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Study of Genetic Variability and Correlation of Potato (*Solanum tuberosum* L.) genotypes grown in Bangladesh

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Abstract

The experiment was conducted at Botanical Research Field of Rajshahi University, Rajshahi, Bangladesh during the rabi crop season of 2011-2012. Ten characters were included in the present investigation to study the variability and correlation coefficient in potato. The range of variation was pronounced in most of the characters, which indicates that the characters were quantitative in nature and are under polygenic control. Analysis of variance indicated significant difference among the genotypes with respect to all the characters studied. Moderate to high phenotypic as well as genotypic coefficient of variation was registered for all the characters except main stem number/plant and secondary stem number/plant. Higher heritability coupled with higher genetic advance as percent of mean was noticed for most of the characters except main stem number/plant, secondary stem number/plant and dry matter (%)/plant. Tuber yield/plant had a significant positive correlation with plant height, main stem number/plant, canopy size, leaf area/plant and dry matter (%)/plant. Depicted that these characters, have high and positively correlated towards tuber yield/plant and could considered as selection criteria in potato breeding program.

Keywords: Genetic variability, correlation, potato

INTRODUCTION

Potato *(Solanum tuberosum* L.*)* is one of the most important horticultural and economical food crops in Bangladesh as well as many countries of the world. It is an important vegetable crop in Bangladesh. In Bangladesh the tuber yield of potato is very low (7.54 t/ha) compared to other tropical countries (BBS, 2007). Its area and production are increasing day by day; the UN general assembly seeks to focus world attention on the role of potato in defeating hunger and poverty (Hossain et al. 2008). To feed this ever growing people there is a need to increase productivity in potato. Tuber yield is the cumulative effect of many component characters individually contributing towards yield. Yield is the result of interactions among several characters which are greatly influenced by environmental factors.

Information on the nature and magnitude of variability present in a population owing to genetic and non genetic causes is an important prerequisite for initiating any systematic breeding program. As yield is the main object

of a breeder, so it is important to know the relationship between various characters that have direct and indirect effect on yield. The knowledge of association of quantitative characters, especially the yield and its attributes provide an idea of association that could be effectively utilized in selecting the desired characters in segregating population. Variability is, therefore, a key factor, which determines the progress expected from selection. However, selection can act effectively only on heritable portion of variation. A quantitative measure, the estimates of heritability, provides a clear picture of the relative amount of heritable variation. Moreover, heritability in a broad sense accompanied by higher genetic advance is a reliable measure of the amount of genetic gain through selection (Johnson *et al.*, 1955).

Therefore, the present study was conducted to determine the nature and magnitude of variability, heritability, genetic advance and correlation among ten quantitative characters in 31 genotypes of potato.

MATERIALS AND METHODS

Materials

The plant materials for the present study comprised 31 exotic and local potato varieties. These were collected from genetic engineering and plant breeding laboratory Department of Botany, University of Rajshahi and Akafuji agro-technologies Ltd. Rajshahi, Bangladesh. The varieties were All blue, Granula, Shepody, Lady rosety, Petroneous, Carage, Banana, Quience, Baraka, Blady, JPR, Shita white, Altra, Febula, Chieftan, Hipita, Innovator, Jamalu, Akira, Dumini, Shill bilati, Atlanta, Hagri, All red, Asterix, Atlas, Lalpakri, Voyager, Haita red, Diamond, Indurkani and were grown at Botanical research field at Rajshahi University, Rajshahi, Bangladesh during the rabi crop season of 2011-2012.

Field evaluation

The experiment was laid out in a randomized complete block design with three replications. The field size was 26×12 sq. m. whole experimental field was divided into three blocks and the size of each block was 3 m × 26 m. Each replication comprised one block. There were 31 rows in each replication. At the final land preparation recommended doses of fertilizers (Anonymous, 1997) viz., 420 kg/ha N, 350 kg/ha P, 350 kg/ha K, 20 kg/ha S, 110 kg/ha gypsum, 12-15 tons/ha cowdung, were used. The potato tubers were planted during first week of November for two years. Intercultural operations like weeding, irrigation, mulching and earthing up were performed as and when necessary. Indofile M-45 (0.2%) was sprayed at 15 days interval commencing from 30 days after planting for prevention of fungal disease. Ten potato plants were selected at randomly in each replication and observations were recorded for plant height (cm) (PH), main stem number/plant (MSN), secondary stem number/plant (SSN), leaf number/plant (LN), leaf area/plant (LA), canopy size(CS), dry matter(%)/plant (DM), number of tuber/plant (NT), tuber weight/plant (TW), average tuber weight/plant (ATW).

Statistical analysis

Analysis of variance was worked out using the method of Panse and Sukhatme (1967). Genotypic (GCV) and phenotypic co-efficient of variation (PCV), heritability in broad sense (h^2b), genetic advance (GA), genetic advance as % of mean (GAM), genotypic (r_g) and phenotypic (r_p) correlation coefficients were done following the formulae used by Singh and Choudhury (1985). The above calculations were done for all the studied characters.

RESULTS AND DISCUSSION

Analysis of variance (Table 1) revealed significant mean sum of squares for all the characters indicating the presence of sufficient genetic variation among the genotypes ($p<0.01$) tested. The phenotypic coefficient of variation (Table 2) ranged from a low of 14.48 for main stem number/plant to a high of 14642.4 for canopy size. Similarly, the genotypic coefficient of variation also ranged from 3.28 for main stem number/plant to 13976.6 for canopy size. This indicates the presence of wide range of genetic variation in the test entries. Higher magnitude of both phenotypic as well as genotypic coefficient of variation i.e. PCV and GCV was noted for almost all the traits except for main stem number/plant (14.48 and 3.28, respectively). This confirms that the variability for all the characters in the test genotypes was a result of genetic effects which were less affected by the growing environment. Hence there is an ample scope of improvement through selection. These findings are in a consonance with the findings of Desai and Jaimini (1997), Chaudhary (1985) and Chaudhary and Sharma (1984) in potato. They have also recorded high PCV and GCV for tuber yield per plant, tuber number and average tuber weight. Moderate values of both phenotypic and genotypic coefficient of variation were observed for plant height (2181.95 and 2106.56) and leaf number/plant (1729.77 and 1634.95) indicating the limitation of selection for the improvement of these traits. However, moderate GCV combined with higher PCV was observed for some of the characters *viz*., leaf area/plant (311.26 and 368.30), dry matter (%)/plant (23.33 and 35.98), number of tuber/plant (216.23 and 255.62),tuber weight/plant

(12198.1 and 12925.0), average tuber weight/plant (2909 and 2969). The PCV was higher than the corresponding GCV for most of the characters denoting environmental factors influencing their expression. Mondal (2003) were reported higher genotypic and phenotypic coefficients of variation for average tuber weight/plant, tuber yield/plant and tubers number/plant in potato. Bhardwaj *et al.* (2005) observed that fruit firmness, yield/plant and size of stem recorded comparatively high estimates of phenotypic and genotypic coefficients of variation and heritability, genetic advance as percentage of mean in tomato.

Table 1: Analysis of variance for different characters in 31 potato genotypes

SL	Characters	Source			
		Mean sum of squares			
		Replication	Genotypes	Year	Error
	Degrees of freedom	2	30	1	744
1	Plant height(cm)	211.631	72645.254**	628.618	40.999
2	Main stem/plant	0.349	4.099**	7.768	0.267
3	Secondary stem/plant	0.136	5.524**	4.972	0.196
4	Canopy size	16484.440	3389210**	25754.96	968.65
5	Leaf no./plant	12.004	25191.32**	997.17	22.57
6	Leaf area/plant	875.597	10643.73**	16319.63	35.74
7	Dry matter(%)/plant	7.651	480.32**	239.58	1.22
8	Number of tuber/plant	21.492	993.82**	132.47	2.22
9	Tuber weight/plant	11312.600	1268199**	244296.1	1073.84
10	Average tuber wt./plant	80.210	31386**	140.37	0.644

*, ** Significant at 5% and 1% level of probability

Table 2: Estimation of genetic parameters for different characters in 31 potato genotypes

SL	Characters	Mean	Range	GCV	PCV	h^2b	GA	GAM
1	Plant height(cm)	114.929	25.12-232.25	2106.56	2181.95	96.544	99.594	86.65
2	Main stem/plant	2.915	01-07	3.28	14.48	22.676	0.303	10.41
3	Secondary stem/plant	2.649	01-05	6.52	20.40	31.986	0.484	18.28
4	Canopy size	803.41	121.92-1828.8	13976.6	14642.4	95.452	674.42	83.94
5	Leaf no./plant	51.05	20-160	1634.95	1729.77	94.518	57.863	113.33
6	Leaf area/plant	82.299	26-138.9	311.26	368.30	84.511	30.309	36.82
7	Dry matter(%)/plant	18.481	7-30	23.33	35.98	64.830	3.444	18.636
8	Number of tuber/plant	14.820	4-38	216.23	255.62	84.590	10.725	72.369
9	Tuber weight/plant	346.147	100-1120	12198.1	12925.0	94.376	411.22	118.79
10	Average tuber wt./plant	36	4-166	2909	2969	98	66	183.42

Table legend: GCV = Genotypic coefficient of variability; PCV = Phenotypic coefficient of variability; GA = Genetic advance; h^2b= heritability in broad sense; GAM = Genetic advance as % of mean

Table 3: Correlation coefficient (r_g, r_p) among different pairs of characters in potato

Characters		PH	MSN	SSN	CS	LN	LA	DM	NT	ATW	TW
PH	r_g	1.000	0.003**	0.0007**	0.126**	-0.146**	0.383**	-0.019**	-0.145**	0.078**	0.493**
	r_p	1.000	0.001**	0.0006**	0.127**	-0.141**	0.346**	-0.019**	-0.133**	0.076**	0.472**
MSN	r_g		1.000	0.552	0.094**	0.256**	0.075**	-0.013**	-0.096**	-0.127**	0.115**
	r_p		1.000	0.158	0.043**	0.117**	0.029**	-0.011**	-0.042**	-0.065**	0.054**
SSN	r_g			1.000	0.320**	-0.202**	0.207**	0.133**	-0.166**	-0.090**	-0.202**
	r_p			1.000	0.175**	-0.110**	0.106**	0.052**	-0.143**	-0.088**	-0.190**
CS	r_g				1.000	-0.240**	0.385**	0.506**	-0.125**	0.333**	0.355**
	r_p				1.000	-0.230**	0.345**	0.397**	-0.115**	0.322**	0.337**
LN	r_g					1.000	-0.447**	0.200**	-0.166**	-0.090**	-0.202**
	r_p					1.000	-0.398**	0.159**	-0.143**	-0.088**	-0.190**
LA	r_g						1.000	0.014**	-0.337**	0.053**	0.124**
	r_p						1.000	0.005**	-0.286**	0.049**	0.110**
DM	r_g							1.000	-0.172**	0.310**	0.474**
	r_p							1.000	-0.117**	0.243**	0.372**
NT	r_g								1.000	-0.395**	-0.135**
	r_p								1.000	-0.364**	-0.120**
ATW	r_g									1.000	0.789**
	r_p									1.000	0.759**

*, ** Significant at 5% and 1% level of probability

Table Legend r_g = Genotypic correlation coefficient**;** r_p = Phenotypic correlation coefficient**;** PH=Plant height (cm); MSN =Main stem umber/plant; SSN =Secondary stem number/plant; CS =Canopy size; LN =Leaf number/plant; LA =Leaf area/plant; DM =Dry matter (%)/plant; NT =Number of tuber/plant; ATW =Average tuber weight/plant; TW =Tuber weight/plant

High heritability (h^2b) estimates were noticed for all the traits except main stem number/plant and secondary stem number/plant (22.67 and 31.98) indicating that these traits responded satisfactorily to selection. Moreover, higher heritability (h^2b) estimates were coupled with high genetic advance as per cent of the mean for all the characters except main stem number/plant, secondary stem number/plant (10.41 and 18.28) and dry matter (%)/plant (18.28). This shows that the later three traits may not be improved through selection and creation of variation might be required through suitable programme. The results of the present study revealed that tuber yield per plant, tuber number per plant and tuber weight per plant exhibited higher phenotypic and genotypic coefficients of variation as well as higher heritability combined with higher genetic advance as per cent of the mean. This indicates that there is ample amount of genetic variability in the test entries for these traits and hence the genotypes could be further improved through selection. Very low heritability coupled with moderate genetic advance was observed for main stem number/plant and secondary stem number/plant through selection for this trait. High heritability was observed for canopy size (95.45) and plant height (96.54), suggesting selection for these characters is effective and improvement is made through phenotypic selection. Tuber number/plant, tuber weight/plant, plant height, canopy size, number of tuber/plant, number of leaf/plant and leaf area/plant had high heritability estimates associated with high genetic advance as percentage of mean values. This indicates the presence of additive gene effects. Heritability estimates with genetic advance as percentage of mean are more useful in predicting yield under phenotypic selection than heritability alone in potato (Mondal, 2003). In the present investigation, plant height, canopy size, number of leaf, leaf area, number of tuber/plant had higher GCV and PCV, high h^2b values and GAM which indicates that these characters are most vital in the selection for yield improvement.

In the majority of the characters the r_g (Genotypic correlation coefficients) were higher than the corresponding r_p (Phenotypic correlation coefficient) (Table 3), suggesting that the character association been largely effected by environment in such cases. Tuber weight/plant (yield) showed significant positive correlations with plant height, main stem number/plant, canopy size, leaf area/plant, and dry matter (%)/plant at genotypic and phenotypic level. The findings of Dayal (1984), Mondal (2003) and Haydar (2007) are in agreement with this result. Bhardwaj (2005) reported significant positive correlation of yield/plant with fruit

firmness, size of stem and fruit shape index at genotypic level in tomato. The correlation study suggested that the important characters like plant height, main stem number/plant, canopy size, leaf area/plant, and dry matter (%)/plant has positive effect. Increases of plant height and canopy size showed positive association reflects tuber yield increase. On the other hand, positive associations with plant height and canopy size, and leaf area indicate that vegetative fresh and vigorous plant stature with more tubers produces more yields. Thus, the characters canopy size and plant height is the important selection criteria for yield improvement.

REFERENCES

Anonymous.1997, Fertilizer Recommendation Guide. Bangladesh Agricultural Research Council. Farmgate, New Airport Road Dhaka-1215

Ara,T., Haydar,A., Islam, M.A., Azad, MAS. and Khokan, E.H., 2009. Path analysis in potato J.Soil.Nature. 3 (2):20-23

BBS, 2007, Year book of Agricultural Statistics. Bangladesh Bureau of Statistics. Statistics Division, Ministry of Planning, Dhaka, Bangladesh.p. 117

Bhardwaj, N. V. and Sharma, J.A., 2005. Genetic parameters and character association in tomato. Bangladesh J.Agric. Res. 30(1): 49-56.

Chaudhary, S.K. and Sharma, S.K., 1984, Genetic vriability for yield and its components in potato breeding materials. Indian Journal of Agricultural Sciences, 54:941-942.

Chaudhary, S.K., 1985, Variability for some quantitative characters in potato. Crop Improvement, 12: 179-199.

Dayal T.R.M.D.Upallhya,V.P.,Malhotra and Mehra, K.L., 1984. Heritability and correlation in yield and other quantitative characters in potato (*Solanum tuberosum* L.). Indian J. Agric. Sci., 42(6): 464-466.

Desai, N.C. and Jaimini S.N., 1997, Genetic variability, heritability and genetic advance for yield in potato. Indian Journal of Potato Association, 24:52-58.

Dewey,D.R and K.H. Lu. 1959. A correlation and path-coefficient analysis of components crested wheat grass seed production. Agron. J., 51: 515-518.

Haydar, A., 2007. Genotype- Environment Interaction in potato (*Solanum tuberosum* L.). M.Phil. Thesis. Department of Botany. University of Rajshahi, Bangladesh.

Hossain, M.A., Hasan, M.K., Naher, Q., 2008. Assessment of technical efficiency of potato producers in some selected areas of Bangladesh. J. Argil. Rural Dev. 6 (1& 2): 113-118.

Johnson,H.W., Pobinson, H.F. and Comstock, R.E., 1955, Estimat of genotypic and environmental variances in soybean. Agronomy Journal, 47:477-483.

Mondal. M.A.A., 2003. Improvement of Potato *(Solanum tuberosum* L.) through hybridization and in vitro culture technique. Ph.D. Thesis, Rajshahi University, Rajshahi, Bangladesh

Panse, V.G. and Sukhatme, P.V., 1967, *Statistical Methods for Agricultural Workers. Indian* Council of Agricultural Research, New Delhi

Regassa,D., and Basavaraj,N., *2005*, Genetic Variability Studies in Potato (*Solanum tuberosum* L.) Karnataka J. Agric. Sci., 18(1) :87-90.

Singh,R.K. and Choudhury, B.D., 1985. Biometrical methods in quantitative genetic analysis. Revised edn., Kalyani Publisheds. Ludhiana, India. pp. 39-80.