Estimation of genetic parameters and association of traits related to yield in potato (*Solanum tuberosum* L.)

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Potato (*Solanum tuberosum* L.) is an important calorie rich crop having potentiality to reduce food deficit for ever growing population in the world. It is a short duration crop for which it is superior to other cultivated crops with respect to per unit area as well as per unit time of production. Tuber yield is a complex character associated with many interrelated traits and progress of breeding for its improvement is mainly conditioned by the magnitude and nature of variability present in the population and association of the various component traits. Estimated values of GCV, PCV, heritability, genetic advance as percent of mean, correlation coefficient along with path analysis for the traits will predict the usefulness of the traits for perfect crop improvement with suitable breeding design. The present investigation was carried out to study the features which can be utilized to design a successful breeding programme for development of high yielding potato lines.

The study was carried out at agricultural farm of B.C.K.V, Adisaptogram, Hoogly. The experimental field was situated at $22^0 57'$N latitude, $88^0 20'$E longitude and 7.8m above mean sea level. The soil was sandy loam in texture with moderate fertility status. During experiment, minimum temperature ranged from 9^0C in month of January to 20^0C in month of March and maximum temperature similarly ranged from 24^0C to 35^0C. During growth period of potato the winter period was very short and mild with minimum amount of precipitation not exceeding than 2.25 mm. Five genotypes namely cv

Kufri Surya, Kufri-22, Kufri G-4, Kufri Khyati and Kufri Sadabahar which could be harvested early were considered and was planted on 2nd week of November, 2009 following randomized block design with four replications. Each genotype planted on 3 m long and 2.5 m wide plot consisting of five rows. Standard agronomic practices followed during land preparation and the growing season. The traits concerned with tuber yield potentiality like sprouting percentage (%), plant height at 30 days and 60 days (cm), number of branches, number of leaves, number of leaflets.leaf[1], number of interjected leaflets, number of marketable tubers and yield of tubers.plot[1] (kg) were considered in present investigation. Data for these traits other than sprouting percentage and number of marketable tubers and yield were recorded per plot basis were taken from five randomly selected plants from each plot. Genotypic and phenotypic variation, broad sense heritability, genetic advance as percent of mean, genotypic and phenotypic correlation coefficients were estimated using the formula suggested by Singh and Chaudhary (1979), Johnson *et al.* (1955), Al-jibouri *et al.*(1958) respectively. Path analysis was done according to the method suggested by Dewey and Lu (1959).

Significant varietal differences were observed for all the traits which predicted the presence of substantial amount of genetic variation which can be effectively utilized in breeding for potato improvement (Table-1). Per-se performance of the genotypes are presented in table-2.

Table 1: Analysis of variance of different genetic parameters in potato (Mean sum of squares)

Characters	Sources of variation with df in parenthesis		
	Replication 3	Treatment 4	Error 12
Sprouting (%)	2.6008	48.5688**	6.9331
Plant height at 30 DAP(cm)	6.8170	4.9450**	12.8583
Plant height at 60 DAP(cm)	6.6672	48.4712**	6.4165
Number of branches	0.0000	3.7000*	0.3333
Number of leaves	2.6000	18.0282**	1.1833
Number of leaflets leaf[1]	0.0667	4.88898**	0.9000
Number of interjected leaflets	4.2000	4.6142**	2.1167
Number of marketable tubers	1437.2688	8.4029**	671.2661
Yield of tubers plot[1] (kg)	2.5792	8.7249**	0.9236

*Note: No. of replications=4, No.of Genotypes=5, D.F. =Degrees of freedom, *, ** Significant at 5% and 1% level of significance, respectively.*

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Highest sprouting percentage was observed in Kufri G-4 and Kufri Khyati. Plant height at 30days was highest in Kufri G-4, Kufri Khyati and Kufri-22 and that at 60 days was found in Kufri Khyati followed by Kufri-22. Number of branches showed similar result as plant height at 60 days. Numbers of leaves were more or less similar in all the genotypes except Kufri Sadabahar. Wide variation was observed among the genotypes for number of leaflets per leaf where Kufri Khyati and Kufri Surya showed highest and lowest number respectively. Significantly least number of interjected leaflets was found in Kufri-22. Highest number of marketable tubers was observed in Kufri-22 followed by Kufri Khyati.

Table 2: *Per-se* performance of the potato genotypes

Genotypes	Characters							
	Sprouting (%)	Plant height (cm)		No. of branches	No. of leaves	Leaflets leaf[1]	No. of interjected leaflets	No. of marketable tubers plot[1]	Yield of tubers plot[1] (kg)
		30 DAP	60 DAP					
1.Kufri Surya	72.33	36.00	51.17	3.33	13.33	7.33	10.00	218.00	21.27
2.Kufri 22	86.67	38.33	62.17	3.67	17.33	6.33	7.67	290.33	19.30
3.Kufri G4	99.33	41.67	59.33	3.67	17.67	9.33	11.33	214.67	17.87
4.Kufri Khyati	96.67	40.00	78.17	4.00	20.67	8.67	7.00	240.33	21.57
5.KufriSadabahar	88.00	29.83	56.50	2.33	16.00	8.67	10.00	171.33	21.43
Mean	**88.60**	**37.17**	**61.467**	**3.40**	**17.00**	**8.07**	**9.20**	**226.93**	**20.29**

Yield of tubers was found highest in Kufri Sadabahar, Kufri Surya, Kufri Khyati followed by Kufri G-4 while Kufri-22 was the lowest yielder. The mean, range, coefficients of genotypic and phenotypic variation, heritability, genetic advance as percent of mean presented in table-3.

Table 3: Variability and genetic parameters for different characters of potato

Sl. No.	Traits	Mean	Range	LSD(0.05)	G.C.V.	P.C.V.	H[2]	G.A (%) of mean
1.	Germination (%)	88.60	72.33-99.33	4.96	11.83	12.21	0.94	23.64
2.	Plant height (30DAP) (cm)	37.17	29.83-41.67	6.75	11.06	14.68	0.57	17.18
3.	Plant height (60DAP) (cm)	61.47	51.17-78.17	4.77	16.39	16.90	0.94	32.75
4.	Number of branches	3.40	2.33-4.00	1.09	16.11	23.41	0.47	22.84
5.	Number of leaves	17.00	13.33-20.67	2.05	15.25	16.53	0.85	28.96
6.	Number of leaflets leaf[1]	8.07	6.33-9.33	1.79	13.39	17.82	0.56	20.72
7.	Number of interjected leaflets	9.20	7.00-11.33	2.74	17.36	23.48	0.55	26.43
8.	Number of marketable tubers plot[1]	222.93	171.33-290.33	48.78	17.94	21.26	0.71	31.17
9.	Yield of tubers plot[1] (kg)	20.29	17.867-21.567	1.81	7.60	8.96	0.72	13.29

Table 4: Genotypic (G) and phenotypic (P) correlation among potato yield and yield components

Characters		Plant height (cm)		No. of branches	No. of leaves	No. of leaflets leaf[1]	No. of interjected leaflets	No. of marketable tubers plot[1]	Yield of tubers plant[1] (kg)
		30 DAP	60 DAP						
Germination (%)	G	0.528*	0.669**	0.390	0.879**	0.753**	-0.050	-0.006	-0.470
	P	0.402	0.617*	0.256	0.806**	0.513*	-0.101	0.057	-0.385
Plant height (30DAP)	G		0.478	1.295	0.620*	0.157	-0.343	0.662**	-0.773**
	P		0.452	0.576	0.379	-0.002	0.049	0.512*	-0.370
Plant height (60DAP)	G			0.762**	0.975**	0.266	-0.857**	0.402	0.140
	P			0.400	0.896**	0.149	-0.596*	0.334	0.169
No. of branches	G				0.704**	-0.268	-0.686**	0.998**	-0.337
	P				0.373	0.044	-0.204	0.435	-0.347
No. of leaves	G					0.369	-0.560*	0.341	-0.119
	P					0.334	-0.582*	0.301	-0.105
No. of leaflets leaf[1]	G						0.594*	-0.876**	-0.136
	P						0.290	-0.449	-0.004
No. of interjected leaflets	G							-0.750**	-0.509*
	P							-0.537*	-0.271
No. of marketable tubers plot[1]	G								-0.439
	P								-0.126

*, ** *Significant at 5% and 1% level of significance, respectively.*

Higher magnitude of differences between PCV and GCV were found in the traits except sprouting percentage, plant height at 60 days and number of leaves which indicated substantial

environmental influence on the traits. Character with high GCV was found from plant height with low environmental influence indicating its high potentiality for effective selection (Burton, 1957). High heritability along with high genetic advance had been exhibited by plant height at 60 days followed by number of leaves and sprouting percentage suggesting additive genetic control on expression of these traits providing ample scope for direct selection on the basis of these traits for crop improvement. On the contrary, plant height at 30 days showed low heritability coupled with low genetic advance so, if plant height is

to be considered for selection, the height at later period of growth should be given due consideration. Similar observations were also reported for plant height and number of leaves by Sattar et al. (2007). Similarly, number of tubers was found to be important for direct selection and supported the observation made by Desai and Jamini (1997).Tuber yield had moderately high heritability with low genetic advance and may be controlled by both additive and non-additive gene action and indirect selection through population improvement may be advocated for its improvement.

Table 5: The pathway associations of different traits in potato

Characters	Germination (%)	Plant height (cm) 30 DAP	Plant height (cm) 60 DAP	No of branches	No of leaves	No of leaflets leaf^{-1}	No of interjected leaflets	No of marketable tubers plot^{-1}	Genotypic yield correlation
Germination (%)	-0.135	-0.130	1.483	-0.135	-2.088	0.509	0.027	-0.001	-0.470
Plant height (30DAP) (cm)	-0.071	-0.246	1.059	-0.450	-1.474	0.106	0.184	0.118	-0.773**
Plant height (60DAP) (cm)	-0.090	-0.117	2.216	-0.264	-2.315	0.180	0.461	0.072	0.140
No of branches	-0.053	-0.318	1.688	-0.347	-1.674	-0.181	0.369	0.178	-0.337
No of leaves	-0.119	-0.153	2.160	-0.245	-2.375	0.249	0.301	0.061	-0.119
No of Leaflets Leaf^{-1}	-0.102	-0.039	0.589	0.093	-0.877	0.676**	-0.320	-0.156	-0.136
No of interjected leaflets	0.007	0.084	-1.898	0.238	1.33	0.402	-0.538*	-0.134	-0.509*
No of marketable tubers plot^{-1}	0.001	-0.163	0.891	-0.346	-0.811	-0.592	0.403	0.178	-0.439

Note: Residual effect=0.2614, *, ** Significant at 5% and 1% level of significance, respectively.

All the traits failed to show positive association with yield but plant height at 60 days showed maximum direct effect on yield with positive correlation coefficients both at phenotypic and genotypic levels (Table 4 and 5). So, restricted selection may be advised for yield improvement on the basis of plant height not before 60 days of growth along with the traits showing positive association with it like sprouting percentage, number of leaves and number of branches. Stronger positive correlation between tuber yield and plant height with its maximum direct effect was also found by Burham (2007) and Mousang et al. (2010). Maximum negative direct effect with significant negative association with yield was observed for number of interjected leaflets, as a result of which selection for least number of interjected leaflets should be emphasized to increase tuber yield and Kufri-22 may be utilized for effective reduction of number of lateral leaflets.

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