J. Sher-e-Bangla Agric. Univ., 3(2): 14-18, July 2009 ISSN 1997-6038

GENETIC VARIABILITY, CHARACTER ASSOCIATION AND PATH ANALYSIS OF YIELD COMPONENTS IN POTATO

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ABSTRACT

Thirty one genotypes of potato were evaluated in order to find out genetic variability, character association and path analysis of tuber yield and its component characters. All the genotypes showed highly significant variation for all the characters studied. High genotypic coefficient of variation (GCV) as well as phenotypic coefficient of variation (PCV) was observed for individual tuber weight/plant (ITW), tuber weight loss percentage at 150 days after harvest due to respiration (TWL), tuber weight/plant (TW), tuber number/plant (TN) and plant height at 50, 70 and 90 days after planting (PH50, PH70 and PH90 DAP). Heritability estimates were found high for PH, TW, TN, ITW and TWL. TW was found to be positively and significantly associated at genotypic as well as phenotypic levels with PH (50, 70 and 90 DAP), TN, ITW and TWL and also strong positive significant association among themselves. Path co-efficient analysis revealed that PH (50 and 70 DAP), number of stems/plant (NS), ITW and TWL have direct positive influence on TW.

Key words: Potato, variability, correlation and path co-efficient

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important crops of Bangladesh. Next to cereal, potato is the only crop, which substantially supplements the food requirement of the country. Yield is the result of interaction among several characters, which are greatly influenced by environmental factors. A study of correlation between quantitative characters provides us with an idea of selection for a better type in potato breeding programme. A few correlation studies pertaining to potato are available in literature (Birhman and Kaul, 1992; Pandita and Sidhu, 1980; Singh and Chaudhary, 1985; Mondal *et al.*, 2003 and 2004). However, knowledge of correlation is often misleading because when more variables are included in the study, the indirect association becomes more complex. In such a situation the path coefficient analysis provides an effective means of finding direct and indirect causes of association. Therefore, the study was undertaken with a view to estimate genetic variability, correlation and path coefficient of yield and yield contributing characters in potato.

MATERIALS AND METHODS

The seed tubers of the 31 potato genotypes were grown in the field following randomized block design with three replications at research field at the Institute of Biological Sciences, Rajshahi University during rabi season of 2001-2002. Individual plot size was 3m. x 3m. The line to line and tuber to tuber distance was 60 and 20 cm, respectively. Recommended doses of fertilizers were applied. Irrigation and other intercultural operations were done for raising good crops. Data were recorded for days to emergence (DE), plant height (PH) at 50, 70 and 90 days after planting, no. of stems/plant (NS), tuber numbers/plant (TN), tuber dry matter content (DM%), individual tuber weight/plant (ITW), tuber weight/plant (TW) and percent tuber weight loss at 150 days after harvest due to respiration (TWL). Data on different characters were analyzed statistically. Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were computed according to Burton (1952). The broad sense heritability (h^2b) and genetic advance as percentage of means (GA) were calculated as suggested by

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Johnson *et al.* (1955). Genotypic and phenotypic correlation coefficient were calculated according to Miller *et al.* (1958) and path coefficient analyses were performed according to method suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Genetic variability: The analyses of variance of different characters of 31 potato genotype were presented in Table 1.

Table 1. Analysis of variance for different characters in potato

Source of variation	df	Mean sum of square									
		DE	PH (50 DAP)	PH (70 DAP)	PH (90 DAP)	NS	TN	ITW	TW	DM (%)	TWL
Replication	3	0.77	5.85	14.82	20.50	0.32	16.41	25.98	114.98	0.32	4.77
Genotype	30	11.53**	206.33**	276.99**	275.17**	3.34**	138.41**	280.19**	20521.90**	19.08**	104.51**
Error	90	0.12	15.17	14.65	19.43	0.71	9.32	11.19	76.98	1.68	1.88

** indicates significant at 1% levels of probability

DE= Days to emergence, PH(50 DAP)= Plant height at 50 days after planting, PH(70 DAP)= Plant height at 70 days after planting, PH(90 DAP)= Plant height at 90 days after planting, NS= No. of stems/plant, TN= Tuber numbers/plant, ITW= Individual tuber weight/plant, TW= Tuber weight/plant, DM (%)= Tuber dry matter content, TWL = Tuber weight loss due to respiration.

All the genotypes showed highly significant differences for all characters studied suggesting considerable genetic variation among the genotypes and indicating the possibility for further improvement. About similar results were also reported by Mondal *et al.* (2003), Padita and Sidhu (1981) and Desai and Jaimini (1998). The estimated δ^2g, δ^2p, GCV, PCV, h^2b, and GA as percentage of mean are presented in Table 2. It was observed that the genotypic variance followed the same trend of phenotypic variance for all the characters indicating that phenotypic variability might be considered as a reliable measure of genetic variability. The lower value of environmental variance than genotypic and phenotypic variance for all the characters except NS indicated that the environmental influences were negligible for the expression of these characters. High GCV as well as PCV was observed for ITW, TWL, TW, TN and PH (50, 70 and 90 DAP) in all the analyses. These results suggest that the greater variability for these characters among the varieties was due to genetic causes which are less affected by environment and hence could be improved through selection.

Table 2. Estimates of genetic parameters for yield and yield contributing characters in potato

Characters	Genetic parameters					
	δ^2g	δ^2p	GCV	PCV	H^2b	GA (%)
DE	2.68	3.49	15.49	17.69	0.88	27.96
PH (50 DAP)	47.79	62.96	24.13	27.70	0.87	43.31
PH (70 DAP)	65.59	80.34	19.34	21.41	0.90	36.01
PH (90 DAP)	63.93	83.36	15.56	17.77	0.87	26.06
NS	0.65	1.36	15.26	21.98	0.69	21.64
TN	32.27	41.58	30.92	35.10	0.88	56.12
DM (%)	4.35	6.02	9.65	11.36	0.85	16.89
ITW	67.25	78.44	60.61	65.46	0.93	115.53
TWL	25.66	27.54	34.43	35.67	0.97	68.46
TW	5111.23	5188.20	33.00	33.25	0.99	67.48

δ^2g = genotypic variance, δ^2p = phenotypic variance, GCV = genotypic co-efficient of variation, PCV = phenotypic co-efficient of variation, h^2b = the broad sense heritability, GA(%) = genetic advance as percentage of mean

High GCV and PCV for TN, ITW and TW was also observed by Chaudhary (1985), Chaudhary and Sharma (1984), Garg and Bhutani (1991), Pandita and Sidhu (1981), Pandita *et al.* (1980) and Desai and Jaimini (1997). However they also observed moderate GCV and PCV for plant height and tuber day matter content Heritability estimates in broad sense were relatively high for almost all the characters studied. High heritability estimates have found to be helpful in making selection of superior genotypes on the basis of phenotypic performance. In the present study high heritability estimates for PH (70 DAP), TW, TN, ITW and TWL were indicated high to moderate genetic advance as percentage of mean. It suggested that these characters are more influenced by the environment. So, the improvement of the genotypes could be practiced following simple selection method. The findings reported by Desai and Jaimini (1997), Chaudhary (1985), Pandita and Sidhu (1981) and Metin (1985) were also in agreement with the present results. High heritability does not necessarily mean that the character will show high genetic advance. However, whenever this association exists, it is important for the breeding point of view. High heritability but low genetic advance (% of mean) for DM (%) in the present study suggested that there is less scope for farther improvement by selection for this trait. Similar results have also been reported by Desai and Jaimini (1997).

Correlation Co-efficient: The correlation co-efficient between TW and its component characters and among various components themselves were estimated at genotypic and phenotypic levels (Table 3). It was revealed that in most of the cases, the values of genotypic correlation co-efficient were higher than the corresponding phenotypic correlation co-efficients indicating less environmental effect. Lower phenotypic correlation coefficients than genotypic correlation coefficients indicate that both environmental and genotypic correlations in those cases act in same direction and finally maximize their expression at phenotypic level.

Table 3. Genotypic and phenotypic correlation co-effecient among different pairs of characters in potato

		DE	PH (50 DAP)	PH (70 DAP)	PH (90 DAP)	NS	TN	DM (%)	ITW	TWL	TW
DE	g	1.000	-0.108	-0.164	-0.140	-0.155	-0.266**	0.898**	0.026	-0.853**	-0.260**
	p	1.000	-0.074	-0.079	-0.065	-0.068	-0.138	0.453**	-0.007	-0.470**	-0.153
PH (50 DAP)	g		1.000	0.842**	0.898**	0.389**	-0.009	-0.008*	0.212*	0.110	0.275**
	p		1.000	0.801**	0.809**	0.237**	0.016	-0.133	0.165	0.076	0.230**
PH (70 DAP)	g			1.000	0.972**	0.391**	0.054	-0.155	0.143	0.097	0.269**
	p			1.000	0.917**	0.232**	0.066	-0.172	0.110	0.090	0.227*
PH (90 DAP)	g				1.000	0.396**	0.055	-0.157	0.144	0.098	0.331**
	p				1.000	0.228**	0.064	-0.169	0.108	0.089	0.283**
NS	g					1.000	0.430**	-0.103	-0.236**	0.009	0.207*
	p					1.000	0.269**	-0.055	-0.168	-0.007	0.141
TN	g						1.000	-0.358**	-0.561**	0.330**	0.331**
	p						1.000	-0.264**	-0.566**	0.256**	0.282**
DM (%)	g							1.000	-0.133	-0.977**	-0.465**
	p							1.000	-0.098	-0.782**	-0.391**
ITW	g								1.000	0.255**	0.580**
	p								1.000	0.245**	0.547**
TWL	g									1.000	0.579**
	p									1.000	0.245**

* & ** indicates significant at 5% and 1% level of probability, respectively.

Among different characters studied, TW was found to be positively and significantly associated at genotypic as well as phenotypic levels with PH (50, 70 and 90 DAP), TN, ITW and TWL. Strong positive significant associations were also observed among themselves. However, TW showed positive significant association with NS at genotypic level only. As yield is the ultimate gole, the positive association of these characters would help for selecting best individual. Similar results have also been reported by Desai and Jaimini (1998), Pandita and Sidhu (1980) and Garg and Bhutani (1991). However, DM (%) was significantly and negatively associated with TW both at genotypic and phenotypic level. Negative association of DM (%) with PH (50 DAP), TN, TWL; ITW with NS, TN; TWL with DE observed in the study was in agreement with the previous findings of Gaur *et al.* (1978), Pandita and Sidhu (1980), and Singh *et al.* (1979).

Significant positive association of NS with TN both at genotypic and phenotypic level suggested that the selection for higher TN might be done by selecting for higher NS. Desai and Jaimini (1998), Singh and Singh (1987) and Mishra and Gautam (1989) have also reported a positive correlation between the numbers of stems with number of tubers.

Path Coefficient: Path coefficient analyses at genotypic level were estimated (Table 4). At genotypic level the direct effect revealed that the characters PH (50 and 70 DAP), NS, ITW and TWL having positive correlation with TW also had direct positive influence on TW, suggesting thereby good scope for improvement of TW by selecting tall plant type in combination with higher NS and higher ITW. These findings are in agreement with previous reports of Mondal *et al.* (2004), Desai and Jaimini (1998), Pandita and Sidhu (1980) and Verma and Jha (1990). They also noticed a high positive direct effect of number of tubers and dry matter content on tuber yield and advocated for giving more importance of these characters during selection to get improvement in tuber yield. DM (%), having the highest negative direct effect on TW, showed the high positive indirect effect through DE, NS, ITW and TWL. In such a situation indirect factors are to be considered simultaneously for selection. Path coefficient values based on phenotypic correlation revealed that DE, PH at 90 DAP, NS, TN and TWL had direct positive effect towards TW also having positive correlation with TW. Therefore, proper attention should be given to the above characters for the improvement of tuber yield.

Table 4. Path co-efficient analysis of genotypic correlation showing direct and indirect effect of yield contributing characters on yield in potato

	DE	PH (50 DAP)	PH (70 DAP)	PH (90 DAP)	NS	TN	ITW	DM (%)	TWL	r_g with yield
DE	**-0.4035**	-0.2926	-0.0776	0.2896	-0.0918	0.0959	-0.0304	9.4716	-9.2212	-0.2600
PH (50 DAP)	0.0436	**2.7090**	0.3986	-1.8573	0.2306	0.0032	-0.2480	-2.1939	1.1891	0.2750
PH (70 DAP)	0.0662	2.2810	**0.4734**	-2.0103	0.2318	-0.0195	-0.1673	-1.6349	1.0486	0.2690
PH (90 DAP)	0.0565	2.4327	0.4602	**-2.0682**	0.2347	-0.0198	-0.1685	-1.6560	1.0594	0.3310
NS	0.0625	1.0538	0.1851	-0.8190	**0.5927**	-0.1551	0.2761	1.0864	0.0973	0.2070
TN	0.1073	-0.0244	0.0256	-0.1138	0.2549	**-0.3606**	0.6559	-3.7781	3.5642	0.3310
ITW	-0.3624	-0.5635	0.0734	0.3247	-0.0611	-0.1292	**0.1556**	10.5475	-9.5166	0.5800
DM (%)	0.3442	0.2980	0.0459	-0.2027	0.0053	-0.1189	-0.2983	**-10.3049**	10.6964	-0.4650
TWL	-0.5105	0.4243	0.0677	-1.2978	-0.9399	0.0482	-1.1698	-1.2002	**2.7566**	0.5790

Residual effect=-05175
Bold figure indicates direct effect

The result of the study indicated high heritability together with high to moderate GA as percentage mean for PH, TW, TN, ITW and TWL. Therefore, selection through the above characters would be effective for the improvement of potato. Correlation and path co-efficient analysis suggested that during selection more emphasis should be given on DE, PH, NS, TN, ITW and TWL, since these characters have high correlation and high direct effect on yield.

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