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Genetic Variability, Character Association and Path Coefficient Analysis of Yield Attributes for Medium and Late Maturing Potato Cultivars

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A B S T R A C T

The present study emphasized on determination of the nature and magnitude of variability, heritability and genetic advance on yield and yield attributing characters in 19 potato genotypes harvested on different date. The estimation of correlation co-efficient among the characters along with their direct and indirect effect on yield is necessary to carry out proper selection on the basis of the traits. Wide ranges of variation have been observed for all the traits both in early and late harvesting situation. High heritability was observed by dry matter %, total tuber yield and marketable tuber yield for both the days of harvesting. Significant positive correlations were observed between total tuber yield with germination%, non-marketable tuber yield and marketable tuber yield both at genotypic and phenotypic level at both 75 Days after planting and 90 days after planting. Most of the characters showed significant correlation among themselves in late harvest in compare to early. Genotypes like MS/1-4353, K. Pushkar, K. Surya, Chipsona-1, K. Bahar and K. Pukhraj are very promising tuber yielder.

Introduction

Potato is an excellent low fat source of carbohydrates with one-fourth the calories of bread. When boiled it provides more protein than maize with nearly twice the calcium. Potato of an average size with skin provides about 10 percent of the recommended daily intake of fibre. Breeders should take the challenge to provide food at cheaper rate to the millions of hungry people in developing countries by increasing the production of potato per unit area and per unit time. To initiate any breeding programme to this direction, presence of enough genetic variability in the population for yield related traits should be considered as pre requisite element. Moreover, application of perfect breeding method is dependent on estimation of genetic gain of the characters for successful selection as to develop desirable traits suggested (Johnson *et al.*, 1955). The estimation of correlation co-efficient among the characters is necessary to carry out proper selection on the basis of simultaneous selection of correlated characters. The effect of harvesting at different dates on tuber yield on different genotypes can identify high

yielding varieties which can be harvested even earlier with satisfactory yield so that farmer get benefit by selling their produce at higher premium value in off-season and at the same time land will be free for next pre kharif crop. Therefore, the present study had emphasized the determination of the nature and magnitude of variability, heritability and genetic advance on different traits concerned with yield and effect of date of harvesting on yield and related traits.

Materials and Methods

The field experiment of the present study was carried out at the Block Seed Farm, Adisaptagram of Hooghly district in West Bengal, India. The experimental place was situated at 22.57^0 N latitude and 88.20^0 E longitudes with an elevation of 7.8 meters from mean sea level. The climate of this region is sub-tropical humid. And the entire year can be classified into three distinct seasons namely winter season, Summer season and Rainy Season. Occasionally late monsoon rain in the month of October causes some hazards to the planting of potato. The maximum and minimum temperature during the experiment ranged from 24.38 - 34.42 and 9.51 - 25.05 respectively. During the investigation period the maximum mean monthly temperature was 35.92 in the month of March and the minimum mean monthly temperature was 12.54 in the month of December. The daily mean temperature remained congenial to sustain crop growth and tuberization up to the middle of February and thereafter the temperature began to shoot up. Very low rainfall occurred during the investigation period. The monthly maximum and minimum relative humidity (RH) varied from 89.27 – 95.01 % and 40.13 – 70.11 % during the investigation period. The experiment was conducted in RBD Design with 19 genotypes in 3 replications.

The genotypes were harvested in two dates (75 days after planting and 90 days after planting). Cultivated variety K. Jyoti from farmer field taken as a local check variety for West Bengal condition because it's seems to be promising in West Bengal. For obtaining good harvest NPK was applied with a dose of 200: 150: 150 kg/ha respectively. Intercultural operations and plant protection measures were taken from time to time and as and when required. Germination was recorded after 30 days of planting. Plant height was measured from ground level to top of the highest branch at the time of 50 days of crop growth. Five plants were selected from each plot and each replication for recording plant height. Marketable yield, Non-marketable yield, Harvest index, Total tuber Yield, Number of leaves/Plant, Leaf Area Index, Equatorial diameter, Polar diameter, Dry matter content were recorded**.**

Results and Discussion

The mean, range, phenotypic, genotypic and environmental variances, coefficient of variation (CV), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (broad sense), genetic advance (GA) and genetic advance as percentage of mean (GA as % mean) of eleven characters from 19 genotypes which were harvested after 75 and 90 days after planting are presented in the (Tables 1 and 2).

Wide range of variation was observed for all the traits in early as well as late harvested genotypes. Total tuber yield, marketable tuber yield and non-marketable tuber yield showed satisfactory yield when harvested late. Randhawa and Kooner (1994) observed significantly higher yield when harvested late. There were significant differences in polar and equatorial diameter at 90 days of harvesting as compared to 75 days. Highest difference between PCV and GCV were

observed for non-marketable tuber yield in early and late harvested potato genotypes. High magnitude of difference between PCV and GCV implied environment effect pre dominantly acting upon the expression of phenotypic behaviour of the character. High heritability was recorded in dry matter % followed by germination %, harvest index, total tuber yield and marketable tuber yield for both early and late harvested potato genotypes. Mishra *et al.,* (2006) observed high GCV, heritability and GA with respect to plant height, total tuber yield, marketable tuber yield and dry matter content. Kim *et al.,* (1993) observed more than 70 % heritability for dry matter content in tuber for early and late harvested potato. High heritability coupled with high genetic advance in total tuber yield and marketable tuber yield was found indicating the influence of additive gene effect on these characters. Pandey *et al.,* (2005) reported high GCV and PCV for marketable tuber yield, average tuber yield and total tuber yield/plot. Low heritability along with low GA in leaf/plant at 50 DAP revealed the influenced of interactions of several genes with little prospect for their inclusion in potato improvement programme. Bhagowati *et al.,* (2002) observed low heritability for leaf/plant and tuber number.

List of genotypes used in the experiment

Sl. No.	Genotypes	Source of Materials
1	J/99-48	Central Potato Research Institute, Kufri, Shimla
2	J/99-242	Central Potato Research Institute, Kufri, Shimla
3	K. Ashoka	Central Potato Research Institute, Kufri, Shimla
4	K. Chandramukhi	Central Potato Research Institute, Kufri, Shimla
5	K. Khyati	Central Potato Research Institute, Kufri, Shimla
6	2001-P-26	Central Potato Research Institute, Kufri, Shimla
7	MS/1-4353	Central Potato Research Institute, Kufri, Shimla
8	MS/1-4906	Central Potato Research Institute, Kufri, Shimla
9	K. Pushkar	Central Potato Research Institute, Kufri, Shimla
10	K. Pukhraj	Central Potato Research Institute, Kufri, Shimla
11	K. Bahar	Central Potato Research Institute, Kufri, Shimla
12	K. Jyoti	AICRP on POTATO West Bengal Project,
13	Chipsona-1	Central Potato Research Institute, Kufri, Shimla
14	Chipsona-2	Central Potato Research Institute, Kufri, Shimla
15	Chipsona-3	Central Potato Research Institute, Kufri, Shimla
16	MP/98-71	Central Potato Research Institute, Kufri, Shimla
17	K. Surya	Central Potato Research Institute, Kufri, Shimla
18	K. Sindhuri	Central Potato Research Institute, Kufri, Shimla
19	Atlantic	Central Potato Research Institute, Kufri, Shimla

K. - Kufri; Local check- K. Jyoti*

Table.1 Variability and genetic parameters for different characters of potato genotypes harvested at 75 DAP

Character	Range	Mean	CD	Variance			GCV	PCV	h^2	GA
				GV	PV	EV				
Germination %	50.217-94.167	76.875	13.922	140.986	211.654	70.668	15.4456	18.9247	0.6661	25.9684
Leaves no. at 50 DAP	12.467-15.533	13.798	2.188	0.500	2.245	1.746	5.1229	10.8569	0.2225	4.9783
Plant Height at 50 DAP (cm.)	37.357-64.287	48.954	6.372	49.116	63.920	14.804	14.3160	16.3316	0.7684	25.8513
Leaf Area Index	0.187-0.337	0.226	0.054	0.001	0.002	0.001	12.4278	19.1045	0.4232	16.6540
Harvest Index	57.000-80.333	66.860	11.986	22.865	75.244	52.378	7.1520	12.9739	0.3039	8.1217
Polar Diameter(mm.)	39.767-67.217	53.242	7.966	45.521	68.656	23.135	12.6722	15.5628	0.6630	21.2561
Equatorial Diameter(mm.)	25.793-56.360	43.399	7.815	55.890	78.160	22.270	17.2262	20.3712	0.7151	30.0076
Dry Matter %	14.350-23.370	18.214	0.357	3.837	3.883	0.046	10.7545	10.8194	0.9880	22.0214
Non Marketable tuber Yield (in Kg.)	0.267-3.267	1.125	1.280	0.489	1.087	0.597	62.1441	92.6194	0.4502	85.8945
Marketable Tuber Yield (in Kg.)	11.400-25.667	18.652	2.473	14.521	16.751	2.230	20.4305	21.9431	0.8669	39.1855
Total Tuber Yield (in Kg.)	11.900-28.033	19.739	2.661	17.350	19.932	2.582	21.1022	22.6181	0.8704	40.5571

Coefficient of variation (CV), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (broad sense), genetic advance (GA), Genotypic variance(GV), Phenotypic variance (PV), Environmental Variance (EV), Days after planting (DAP), Critical difference (CD).

Table.2 Variability and genetic parameters for different characters of potato genotypes harvested at 90 DAP

Character	Range	Mean	CD	Variance			GCV	PCV	h^2	GA
				GV	PV	EV				
Germination %	43.967-97.330	73.553	9.965	250.720	286.926	36.206	21.5274	23.0294	0.8738	41.4542
Leaves no. at 50 DAP	12.200-15.933	13.593	2.499	0.129	2.406	2.277	2.6461	11.4113	0.0538	1.2640
Plant Height at 50 DAP(cm.)	33.650-66.890	47.418	8.260	49.604	74.479	24.875	14.8529	18.1999	0.6660	24.9701
Leaf Area Index	0.173-0.377	0.219	0.076	0.002	0.004	0.002	21.8122	30.2497	0.5199	32.4001
Harvest Index	60.333-89.333	71.947	5.657	70.287	81.955	11.669	11.6526	12.5827	0.8576	22.2299
Polar Diameter(mm.)	55.810-72.527	66.121	9.143	14.462	44.940	30.478	5.7515	10.1386	0.3218	6.7212
Equatorial Diameter(mm.)	48.957-67.797	57.222	9.633	9.911	43.741	33.830	5.5018	11.5579	0.2266	5.3950
Dry Matter %	15.520-23.900	19.580	0.385	5.654	5.708	0.054	12.1438	12.2017	0.9905	24.8975
Non Marketable tuber Yield (in Kg.)	0.100-3.267	1.168	1.621	0.338	1.269	0.958	49.7659	97.4248	0.2609	52.3676
Marketable Tuber Yield (in Kg.)	14.467-27.333	21.889	3.177	19.467	23.146	3.679	20.1565	21.9789	0.8410	38.0795
Total Tuber Yield (in Kg.)	14.833-32.867	23.054	3.206	22.005	25.753	3.748	20.3474	22.0120	0.8545	38.7459

Coefficient of variation (CV), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (broad sense), genetic advance (GA), Genotypic variance(GV), Phenotypic variance (PV), Environmental Variance (EV), Days after planting (DAP), Critical difference (CD).

Table.3 Genotypic (G) and phenotypic (P) correlation among different yield attributing characters in Potato genotypes harvested at 75 DAP

Characters		Germination %	Leaves no. at 50 DAP	Plant Height at 50 DAP	Leaf Area Index	Harvest Index	Polar Diameter	Equatorial Diameter	Dry matter %	Non Marketable tuber Yield	Marketable Tuber yield	Total Tuber yield
Germination %	G	1.000	-0.522**	0.225	-0.245	-0.166	0.081	0.102	0.163	0.566**	0.544**	0.583**
	P	1.000	-0.220	0.157	-0.126	-0.085	-0.019	-0.014	0.158	0.372	0.498*	0.534**
Leaves no. at 50 DAP	G		1.000	0.378	-0.612**	-0.170	-0.049	-0.143	0.458*	-0.457*	0.118	0.041
	P		1.000	0.082	-0.063	0.103	-0.045	-0.091	0.204	-0.029	-0.010	-0.011
Plant Height at 50 DAP	G			1.000	0.181	0.026	-0.199	-0.026	0.341	-0.023	0.405	0.366
	P			1.000	0.092	-0.009	-0.111	-0.078	0.287	-0.077	0.358	0.312
Leaf Area Index	G				1.000	0.003	0.171	0.066	-0.074	-0.355	-0.181	-0.218
	P				1.000	-0.193	0.145	0.116	-0.068	-0.068	-0.171	-0.176
Harvest Index	G					1.000	-0.204	-0.227	-0.055	-0.178	0.351	0.287
	P					1.000	-0.103	-0.182	-0.035	0.010	0.195	0.179
Polar Diameter	G						1.000	0.901**	-0.235	0.333	0.065	0.109
	P						1.000	0.654**	-0.205	0.127	0.062	0.085
Equatorial Diameter	G							1.000	-0.048	0.204	0.092	0.114
	P							1.000	-0.056	0.059	0.037	0.046
Dry matter %	G								1.000	0.013	0.270	0.243
	P								1.000	0.007	0.263	0.237
Non Marketable tuber yield	G									1.000	0.485*	0.589**
	P									1.000	0.290	0.472*
Marketable Tuber yield	G										1.000	0.992**
	P										1.000	0.980**
Total Tuber yield	G											1.000
	P											1.000

*, **= Significant at 5% and 1% levels respectively

Table.4 Genotypic (G) and phenotypic (P) correlation among different yield attributing characters in Potato genotypes harvested at 90DAP

Characters		Germination %	Leaves no. at 50 DAP	Plant Height at 50 DAP	Leaf Area Index	Harvest Index	Polar Diameter	Equatorial Diameter	Dry matter %	Non Marketable tuber Yield	Marketable Tuber yield	Total Tuber yield
Germination %	G	1.000	-0.732**	0.463*	0.142	-0.272	-0.039	0.222	-0.264	0.948**	0.360	0.456*
	P	1.000	-0.098	0.397	0.120	-0.224	-0.041	0.188	-0.252	0.457*	0.353	0.438
Leaves no. at 50 DAP	G		1.000	0.298	-1.231**	0.013	-0.641**	-2.264**	0.829**	-2.290**	0.105	-0.190
	P		1.000	0.010	-0.269	0.087	-0.074	-0.244	0.203	-0.258	0.139	0.073
Plant Height at 50 DAP	G			1.000	0.053	-0.518**	0.284	0.327	-0.062	0.271	0.269	0.286
	P			1.000	0.109	-0.443	0.050	0.116	-0.049	0.130	0.253	0.269
Leaf Area Index	G				1.000	-0.352	0.034	1.060**	-0.654**	0.724**	-0.411	-0.297
	P				1.000	-0.263	0.012	0.268	-0.489*	0.370	-0.261	-0.163
Harvest Index	G					1.000	-0.058	-0.501*	0.266	0.004	0.315	0.296
	P					1.000	0.005	-0.149	0.236	-0.019	0.309	0.289
Polar Diameter	G						1.000	0.518**	-0.040	0.588**	0.184	0.247
	P						1.000	0.408	-0.034	-0.184	0.074	0.029
Equatorial Diameter	G							1.000	-0.672**	0.939**	-0.393	-0.253
	P							1.000	-0.347	0.013	-0.094	-0.085
Dry matter %	G								1.000	-0.399	0.397	0.324
	P								1.000	-0.183	0.358	0.298
Non Marketable tuber Yield	G									1.000	0.428	0.527**
	P									1.000	0.120	0.339
Marketable Tuber yield	G										1.000	0.994**
	P										1.000	0.975**
Total Tuber yield	G											1.000
	P											1.000

*, **= Significant at 5% and 1% levels respectively

Table.5 Path coefficient analysis for potato genotypes harvested at 75 DAP

Characters	Germination %	Leaves no. at 50 DAP	Plant Height at 50 DAP	Leaf Area Index	Harvest Index	Polar Diameter	Equatorial Diameter	Dry matter %	Non Marketable tuber Yield	Marketable Tuber yield	Genotypic yield correlation
Germination %	**-0.00183**	-0.00219	-0.00317	-0.00187	0.00375	-0.00153	0.00105	-0.00246	0.07693	0.51452	0.583**
Leaves no. at 50 DAP	0.00096	**0.00420**	-0.00532	-0.00468	0.00384	0.00092	-0.00147	-0.00692	-0.06220	0.11158	0.041
Plant Height at 50 DAP	-0.00041	0.00159	**-0.01407**	0.00139	-0.00060	0.00375	-0.00027	-0.00516	-0.00318	0.38267	0.366
Leaf Area Index	0.00045	-0.00257	-0.00255	**0.00764**	-0.00007	-0.00323	0.00068	0.00113	-0.04834	-0.17133	-0.218
Harvest Index	0.00030	-0.00071	-0.00037	0.00003	**-0.02259**	0.00385	-0.00233	0.00083	-0.02423	0.33185	0.287
Polar Diameter	-0.00015	-0.00021	0.00280	0.00131	0.00461	**-0.01883**	0.00928	0.00355	0.04522	0.06110	0.109
Equatorial Diameter	-0.00019	-0.00060	0.00037	0.00050	0.00512	-0.01696	**0.01029**	0.00072	0.02779	0.08692	0.114
Dry matter %	-0.00030	0.00192	-0.00480	-0.00057	0.00125	0.00443	-0.00049	**-0.01511**	0.00173	0.25513	0.243
Non Marketable tuber Yield	-0.00104	-0.00192	0.00033	-0.00272	0.00402	-0.00626	0.00210	-0.00019	**0.13598**	0.45868	0.589**
Marketable Tuber yield	-0.00100	0.00049	-0.00569	-0.00138	-0.00792	-0.00122	0.00095	-0.00408	0.06593	**0.94594**	0.992

Residual Effect = 0.6802012, *, **= Significant at 5% and 1% levels respectively

Table.6 Path coefficient analysis for potato genotypes harvested at 90 DAP

Characters	Germination %	Leaves no. at 50 DAP	Plant Height at 50 DAP	Leaf Area Index	Harvest Index	Polar Diameter	Equatorial Diameter	Dry matter %	Non Marketable tuber Yield	Marketable Tuber yield	Genotypic yield correlation
Germination %	**-0.00300**	0.00048	-0.00086	-0.00081	0.00073	0.00002	0.00082	0.00016	0.11945	0.33918	0.456*
Leaves no. at 50 DAP	0.00220	**-0.00065**	-0.00056	0.00698	-0.00003	0.00040	-0.00835	-0.00051	-0.28845	0.09887	-0.190
Plant Height at 50 DAP	-0.00139	-0.00019	**-0.00187**	-0.00030	0.00139	-0.00018	0.00121	0.00004	0.03420	0.25353	0.286
Leaf Area Index	-0.00043	0.00080	-0.00010	**-0.00567**	0.00095	-0.00019	0.00391	0.00040	0.09117	-0.38747	-0.297
Harvest Index	0.00082	-0.00001	0.00097	0.00200	**-0.00269**	0.00004	-0.00185	-0.00016	0.00057	0.29621	0.296
Polar Diameter	0.00012	0.00042	-0.00053	-0.00172	0.00016	**-0.00062**	0.00191	0.00002	0.07403	0.17330	0.247
Equatorial Diameter	-0.00067	0.00148	-0.00061	-0.00601	0.00135	-0.00032	**0.00369**	0.00041	0.11835	-0.37026	-0.253
Dry matter %	0.00079	-0.00054	0.00012	0.00371	-0.00072	0.00003	-0.00248	**-0.00061**	-0.05021	0.37365	0.324
Non Marketable tuber Yield	-0.00285	0.00149	-0.00051	-0.00410	-0.00001	-0.00036	0.00346	0.00024	**0.12599**	0.40320	0.527**
Marketable Tuber yield	-0.00108	-0.00007	-0.00050	0.00233	-0.00085	-0.00011	-0.00145	-0.00024	0.05394	**0.94176**	0.994**

Residual Effect = 0.692551, *, **= Significant at 5% and 1% levels respectively

Total tuber yield at early harvest showed significant positive correlation with germination %, marketable tuber yield and non-marketable tuber yield both at genotypic and phenotypic levels (Table 3). Similarly germination also showed significant positive association with marketable as well as non-marketable tuber yield. Polar and equatorial diameter of tubers showed significant positive associations among themselves at phenotypic as well as genotypic levels. Dry matter % showed significant positive association with leaves/plant at 50 DAP. Total tuber yield at late harvested potato (Table 4) showed positive and significant correlation with marketable tuber yield at both phenotypic as well as at genotypic levels. Birhman and Kaul (1989) showed high correlation with total tuber yield and marketable tuber yield. Similarly total tuber yield exhibited significant positive association with germination percentage and non-marketable tuber yield when harvested late. Leaf area index showed negative though not significant association with non-marketable tuber yield in early harvested potato. On the contrary it showed significant positive association at genotypic level when harvested late. Geamanu and Birnaure (1989) showed positive correlation between non marketable tuber yield and leaf area index.

At early harvest (Table 5) highest direct effect on total tuber yield was exerted by total marketable tuber yield followed by non-marketable tuber yield. Roy and Singh (2006) observed plant height, no. of tubers/plant and marketable yield to exert positive direct effect on total yield. Direct effects of other traits were found to be negligible. Germination percentage showed negative direct effect on total tuber yield contributed mainly via indirect effect of marketable tuber yield although strong positive association was observed between total tuber yield and germination percentage. Kim *et al.,* (1993) showed different pattern of direct and indirect effect of characters due to change of date of harvesting. For late harvested genotypes (Table 6) highest direct effect on total tuber yield was exerted by total marketable yield followed by non-marketable tuber yield. Pandey *et al.,* (2005) observed positive direct effect of marketable tuber yield and tuber/plant with total tuber yield. Strong positive association was shown between total tuber yield and germination percentage and it‘s influenced on the trait was mainly influenced by indirect effect via marketable tuber yield.

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