.620	2.22	6.09	41.38	4.32	84.06	1.52	2.34	113.2
C.D at 0.05	10.50	7.50	0.531	3.375	4.436	1.695	0.0058	3.34	2.006	1.93	1.01	1.77	3.05	37.39	5.091	79.21	1.486	2.174	90.82
0.01	13.88	9.92	0.701	4.448	5.862	2.240	0.0075	4.414	2.65	2.55	1.33	2.33	4.04	49.40	6.725	104.68	1.962	2.873	120.01

Table III: Different groupings of collected accessions of edible aroids after characterization from different districts of Bangladesh

Total Collected accessions	Different morphotypes	Species	Dissimilarities % in comparison	Local cultivars
Dha-1.1-1.32, Tan-1.84-1.108Gaz-1.33-1.66,Mun-1.67-1.83, Sat-1.109-1.150, Khu-1.151-1.183,Jes-1.176-1.217, Kus-1.359-1.393, Bar-1.394-1.436Raj-1.227-1.250, Bog-1.282-1.323, Nao-1.324-1.358	Mor #1, Mor #2, Mor #3, Mor #4, Mor #5, Mor #6, Mor # 7, Mor #8, Mor # 9, Mor # 10	Colocasia esculenta (L) Schott	149(8.56)	Muk-1 (Charakachu)
	Mor # 11,Mor # 12, Mor # 13, Mor # 14, Mor # 15, Mor #16, Mor # 17, Mor # 18, Mor # 19, Mor # 20	Colocasia esculenta (L) Schott	162(9.31)	Muk-2 (Boya kachu)
	Mor # 21,Mor # 22, Mor #23, Mor # 24, Mor # 25, Mor # 26, Mor # 27,Mor # 28, Mor # 29, Mor # 30.	Colocasia esculenta (L) Schott	136(7.82)	Muk-3 (kurikachu)

petiole is extremely variable and tremendous variation of the patterns (stripe, blotches, dots, patches, etc.) and secondary colour of the petioles were observed. Most of the mukhikachu edible accessions produce corms and cormels. The shape of the primary corms of edible aroids are globular, elliptical and roundish, The variation of leaf shape were also found heart shaped, peltate or hastate in mukhikachu. Color of the corm flesh varied white, yellowish, brown and whitish. Palatability of cooked starch was tasted with food habit of localized aroid growing farmers through grading by not acceptable, poor and acceptable. Among the *C. esculenta* L.Schott, Mor # 3, Mor # 4, Mor # 7, Mor # 8 for Muk-1 (*Charakachu*); Mor # 12, Mor # 14, Mor # 15, Mor # 17.Mor # 20 for Muk-2 (*boyakachu*); Mor # 26, Mor # 28 and Mor # 30 for Muk-3 (*kurikachu*) showed best performances regarding yield per plant (Table III).

Variation in mean performances

High range of variation was observed in thirty accessions which represent three cultivars for plant height (232 %), leaf length (168 %), leaf breadth (228 %), LAI (188.88 %), corm length (250 %), corm breadth (525 %), cormel number (1100 %), cormel weight (820 %), cormel length (366.66 %), cormel breath (1200 %) and yield per plant (371 %) belonging to the *C. esculenta*. Among the three cultivars of this species, variation for plant height (116 %), leaf length (73.74 %), leaf breadth (92.80 %), LAI (12.50 %), corm length (70 %), corm breadth (248.92 %), corm weight (57.36 %), cormel number (186.42 %), cormel weight (231.76 %), cormel length (110.76 %), cormel breadth (86.35 %) and yield per plant (120.32 %) were also shown. Among the cultivars, ghot kachu cultivars had high yield due to presence of large number of cormels and cormel weight but other cultivars had small number of cormels which indicate reduced yield. Cultivars *kurikachu* and *boya kachu* showed lower yield due to lower size of corm. The analysis of variations revealed (Table IV) highly significant differences among the accessions as well as three cultivars of this species for almost all characters. Among the cultivars the genetic variability parameters for maximum characters revealed that phenotypic coefficient of variability cvp was higher (Table V) in magnitude than the corresponding genotypic coefficient of variability (cv_g). These were further substantiated by higher estimates of phenotypic (σ^2_p) and genotypic variances (σ^2_g). The values of phenotypic and genotypic coefficient of variation indicated that there were considerable environmental influences upon the phenotypic expression for few characters. Higher and nearest values of cv_p to values of cv_g indicated higher degree of genetic variability. So, high genetic variances for studied characters indicated the exploitation of variability through selection. Mukhikachu for LAI, peduncle length, spathe breadth and panikachu for leaf area index which have higher cv_e than those of cv_g suggested limited variability and greater role of environmental factors in the expression of these traits. According to Ofori and Bernett-Larteg (1995), morphological characters are important diagnostic features for distinguishing among genotypes. They may serve as genetic markers which facilitate and speed up selection in crop improvement programmes. The presence of some morphological features may also be indicative of some important traits. Each of thirty accessions for mukhikachu showed good performances for yield per plant. The main difference between dasheen (panikachu) and eddoetype (mukhikachu) is in shape and size of the main corm and cormels. Some accessions were found to be intermediate types. Eddoes were further grouped into three local cultivars depending on their corm, cormel, sizes and cormel pattern. Cultivars adapted to flooded conditions are always dasheen types and eddoes are always found to be cultivated in rainfed conditions. Moreover eddoe types exhibit sterile tips of their spadix shorter than dasheen types. In India, CTCRI (Central Tuber Crops Research Institute) is holding about 350 accessions collected from different parts of India (Thankamma Pillai, 1993). Chand *et al*. (1987) studied the analysis of variance for nine characters and revealed highly significant differences between genotypes. A wide range of variation was observed for plant height, number of suckers per plant and corm size in taro. Chand *et al,* (1987) observed high phenotypic and genotypic coefficients of variation for number of suckers per plant and yield per plant. Pandey *et al.* (1996) observed wide range of variability among 31 genotypes for yield per plant, weight of mother cormels and weight of cormels. Pandey *et al.* (1996) studied 31 genotypes of taro and assessed for variability for 8 yield contributing characters. Wide range of variation was observed for yield per plant, weight of mother cormels and weight of cormels. Dwivedi and Sen (1997) found superiority of selection of taro entries based on corm weight and girth of main sucker. Pandey and Singh (2006) estimated variance, for eighteen characters in taro. He reported the gcv was highest in cormel number per plant. Cheema *et al.* (2007) studied genetic variability for yield and quality traits in Arvi. Estimates of phe-

Table IV: Mean squares of ANOVA for yield and yield contributing characters of three cultivars in mukhi kachu .

Souces of variation	df	Mean squares for																	
		PLH	PEL	PEB	LEL	LEB	LEN	LEI	IFL	PEL	SPL	SPB	CRL	CRB	CRW	CON	COW	COL	COB	YPP
Cultivars	2	9854.8**	4169.1**	34.40**	937.70**	479.02**	34.81**	0.0000285 ns	60.54**	2.64 ns	157.91**	0.070 ns	129.73**	1446.04**	36836**	385.23**	19923 2**	54.97**	163.24**	39933 2**
Block	2	15.3 ns	70.6*	0.274 ns	3.97 ns	9.01*	5.51**	0.00008**	0.580 ns	0.270 ns	6.86**	0.491 ns	24.38**	16.60*	15356**	6.03 ns	7336*	0.586 ns	2.03 ns	32399**
Interaction	4	177.1**	63.3*	0.366*	34.48**	3.29 ns	3.11*	0.000002 ns	4.59 ns	1.60 ns	4.10*	0.306 ns	8.55**	21.84**	1172 ns	20.17 ns	5320 ns	7.10**	2.89 ns	5543 ns
Error	81	42.2	21.6	0.108	4.36	2.51	1.10	0.00001	4.27	1.54	1.43	0.394	1.20	3.58	535	9.92	2401	0.845	1.81	3156
Total	89	10089.4	4324.60	35.14	980.51	493.83	44.53	0.000124	70.00	6.050	170.30	1.261	163.86	1488.06	53899	421.35	21428 9	63.50	169.97	44043 0

*significant at 0.05 level ** significant at 0.01 level

Table V: Estimates of range and genetic parameters for yield and yield contributing characters of three cultivars in mukhi kachu

Genetic Parameters	PLH	PEL	PEB	LEL	LEB	LEN	LEI	IFL	PEL	SPL	SPB	CRL	CRB	CRW	CON	COW	COL	COB	YPP
Range	25.00-83.00	13.00-60.00	2.00-5.66	12.5-33.5	6.25-20.50	4.00-10.00	0.009-0.026	9.00-19.00	7.00-12.50	7.00-16.00	2.00-5.00	4.00-14.00	4.00-25.00	80.00-270.00	2.00-24.00	50.00-460.00	1.50-7.00	1.00-13.00	140.00-660.00
σ^2_p	3313.06	1404.10	11.53	315.47	161.34	12.33	0.000018	23.02	1.907	53.59	0.284	44.04	484.40	12635.33	135.02	68011.33	18.88	55.26	135214.66
σ^2_g	3270.86	1382.5	11.43	311.11	158.83	11.23	0.000051	18.75	0.367	52.16	-0.108	42.84	480.82	12100.33	125.10	65610.33	18.04	53.45	132058.66
σ^2_e	42.2	21.6	0.108	4.36	2.51	1.10	0.000133	4.27	1.54	1.43	0.394	1.20	3.58	535	9.92	2401	0.845	1.81	3156
CV_p	125.97	121.38	113.18	87.53	105.76	56.81	24.79	35.17	13.60	68.03	16.44	84.75	176.77	76.46	161.38	207.81	114.95	93.62	135.83
CV_g	125.17	120.44	112.69	86.93	104.93	54.22	13.05	31.74	5.96	67.12	10.14	83.59	176.12	74.83	155.34	204.11	112.36	92.07	134.24
CV_e	14.21	15.05	10.95	10.29	13.19	16.97	21.08	15.14	12.22	11.11	19.37	13.99	15.19	15.73	43.74	39.046	24.31	16.94	20.75
h^2 (bs)	98.70	98.40	99.00	98.60	98.40	91.00	27.70	81.40	19.30	97.30	38.00	97.20	99.20	95.70	92.60	96.40	95.50	96.70	97.60
GA	117.03	75.95	6.92	36.07	25.74	6.58	0.0024	8.045	0.549	14.67	-0.417	13.28	44.97	107.57	22.165	251.40	8.54	14.80	358.89
GA %	236.13	246.03	230.66	177.77	214.16	106.47	13.87	58.98	5.40	136.33	12.87	169.60	361.20	73.17	307.84	200.33	225.92	186.39	132.57

notypic and genotypic coefficients of variation were high for number of leaves per plant, oxalate content, number of corms and cormels per plant, total yield per plant and corm weight.

Conclusion

From this study it is concluded that the variation observed among collected accessions as well as among cultivars. So that the selected accessions can be utilized for further research works.

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